THE
JOURNAL OF MICROSCOPY
AND
NATURAL SCIENCE:
THE JOURNAL OF
THE POSTAL MICROSCOPICAL SOCIETY.

EDITED BY

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Honorary Secretary of the Postal Microscopical Society.

ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

VOL. IV.

London:
BAILLIÈRE, TINDALL, & COX, KING WILLIAM ST.,
STRAND, W.C.

Bath:
1, CAMBRIDGE PLACE.

1885.

Preface.

THE second title of our Journal, THE JOURNAL OF NATURAL SCIENCE, has given to it an extended scope, of which we have availed ourselves, and by so doing we think that the interest in the Journal has been much increased. It is not easy in so many good papers to specify any particular one, but we would direct attention to "The Rambles of a Naturalist," by Miss Charlesworth; "What is a Plant?" and "How Plants Grow," by Mr. H. W. S. Worsley-Benison. Papers like these could not have found a place in this Journal had it been confined to Microscopy alone. While the paper on "The Microscope and how to use it," by Miss Latham, still maintains a claim to its first title. This last, we may observe, is the commencement of a series of papers from the same pen, which we hope to continue.

Another special feature introduced in the present volume has been the more extended Reviews of New Books relating to every branch of Natural Science. In writing these notices, which have in most cases been undertaken by specialists in the various departments of science, our object has been not so much to give a *critical* review of each book, as to place before our readers as briefly as possible such a description of the work under notice as will at once enable them to decide whether it is worth their purchase. These notices, although voluminous, have not taken up space usually devoted to other matters, for in addition to using much smaller type, a number of extra pages have been added to each part. It is our intention in future to name, where possible, the price of each book.

We think it better that the Reports of the Annual Meetings of the Postal Microscopical Society should not in future be included in the Journal, but be printed separately, and issued to members only as a supplement.

We have also a very important announcement to make—namely, that on January 1st, 1886, will be commenced an additional Journal, to be called THE SCIENTIFIC ENQUIRER. Its pages will be devoted to—

1.—Questions on all subjects relating to any branch of Natural Science.

2.—Answers to the same by Subscribers.

3.—Contributions on points of interest in any locality—*e.g.*, occurrences of certain plants and insects, and notes on observed habits, etc.

4.—Extracts from recent Foreign Journals.

5.—Letters to the Editor.

6.—Answers to Correspondents.

7.—An Exchange and a Sale Column.

In conclusion, we beg very heartily to thank our numerous contributors and subscribers for their assistance and support, and hope not only to deserve a continuance of this support, but that all will kindly exert their influence on behalf of THE SCIENTIFIC ENQUIRER, just noticed, which will appear simultaneously with the Journal on the 1st of January, 1886.

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THE POSTAL MICROSCOPICAL SOCIETY.

JANUARY, 1885.

Presidential Address.

Read before the Members at the Annual Meeting, held October 8th, 1884.

BY C. F. GEORGE, M.R.C.S., ETC.

IT is with much diffidence that I accept the honour you have done me, of electing me to the post of President of the "Postal Microscopical Society." Residing, as I do, far from all the centres of science—so isolated, that the meeting with a scientific friend is a delightful pleasure of rare occurrence, and my knowledge of the progress of science being almost entirely gleaned from periodicals and our own boxes and note-books, I must be considered eminently unfitted to fill such a post as President of this Society.

I have, however, been greatly reassured by the remarks of former presidents, which lead to the conclusion that the situation is by no means an arduous one, and that, with the exception of the annual address, it may be considered as "*Otium cum dignitate*," and, therefore, peculiarly adapted to myself. I am proud to say that I was one of the first group of members, and am sorry to find that only six of the number are left on the list. Death has robbed us of some; others have emigrated to distant lands, and these, we hope, will continue their researches, and perhaps lay the foundations of other microscopical societies; indeed, I have recently discovered that this has been actually the case, a former active member of this Society having been instrumental in forming a Postal Microscopical Society in New South Wales. I refer to Mr. Kyngdon, against whom I sat at the first of our dinners. The rest have left us for some reason or other best known to themselves.

Our numbers have varied somewhat, but the last list, I believe, contains the greatest number we have ever had, and although the prosperity of a society is not always shown by mere numbers, yet the sinews of war must be thus estimated—*i.e.*, if they all (as I have no doubt all our members do) pay up their subscriptions.

About four years after the formation of our Society (that is, in 1877), Mr. Tuffen West inaugurated the delivery of a presidential address, giving very good reasons why this should be an annual custom. Since that time, one has been prepared yearly, and now that I, in my turn, am called upon to do the same, I find the task one of considerable difficulty.

Our Society welcomes every user of the microscope, no matter whether he be simply a collector of choice slides prepared by others, or himself an adept at mounting; whether he uses the instrument for occasional amusement only, or dips deep into one single branch of microscopic study; whether he uses it as a tool in his business or profession, or as an instrument for general scientific purposes. In fact, whether he be an amateur or professional, he may be a useful member of our Society; we only require that he will do his best to impart what knowledge he possesses, and try to extract from the other members any information he may require for the benefit of all. It may be that we have members possessing time, opportunity, energy, and skill, and desiring to use them, who yet do no real work, simply because they have not yet found out the line of research suitable to them. A single word or hint may set the stone rolling, may produce the "tide, which, taken at the flood, leads on," if not "to fortune," at least to benefit to science in general, and to the "Postal Microscopical Society" in particular.

I desire, therefore, to bring before you this evening, as a theme, perhaps, not entirely unworthy of our annual address, my own particular microscopic hobby. Not that I thereby intend for one moment to depreciate other lines of research, or to check, hinder, or divert any of our members from that especial one which they have already adopted, but only to point out to those who have not as yet found out their particular groove, that there is a wide and easily divided field—one so much neglected as to call urgently for observers and recorders of readily ascertained facts; one that can be taken up and laid down at any time; one that requires only moderate skill in the use of the instrument we all possess; and one in which, interest having been once roused, will not readily be given up. I think many of you will agree with me, that living creatures, as a rule, create greater interest to ordinary microscopic observers, than any other objects, and for the best work in the line I am about to point out, the creatures should be seen and examined whilst alive. Those of you who have taken interest in the slides I have circulated for some years past, will know that I allude to MITES—British Mites. The first and greatest reason for the study of these interesting atoms is that so little is known, or at least recorded, about them in this country. The only general text-book that I know of in our language is that very excellent and cheap book (one of the South Kensington Museum Science Handbooks), "Economic Entomology," by the late Andrew Murray. This book, being a compilation, contains errors, many of which will doubtless be corrected in a second edition. There are, however, very excellent papers scattered in the various scientific periodicals, such as "The Microscopical Transactions," "The Journal of the Royal Microscopical Society," "The Linnæan Transactions," "The Journal of the Quekett Microscopical Club," and "Science Gossip"; and for all further information we must go abroad, and examine French, German, and even Italian and Russian publications. There is, however, a new manual, in English, on one of the families of mites—the

Oribatidæ (examples of which have been circulated in our boxes by Mr. Bostock and myself), the first volume only of which has as yet appeared. It is by my friend Mr. Michael, and is published by the "Ray Society." It is in all respects an admirable work, well illustrated, and is a model for all would-be workers on mites. The perusal of this book is a great treat in store for those who have not yet seen it. I have myself devoured it with pleasure, for it is a work such as one only meets with very occasionally.

But we ought to pay more attention to mites, because they are so common, occurring at times almost everywhere: any neglected corner, any stone not recently disturbed, under the bark of any rotten piece of wood, any neglected morsel of food prepared for man or animals, in our entomological cabinets, parasitic on insects of all kinds, birds, mammals, and not sparing man himself, living on his secretions, without causing him much or any annoyance, as in the case of *Acarus folliculorum*, or else producing that most troublesome and loathsome disease, known by the very characteristic name of "the itch." Then, again, their external anatomy is so varied and curious, that it necessarily claims much attention from the microscopist. The skin is sometimes smooth and very flexible, plain, or covered with markings like that of our fingers; at other times, it is formed of chitinous plates of various sizes and shapes like armour, and ornamented with markings of different kinds.

Their very hairs are extremely various, sometimes simple, long, or short; at other times serrate, like the teeth of a saw, or plumose, like a beautiful feather, sometimes knobbed, at others, flattened out into a scale, and these sometimes like a leaf, and in one case the hairs are like Japanese fans. Their differences so attracted the attention of Hermann a century ago, that he proposed their use in the classification of the *Trombididæ*.

The legs are also remarkable for variety in their structure; sometimes the first pair is scarcely used at all for progression, but act more like antennæ or feelers, in some mites being threadlike, and four or five times the length of the body, as in *Linapodes*; in other cases, they are remarkably short and stout, and armed with enormous claws, like sickles, as in *Disparipes bombi* and *Pygmephorus spinosus*. Sometimes it is the second pair that is so curiously enlarged and modified, as in certain of the *Gamasi.* Then, again, it may be the third pair, as in some of the *Dermaleichi*, notably the one (first described and figured by Hermann) found on the sparrow; and, finally, it may be the *last* pair of legs which is so remarkably different from the others. These modifications are generally found in the male, and are then of a sexual character.

The mouth-organs, also, are modified in a most marvellous manner; they are admirably adapted to the necessities of the creature, and furnish us with numerous and beautiful, as well as instructive objects. All these remarkable variations assist us to recognise and classify these wonderful creatures. Nor must we forget colour; for among the mites we have the most vivid and beautiful, as well as the most varied tints; various shades of red are the most frequent. But we have other striking and brilliant colours, such as blue, green, yellow, black, and white, especially in the *Hydrachnidæ*, and often have I wished for the skill of a West or a Hammond, that I might have recorded the beautiful colours and shades of those lovely creatures.

Although I have so slightly and concisely glanced at some of the characteristics of these living atoms, I hope you will allow that I have made out a case for a record of their more minute and accurate study, and I trust that at least some of our members will be so influenced as to take up the matter seriously, and enrich our note-books with accurate drawings, notes, and descriptions of the specimens they may meet with, so that at some time in the near future their collection may be of service to the microscopist in general, and the acarologist in particular.

In conclusion, I trust that every member of our Society will contribute to the success of the coming session, not only by circulating good slides, accompanied by appropriate notes, but by asking questions when in doubt, when wishing for information, or where anything might be better or more clearly explained; for the asking of questions may cause members to write valuable notes, who otherwise would take it for granted that everybody else was as well informed as themselves. Let us all show that we are in earnest, and the success of the session and the Society will be ensured.

A Piece of Hornwrack: Its Inhabitants and Guests.

By Arthur S. Pennington, F.L.S., F.R.M.S.

Plates 1 and 2.

JOHN ELLIS, the father of English Zoophytology, amongst the other features which characterise his work, was careful to give plain English names to the various objects described by him. It is well for us to know that there is such a genus as *Flustra*, and that it includes the species *Foliacea*, *Securifrons*, *Carbasea*, *Papyracea*, and *Barleei;* but to sit down on the sea-shore and chat with a fisherman or a little child about *Flustra foliacea* would not certainly be a very profitable task. Just as the Church of England graciously permits anyone to use her prayers privately in any language he understands, but enjoins the public use of a language "understanded of the people," so Ellis, whilst retaining for scientific men the generic and specific names known to them, carefully provided popular names for ordinary use. The aptness of these names we shall observe frequently in this paper.

Barren and forsaken indeed must be the coast upon which the ebbing tide does not leave some bunches of Hornwrack. Growing at varying depths in the sea in bunches of foliaceous expansions or narrow ribbon-like segments, the various species of Hornwrack, or Sea-mats as they are sometimes called, are ubiquitous. The five species before named are found in Britain. The first, *Flustra foliacea*, grows, as its name implies, in leaf-like expansions, and has each cell armed with two spines at each side of its upper half. *F. securifrons* is divided into narrow ribbon-like segments, and has its cells oblong and without spines. *F. papyracea* grows in small glistening tufts. All these species have cells on both sides of the fronds. *F. carbasea* has large somewhat oval cells without spines and growing in a single layer. The remaining species, *F. Barleei*, has only been found in Shetland.

It is however of the first species, *F. foliacea*, or "the Broad Leaved Hornwrack," that I propose to write at present. Taking it into the hand, it appears like brownish sandpaper, but placed under the microscope the roughness of its surface is seen to be caused by innumerable cells ranged semi-alternately, and each shaped, as Mr. Gosse not unaptly suggests, like a child's cradle, narrow and straight for the lower half, and bulging out into a semicircle in the upper half, with a couple of blunt spines on each side of the upper margin, and often a single one in the centre. A reference to Plate I., Fig. 2, will show the appearance of the cells under the microscope.

The Rev. P. H. Gosse in "Tenby" * has published a calculation showing the number of cells in a square inch of the *Flustra*. He reckoned these to be as many as 6,720, and as there are, in many specimens, at least 5 square inches on each side, it follows that the cells number not less than 67,200. The inhabitants of these cells exhibit the characteristic polyzoan structure. From the orifice of each cell when alive a bell of tentacles may be seen protruding, in the centre of which is the mouth leading into an œsophagus, and thence to a stomach and intestine. The latter opens outside the bell. Attached to the œsophagus on one side is a small nervous ganglion. The polypide is connected with the base and sides of the cell by a structure known as the *funiculus*, which passes through the base of the cell and serves not only as the usual source of origin of the reproductive organs, but also as the connecting link between the various members of the polyzoan colony. From the sides of the cell (which is called the *zoœcium*) to the stomach and tentacles extend a series of muscles serving to expand and retract the tentacles and their sheath, and to unfold and fold the body of the polypide The growth of a colony takes place by gemmation, but new colonies are formed by sexual reproduction.

The Polyzoa occupy a very undecided position in the scale of classification. They are considered by some as belonging to the VERMES, but by most English naturalists they are included among the MOLLUSCOIDA, a sub-division of the Mollusca. The

* "Tenby, a Sea-side Holiday," by Rev. P. H. Gosse, p. 196, where a most poetical but interesting and accurate description of this species is given.

marine Polyzoa are divided into two groups, the ECTOPROCTA, in which the orifice leading from the intestine is outside the tentacular bell, and the ENDOPROCTA, in which both the orifices of the alimentary canal are within the bell. About the latter of these groups I do not propose to say anything. The ECTOPROCTA are divided into three suborders, the CHEILOSTOMATA, CYCLOSTOMATA, and CTENOSTOMATA. In the first of these—to which the Flustra itself belongs—the orifice of the cell is protected by a moveable operculum or valve. In the second suborder the cells are tubular, and the orifice has no such moveable operculum, although Mr. Waters (Trans. Lin. Soc., Vol. XVII., *Zool.*, page 400) has pointed out that in all this group there is a calcareous partition which closes up the cells, in order probably to protect the tubes of the colony from being choked up with mud and dirt, on the death of the terminal polypides. To this suborder belong the *Crisiæ*, which I shall shortly describe. In the third suborder the polypides never form calcareous cells, and the cell-orifices are protected, not by opercula, but by fringes of *setæ* or bristles. An example of this class will be referred to later.

Such an expanse as that formed by the frond of the *Flustra* is a convenient locality for the founding of other colonies of Polyzoa, and accordingly we find several species growing here and there upon its segments in great luxuriance. First, we notice the "Creeping Coralline" or *Scrupocellaria reptans*, Plate I., Fig. 1 *(a)*, a species that rejoices in at least a dozen synonyms. In the catalogue of slides of a leading Microscopical Society this species occurs under three different names. *Reptans*, or creeping, has always been the favourite specific appellation, and is a very suitable one. The zoophyte creeps along the surface of stones, algæ and other zoophytes, and forms crowded patches. Under the microscope each cell is seen to be armed with four spines, and protected by an operculum, which has a distinct antler shape (Plate I., Fig. 3). When once this operculum is seen, no mistake can be made as to the species under consideration. Each cell is also armed with a long whip, called a *vibraculum*, which sweeps the cell clean, and no doubt wards off intruders. The cells are oval, and arranged in a double line side by side, but so that the orifices of the cells on one side are half way between those of the cells on the other side. This arrangement is called "alternate." The different species of the genus *Bugula*, which comprises the "bird's-head" zoophytes, are often found on the *Flustra*. On the present specimen we observe a bunch of *B. avicularia*, Plate I., Fig. 1 *(b)*. The *Bugulæ* may be easily distinguished by the "avicularia" or bird's-head processes attached to the sides of the zoœcia. These are modified cells, taking in this genus the form of birds' heads, with distinct beaks, which, during life, are in constant motion (see Plate I., Fig. 4). The object of these curious structures is not properly made out. In some cases they serve doubtless to catch passing prey, and hold it until the polypide is ready to devour it, or until, by the decay of some captured worm, crowds of *infusoria* are gathered in the neighbourhood, but this cannot be the universal purpose, as the appendage is fixed in some species so far from the orifice as to be useless as a food-holder. One thing is clear that they are modified forms of ordinary zoœcia. The Rev. Thomas Hincks has traced their development very fully from the zoœcium proper, through the various forms of fixed avicularia, to the free-moving, jointed, and elaborate appendages of the *Bugulæ*. The more common English species of the genus may be distinguished from each other as follows:—*B. plumosa* has an elongated cell, with a large orifice armed with a single spine; *B. turbinata* has an oblong cell, with a single spine at each of the upper angles; *B. avicularia* has two spines on the upper outer angle, and one on the inner angle; and *B. flabellata* has two spines (one much larger than the other) on each of the upper angles. The modes of growth are very varied. *Plumosa* grows in slender shoots; *Turbinata* in graceful spiral coils; *Avicularia* in small white tufts; and *Flabellata* in small but dense fan-shaped shoots, which are of a beautiful light brown colour in life, but after death change to a dull ashy tint. Amongst other species of Cheilostomatous polyzoa found on the Flustra are the "Bull's Horn Coralline," *Eucratea chelata* (Pl. II., Fig. 10), which has the cells shaped like a "bull's horn" or a shoe, and growing in single series; the "Creeping Stony Coralline," *Scrupocellaria scruposa*, which much resembles *S. reptans*, but has only two spines, and wants the antler-shaped operculum; and the "Ciliated Coralline," *Bicellaria ciliata*, whose soft white feathery tufts, with zoœcia protected by six or seven long spines, and distinct round ovicells, form beautiful microscopic objects, especially with a background of polarised light.

The CYCLOSTOMATA delight in the fronds of Flustra as habitats. Tufts of the "Ivory-tufted Zoophyte," *Crisia eburnia*, Plate I., Fig. 1 *(c)*; the "Goat's Horn Coralline," *C. cornuta*, Plate I., Fig. 5; and the "Black-jointed Coralline," *C. denticulata*, Plate II., Fig. 6, may be found often on one frond of Hornwrack. The *Crisiæ* are very beautiful zoophytes; *C. cornuta* is excedingly delicate, looking almost like white hairs tangled together, but under the lens appearing as "branches of single cells shaped like goats' horns inverted, placed one above the other, on the top of each of which is a small circular opening which inclines inwards. At the back of this rises a fine upright hair, near the insertion of the next cell above it."—*Ellis* (see Plate I., Fig. 5 *a.*). The brittle *C. eburnia*, or "Ivory-tufted zoophyte," is easily distinguishable by its brilliant white appearance, and no more beautiful object can be seen under the condenser than a tuft of this species. The cells are arranged in intervals with from three to nine cells in each, and are tubular and covered with minute granulations. The ovicels, which are often present, are pear-shaped and, like the zoœcia, are perfectly white, and spotted with minute dots (see Plate II., Fig. 7). In *C. denticulata* the internodes are longer, having a much larger number of cells, and the joints between the internodes are usually black. The last species is much duller in appearance than *C. eburnia*, grows more erect and to a greater height, and is more branched. I have recently found this species, as well as *C. cornuta*, crowding the margins of rock pools on Filey Brigg. We sometimes find (Plate I., Fig. 1, *d*) on *Flustra* a small round white wart-like polyzoon, with the base expanded slightly as a thin border. Under the lens this is found to be a colony of tubular cells, extending from the centre outwards in radiating lines. The cells are marked with minute dots. This is the "Wart-like Coralline" of Couch, or *Diastopora patina*.

Amongst the CTENOSTOMATA, *Bowerbankia imbricata* (Plate II., Fig. 8), is often found upon the Flustra. The cells are arranged in groups upon a creeping stolon, and are horny and so transparent that the structure of the polypide, and notably its prominent gizzard, may be distinctly seen. The polypide has ten ciliated tentacles, and is often figured as an illustration of polyzoan structure in works on natural history.

Before parting with our specimen of Flustra, we notice (see Plate I., Fig. 1 *e*) running along it a slender brown thread, apparently knotted here and there, and sending off short erect shoots. Occasionally a larger knot appears; this is not a polyzoon but a hydroid, *Sertularella rugosa*, or the "Snail-trefoil Coralline." Under the lens the apparent knots are seen to be the calycles or cells of the polyps, which are wrinkled and shaped like little barrels. The larger knots are the reproductive capsules which have three teeth at the upper end. Ellis gave this hydroid its popular name from the resemblance of its cells to the seed-vessels of the "Snail-trefoil" plant. It is a very common object on Flustra, but not less beautiful on that account (see Plate II., Fig. 9).

I have only named here a few of the many zoophytes (polyzoa and hydroids) which find a resting-place on the Broad-leaved Hornwrack, but, as this is usually deemed so common as not to be thought anything of, I considered it not inopportune to point out that not only is it in itself an object of great beauty, especially when freshly taken from the water and having its characteristic scent of verbena or bergamot, but that it is even of greater interest as the habitat of other interesting forms of zoophytes, which run the risk of being overlooked and neglected owing to the universal distribution of their host. The generic name of the Flustra is derived from the Anglo-Saxon *flustrian*, to weave; and the richest lawns or silks are not woven with greater delicacy than is manifested in the fronds of the various species. As Dr. Landsborough remarked in speaking of the genus, "He alone who gathered together the waters of the sea could teach these marine manufacturers to construct amidst its waves such elegant tabernacles."

EXPLANATION OF PLATES I. AND II.

Plate I.

Fig. 1.—Frond of *Flustra foliacea*, showing growing upon it (*a*) *Scrupocellaria reptans*, (*b*) *Bugula avicularia*, (*c*) *Crisia eburnia*, (*d*) *Diastopora patina*, (*e*) *Sertularella rugosa*.

Fig. 2.—Zoœcia of *F. foliacea* magnified.
,, 3.— ,, ,, *S. reptans* ,,
,, 4.— ,, ,, *B. avicularia* ,,
,, 5.—*Crisia cornuta* ; natural size, 5a ; Zoœcia magnified.

PLATE II.

,, 6.—*Crisia denticulata*, natural size
,, 7.—Zoœcia of *C. eburnia*, magnified.
,, 8.—*Bowerbankia imbricata*, natural size.
,, 9.—Calycles of *S. rugosa*, magnified.
,, 10.—Zoœcia of *E. chelata*, magnified.

All drawn by Mrs. A. S. Pennington.

Rambles of a Naturalist near Amberley.

By Miss A. M. Charlesworth.

IT is a real pleasure to me to recall the few happy weeks of my visit to Amberley, by describing the various flora and fauna found during my stay in the neighbourhood. The first rare flower that I found at Amberley was the *Anemone pulsatilla*. It is very locally distributed, growing only on limestone soils and in exposed places where the wind can blow freely round it. I think it by far the most beautiful of our spring flowers; its rich purple contrasts so well with the bright yellow of its stamens, and it is covered externally by long silky hairs. There is a legend that this flower only grows where Danish blood was spilt. From such names as "Woeful-Dane-bottom," one might certainly conclude that fierce battles may have been fought with the Danes in the neighbourhood of Minchinhampton. This anemone is called the "Pasque flower," as it is in bloom about Easter-tide. I will relate a curious little incident connected with it. I was talking to the owner of one of the most beautiful gardens near Amberley about the wild flowers I had found, and amongst

Hornwrack and its Inhabitants.

Hornwrack and its Inhabitants.

others I mentioned the Pasque flower. I was asked to describe it, and when I said the botanical name was *Anemone pulsatilla*, I was amused to find that our friend had written up to a well-known London florist for roots of this flower, and had received the reply that they had not got any, but would try to get some. And yet in sight of that garden was the slope of hill where I had gathered quite a bunch of the purple flowers. The plant blooms close to the ground, but later on the stem shoots up, and in summer the pretty winged seeds are lifted about a foot from the ground, ready for the wind to waft them away.

There grows where Danish blood was shed
   (So says the legend old),
A blossom, clad in purple vest,
   With heart of yellow gold.

It points us to the hidden tomb
   Where lie the warriors brave;
'Tis like the poet's sad, sweet song
   That blossoms on a grave.

The next flower found was the *Fritillaria meleagris*, and for this I went to some fields at Oaksey, not far from Cirencester. This is also very local, being quite unknown in some counties, though plentiful in others. At Oaksey there are fields so full of them that they have gained the name of the Oaksey gardens. The flower is a very curious one, checkered all over with small squares of a red-brown colour, reminding one somewhat of a chess-board. It is not unlike a tulip in shape, but hangs its head instead of holding it erect. *Fritillaria* comes from a Latin word meaning a dice-box, which I suppose it is thought to resemble. While gathering the flowers, rain came down in torrents, and we returned home drenched to the skin, but quite happy with our arms full of flowers. I may here say that, in asking our way to the field, we had to inquire where the "toad's heads" grew, this being the country name for them. As *Fritillarias* they would be quite unknown. They were formerly called "turkey hen," or "guinea flowers," and in many places are now called "snake's heads"—names all evidently given on account of the curious markings to which I have referred.

Hellebore fœtidus is another rare plant that I found for the first time at Amberley. It is nearly related to *Hellebore niger* (the Christmas rose of our gardens), and, like it, has its petals changed into little nectaries. If you look closely into either of these flowers, you will find that what at first sight appear to be petals, are only sepals, and that the true petals are like minute green pockets surrounding the stamens. These, with the stamens, soon fall off, leaving the carpels standing alone in the centre of the sepals. There is one other wild Hellebore, namely, *H. viridis*, but neither are truly indigenous, having been probably introduced into English gardens during the middle ages, when they were much used medicinally. It grows in a wood near Box, and is very plentiful on some waste ground to the left of Selsley Hill. Minchinhampton Common is remarkably rich in Orchidaceous plants. I was too early to find many in flower, but was pleased to see my favourite *Ophrys muscifera*. It is of a purple-brown hue, having on the lower part of the corolla (termed the labellum) a square patch of pale blue. Even the antennæ are represented by the upper petals, and anyone not knowing the flower would certainly take it to be an insect perched on the stalk. I have found it on the Surrey Hills with as many as eight or nine flowers open at different intervals up the stem, when it is a most curious sight. Nearly all flowers are dependent upon insects for the fertilisation of their seeds; whilst many are most curiously armed against the visits of creeping insects, for these would, if able to get at the flowers, in some cases eat them, and in others rob them of their pollen to no purpose. Those flowers, therefore, that only want to attract bees or other flying insects have their stems, leaves, and calyx covered by a palisade of hairs, sometimes placed with the points inclined out or down, so as to form a sort of "*chevaux-de-frise*," thus keeping off intruders, as we do by our fences and spiked palings. It is only under the microscope that some of these defences are revealed. The leaf of the garden Deutzia (*D. scabra*) is a remarkable instance. Here the leaves and stem are covered by the most beautiful little stellate crystals of silica, whose sharp points would doubtless incommode the pedestrian insect-tramps as much as broken glass would those of our own species.

Many people look upon the scents and colours of flowers as though they were intended solely for their pleasure, little thinking that honey, scent, colour, and even the delicate pencillings and quaint irregularities of some flowers, have all some special reference to their insect visitors. Now, orchids are among the cleverest, so to speak; in their strange contrivances for securing the safe conveyance of their pollen. Space will not allow me to speak of the many tropical orchids I have watched in hot-houses; but over and over again I have seen unwary insects taken in their cunning traps. In his "Reign of Laws," the Duke of Argyll says of them:—"'Moth-traps and spring-guns set on these grounds' might be the motto of the orchids. There are baits to tempt the nectar-loving lepidoptera, with rich odours exhaled by night and colours to shine by day; there are channels of approach along which they are surely guided, so as to compel them to pass by certain spots; there are adhesive plasters nicely adjusted to fit their proboscis, or to catch their brows; and there are hair-triggers carefully set in their necessary path, communicating with explosive shells which project the pollen stalks with unerring aim upon their bodies." The little Fly Ophrys not only attracts flies by its likeness to one of themselves, but also by the shining patch on its labellum, which it is supposed they take to be honey. *Ophrys apifera* grows plentifully near Amberley; and on any bright day in July the bees may be seen bustling in and out of its handsome brown and pink flowers. It is not, however, so like a bee as the former is like a fly. *Ophrys aranifera* is very like the large garden-spiders found in the autumn. The mutual adaptations of flowers and insects are most curious. The butterflies that flit from flower to flower, only bent on sucking out honey for themselves, are insuring the permanence of the species they frequent. But while bees and butterflies have greatly increased the scents and colours of flowers, there can be no doubt that we owe the dingy hues and noxious smell of others to flies. Not long since, I had a curious specimen of one of these last in the *Stapelia*, a native of South Africa, with a smell exactly like tainted beef. This plant has become dependent on flies for the conveyance of its pollen. Now, flies do not appreciate colour or scent, but seek out carrion in which to lay their eggs. The *Stapelia*, therefore, is just the thing to suit them. It is shaped very like a starfish, is of a brown-red colour, and covered with hairs full of a liquid resembling blood, while the smell is almost unbearable. The specimen given to me from the Botanical Gardens at Cambridge was covered with the eggs of the Blow-fly, thus showing how well the fly had been deceived.

The *Listera* (or *Neottia) nidus avis* I had not seen before finding it at Amberley under the beech-trees, on the road below Rodborough Fort. It gets its name of " bird's nest orchis " from the root, which is a dense bunch of thick, rather succulent fibres. At Longfords I found the pretty *Geum rivale*, which I have often found in Switzerland, but never before in England. It is not very unlike the *Geum urbanum*; but, instead of being yellow, the flower is a pinkish orange, with purple veinings; it is also larger and drooping. A variety is sometimes found resembling both species. The *Geranium lucidem*, which I found here very plentifully on the walls, is also uncommon. It has a smaller blossom than the *Geranium Robertianum*, and is of a brighter pink; while the shining leaves are exceedingly beautiful, and turn in autumn to a brilliant red. In the Wood at Highlands I found the rare *Lathræa squamaria* (toothwort). It grows parasitically on the roots of the hazel, and gets its name from the curious appearance of its underground stem, which is sheathed by succulent scales, the abortive forms of what ought to have been its leaves. It is a pale, sickly-looking flower, sometimes, when growing in sunlight, of a mauve tinge, but usually a pale yellow-white, and quite scentless. The secret of its miserable appearance is that it is living entirely at the expense of another. By drawing the prepared juice from another plant, it has lost its own leaves in accordance with Nature's stern rule, that "loss follows disuse."

I am writing this paper beneath a grand old tree, shaded by that glorious green web of Nature's own weaving upon the warp of last year's dead leaves and blossoms. Here as elsewhere true freedom is only found in obedience to law. The smallest details are not left to chance, and there is as exact a geometry here as in the mineral kingdom. Just as certainly as the angles which the axes and planes of different crystals form with each other are determined, the leaves follow a regular plan, and the flowers appear not only at the appointed time, but at the appointed part of the plant. The usual arrangement is the spiral. As a poet beautifully puts it, "Each leaf climbs up its jewelled winding stair." If a thread is drawn round a twig of one of our fruit or forest trees from the base of one leaf to the base of the next, and so on to the base of each following leaf, it will describe a spiral line; the spiral ending with the leaf directly above the one from which it commenced. We can see that the leaves are thus prevented from interfering with each other by excluding light and air, or otherwise impeding each other. This arrangement of the leaves with regard to their placement on the stem is called by botanists, phyllotaxis (from φύλλον, a leaf, and τάξις, arrangement), and it may be expressed in fractions of which the numerator indicates the number of turns of the spiral forming the circle; while the denominator expresses the number of leaves on that circle. Thus in the oak there are two turns and five leaves; the fraction $\frac{2}{5}$ will therefore represent the phyllotaxis of that tree There is the same spiral arrangement in the blossom, only here instead of being drawn out as in the foliage, it is compressed like the rings of a spiral spring that has been pressed down at one end. I have read in one of Hugh Macmillan's delightful books that the angles at which the leaves of the plants diverge as they grow from the stem, express Euclid's idea of the problem of inscribing a regular pentagon in a circle. Those who care to follow out this interesting subject for themselves will find that in different species the number of turns made round the stem in completing the cycle differs, but that both the nature of the spirals and the number of leaves are always determined.

To return to the Amberley flora; I found the *Allium ursinum* very plentiful in most of the woods, and very tantalising too, sometimes, when I took them from a distance to be a bed of the *Convalleria majalis.* The latter lovely flower grows very plentifully in woods above Selsley Hill, but whether truly wild there I cannot say. I was much pleased to find fine specimens of the rare *Paris quadrifolia* in the woods at Longfords. I had not found it in England before, though specimens had been given me from Derbyshire. It used to grow wild near Cambridge, but has now been quite exterminated. May it long live and flourish in the Gloucestershire woods! *Paris* comes from the Latin *par*, because all the parts of this curious plant are in fours. The flower springs from a slender stem that rises in the centre of a whorl of four leaves. It consists of a calyx of four green sepals, a coralla of four narrow yellowish petals, eight stamens, and a bluish-black germen of four cells terminating in four stigmas. Without doubt it is poisonous, as are nearly all green flowers. The dark centre is supposed to serve the purpose of attracting insects, as the flower has neither scent nor bright colour. In the same woods I found the fern *Polypodium calcareum* (limestone polypody), by some botanists regarded as a distinct species, by others a mere variety of *P. dryopteris*, commonly called the oak fern. It is generally of a stouter growth than this last; the rhizome is stronger and the whole plant more rigid, while the frond is expanded instead of drooping. *Scolopendrium vulgare* is also found near Nailsworth, with several other of the commoner representatives of that tribe which so long ago abdicated the throne of the vegetable kingdom. Yes, the ferns that nestle in the shade among moss-covered stones, or droop over our streams with blue-eyed forget-me-nots and sweet-scented rushes, are links connecting the solemn periods of geology with our busy utilitarian age. How much we owe to their ancestors! Age after age those giant tree-ferns grew up, flourished, and died, to be locked up securely under immense rock-pressure, that they might give to us one day the treasure it was foreseen we should require. Foreseen, not by a blind force, that cannot foresee, but by One whose ever present will upholds and directs all things towards that end planned from the very beginning.

One day I noticed a curious appearance on an Anemone leaf. It appeared covered with tiny punctures like those made by the gall-fly, and yet I could see no decided signs of insect life. I solved this puzzle, as I had done many a one before, by the aid of the microscope, and could not prevent an involuntary exclamation of surprise and delight at the fairy scene which filled the field under my inch objective, and which proved to be the lovely fungus, *Æcidium quadrifidum*. I can most heartily recommend the study of these lower forms of vegetable life under the microscope. Whether it be the lichens that paint our old walls with their many-hued frescoes, or the delicate mosses, or tiny fungi found clinging to dead leaves and decaying fruit, all are very beautiful and full of interest, while there is no need to go out of our way to find them. Whilst examining the exquisite spore-urns of our mosses I have often thought what pretty models they would make for jars, jugs, and pitchers. Then the contrasts and harmonies of colour shown by lichens and their fructifications are enough to delight any artist's eye.

I have a few words to say about pond life. There is nothing in the wide range of microscopic research that seems to me so full of interest. Here we see the marvellous workings of life; and surely none but the most stolid and unreflecting mind could study them without awe; for while we can understand more or less of the results, the cause is hidden in mystery. Each discovery which leads us to some elementary law or principle only shows us how much lies behind it. There is a wonderful charm in all efforts to trace beginnings in nature, especially where we can see in the simple structures and faculties of the lower forms of life a foreshadowing of their completion in the frame and mind of man. For a long time all the microscopic inhabitants of water were called Animalculæ, and until the recent improvements in the instruments used for observation, little was known about them. Much has been done of late years by means of the microscope to classify the teeming myriads of our ponds, but very much yet remains to be done. Among some of the most marvellous of these creatures are rotifers. About two hundred species have been discovered and named, but hardly a month passes without some fresh form being noticed, while the male of the commonest species *(R. vulgaris)* has not yet been identified. What a good opening here awaits all who care to make drawings of what they find by means of the camera-lucida. In a pond at Bowbridge, to which I was kindly directed by Mr. Mayo, I found fine specimens of the tube-building rotifer, *Melicerta ringens.* This marvellous creature builds for itself a home in the shape of a tube, out of clay contained in the water. It has a small cup-like process in which it moulds the clay into compact rounded pellets. These it places one by one, as they are made, round the edge of its tube. By putting a little carmine paint into the water, I have seen them very plainly, for the Melicerta devours the carmine greedily, and also uses it for building. I have timed them at work, and find they usually take from three to five minutes to make one pellet. The fringe of cilia round the edge of their lobes moves so rapidly, with an undulatory motion, that it appears like a tiny chain revolving round and round. In a good light the crushing movement of the gizzard may be clearly seen.

On the same weed (the Anacharis) was another creature, well-named the Beautiful Floscule (*Floscularia ornata*). This also lives in a tube, but it is a gelatinous one, very difficult to see, except with a dark-ground illumination, as it is of the same refractive power as the water. The Floscule seems a nervous creature, the least shake of the table, or change in the light, sending it down to the bottom of its tube. When it emerges it pushes out before it a bunch of long fine hairs, looking not unlike one of our old-fashioned hearth-brushes; then, if not frightened in again, it soon unfolds its fringed lobes like some lovely flower expanding in the sunlight. I think (under a really good microscope), there is not anything to be compared to it for beauty. Its long hairs glisten with a bluish-white lustre, and it looks like a crystal vase filled with gems; these being the desmids, *Euglena viridis*, and monads it has swallowed. The *Vorticellæ* are well known to all who have seen anything of pond-life. There are different species, some of which are as large as the Stentors, and can be well observed under a low power. I have frequently found them on Cyclops and Daphnia, and I once found a large water beetle completely enveloped by them. It is a curious sight to watch a cyclops swimming through the water almost hidden by a forest of *Epistylis* or *Carchesium*. When thus fastened to these active little crustacea, they seem to lose the sensitiveness that makes them pop down at the slightest jar or movement of the live-box. These Vorticellæ, be it understood, do not prey upon their hosts, they only look for lodging and provide their own board. There is a creature, now supposed to belong to the Vorticellæ, that much resembles the Floscules, and is called *Acineta*. I found it in the Amberley ponds among the colonies of Vorticellæ. It may be distinguished from the Floscules by having no gelatinous case, and by there being no visible opening or mouth into the interior. I found plenty of the *Stylonichia*, oval animalcules surrounded by cilia, and covered with styles both straight and curved, the latter called uncini, or little hooks. It is most amusing to watch these queer little folk swimming steadily on, and then darting back, but not quite so far as they advanced. They will keep up this peculiarly unrestful motion by the hour together. Increasing by self-division, they multiply so rapidly that it has been calculated that one Stylonichion might produce a million in ten days. Who can gauge the usefulness of all these minute beings, so delicate that a touch will crush them ! and yet so important that without them every stagnant pond would become a centre of infection spreading death to all around. Professor Owen calls them " Nature's invisible Police," and indeed they are like watchful sentinels, ever waiting to arrest all the particles of decaying matter, to turn them back into the ascending stream of animal life. Thus they prevent the gradual diminution of the quantity of organised matter, taking that which would harm us into their own living tissues, and then becoming the food of larger Infusoria, which in their turn are devoured ; food fit for more highly organised beings coming back by this short route from the extreme limits of the world of organised matter. Wherever decay commences, the invisible fairy band of scavengers will be found, and they never, fortunately for us, leave their work unfinished. In their crystal goblets poison changes into food.

I found Hydra plentiful in the ponds near Stroud ; both *H. vulgaris* and *H. viridis* which some naturalists tell us is only a variety of the former. They are very tenacious of life, and I have divided them into many pieces and found each division speedily grow a fresh crown of tentacles. It is known that they have the power of stinging their prey by means of tiny lassoes which they can throw out at will. I had not time to examine the ponds round Amberley, as I should have liked, but from what I saw I should think the ponds, canal, and the Brimscombe basin would repay careful research.

Those who take an interest in conchology may care to know that in " Hardwicke's Science Gossip " for July, there is mention of a rare slug to be found at Brimscombe. It is the variety *Bicolor* of *Arion ater*, which I believe at present has only been found in Ireland. It is always pleasant to see what sort of freemasonry exists between naturalists ; they seem as a rule very free from the selfishness of some collectors, and can rejoice in each other's prizes.

The Microscope and how to Use it.

By V. A. Latham, late Hon. Sec. Norwich Branch U.J.F.C.

First Part.

IN the following series of papers, it will be our endeavour to give some of the best methods for the Preparation and Mounting of microscopic objects.

We will state frankly at the commencement that the methods given will not, in many instances, be original, and perhaps our articles may not be complete, but we trust that they will prove helpful to the general microscopist. But whatever the failings of these papers may be, they have this recommendation, that all the methods herein given have proved themselves thoroughly efficient, and therefore are unhesitatingly recommended.

The Microscope opens up innumerable sources of entertainment and amusement to all classes of students. To the zoologist it is a necessary co-operator. To the geologist it reveals, among other facts, that our coal-beds are the ruins of a gigantic vegetation. Its influence as an instrument of research upon the structure of bodies has been compared to that of the galvanic battery in the hands of Davy upon chemistry. To the pathologist, botanist, and numerous others, has it ever been the source of assisting and forwarding science, adding greatly to our store of knowledge, and as many good microscopes may be purchased for merely nominal sums, every student of science should possess one.

The following notes may be of use :—The microscope having been placed in a convenient position, taking care that the stand is firm and perfectly steady, the mirror is to be adjusted so as to throw a beam of light through the stage-aperture and along the central axis of the tube. Direct sunlight should not be used for illumination, but that thrown from some bright cloud is strongly recommended. The eye-pieces and object-glasses, as well as the mirror, must be kept *perfectly* clean and free from dust by means of a soft piece of wash-leather, which should on no account be used for any other purpose. Specimens should *invariably* be examined, *first with the lowest power and then with the next higher*, and so on until the highest power is reached, using with the low powers a medium-sized diaphragm, and a somewhat smaller one with the higher powers. Before placing or removing specimens, the objective is always to be withdrawn some distance from the stage by drawing the microscope-tube upwards with a gentle turn of the coarse adjustment-screw. When placed in position, the object may be brought to a focus by gently lowering the tube with the coarse adjustment till the specimen is fairly in view, and then, slightly turning the fine adjustment-screw until a clear and distinct image is obtained. Care is to be taken that this fine adjustment-screw is not turned too much to the left so as to rise far out from the stand, nor too much to the right and so become fixed.

It is best to accustom oneself to working with both the left and right eye, at the same time keeping open the one not directly in use. By this means the eyes become less tired, and after a little practice the whole attention will be thrown upon the object under examination. This plan is also of great assistance in making sketches of the preparations. It is a good plan to make drawings of all objects under examination. Our method of procedure is to place the sketch-book or drawing-paper on the right-hand side of the microscope level with the stage, and to draw a faint outline of the object with an "H." pencil, and afterwards carefully finish with the "H.B.," shading where required; coloured chalks or water-colours may be used. The latter, however, we consider preferable.

All drawings should be made of the apparent size as seen in the microscope, and a note to this effect should always be made at the left-hand corner of the paper. It should state the power of the objective, number of eye-piece, and degree of enlargement; *e.g.*, 1 in. A × 25, $\frac{1}{4}$ in. A × 120, as the case may be.

The degree of magnification may always be ascertained by substituting a micrometer slide for the actual slide, and by drawing a few of the lines on the paper at exactly the same distance apart as they appear in the microscope; thus, if 10 lines which are on the micrometer plate $\frac{1}{100}$th of an inch apart appear to occupy one inch, we know that the object is magnified ten times; if only four of these lines occupy an inch, the object is magnified twenty-five times, and so on. But this method of drawing objects from the microscope may not be applicable for all users of the microscope, and those who are unable to adopt it will do well to purchase a camera lucida, or, if expense be an item of consideration, one of the many forms of neutral-tint reflectors will be found to meet every requirement.

We will now describe more particularly some of the principal accessories:—

The **Object-glasses** possess various magnifying powers, according to the distance at which they require to be placed from the object for distinct vision. This, though not absolutely correct, yet may serve as a general expression. Thus, we have 1-inch, $\frac{1}{2}$-inch, $\frac{1}{4}$-inch, $\frac{1}{8}$-inch, $\frac{1}{25}$-inch object-glasses, etc. As the coarse movement raises or depresses the body and object-glass through comparatively large distances, it must be used only on the lower-power object-glasses, as the 2-inch, 1-inch, or $\frac{1}{2}$-inch, or, to bring the object-glass near the focal distance with the higher powers, as the $\frac{1}{4}$-inch, etc. Care should also be taken not to place a slide which has been warmed in any experiment near the object-glass until it has become quite cold.

Eye-pieces.—With all microscopes, one, two, or more eye-pieces are supplied. These possess different magnifying powers, and are lettered or numbered accordingly, the lowest powers with the earliest letters of the alphabet, or with the smallest numbers; thus, A, B, C, or 1, 2, 3, etc.

The following instruments are required for general work; of course, the list does not include all, but others may be added at the convenience of the student, and those students who make histology their special subject will naturally require many more.

Stage-forceps for holding insects and small objects under the microscope; straight and curved forceps for general manipulation; live-box for holding living insects whilst under examination; a pair of straight and a pair of curved-bladed scissors; a few mounted needles for "teasing" out structural details; a set of dipping tubes; a razor or two; and an ether freezing microtome, or a small hand microtome for those whose means are limited. For general use, we strongly advise the student to purchase the freezing microtome, as it will be found much more efficient. A dozen porcelain paint-saucers or watch-glasses, camel-hair pencils; slides, covers (both square and round), and a bull's-eye side-condenser. This last accessory we have so seldom used, that when we have required one we have filled a clear *white* glass bottle with water, and fastened it between the lamp and the object, when it has proved almost as efficient as the bull's eye; but where the student is giving his attention more particularly to opaque objects (Foraminifera, etc.), he will find the bull's-eye condenser very serviceable. A small paraffin oil lamp with a white paper shade is very useful for winter-evening work; Canada Balsam and Benzole, Glycerine Jelly, and various stains and cements. Experience will best teach what stains and cements are most required, and these it will be best to purchase as needed, as it will depend on the class of work.

In studying the microscopic structure of various bodies, it is necessary to add different reagents and staining fluids. Frequently, it is best to put up the object and then add the fluid, which may be done:—(*a*) By the use of a glass rod or blotting-paper; or (*b*) by using the rod and a fine capillary tube.

Testing.—By using reagents in the above manner, many substances may be detected under the microscope by certain characteristic reactions. As examples of this, the reactions of starch and cellulose may be mentioned.

Starch.—Mount a few granules of starch by mixing some in cold water and covering a drop upon a slide. Examine under a high power. Now add by capillary attraction a dilute solution of Iodine, and the granules will turn *blue*; this is a well-known and characteristic reaction.

Cellulose.—Mount some scrapings from the cut surface of a potato. Examine under a high power, and run in a little Iodine solution; the starch-granules present turn blue, and the walls of the cell-spaces containing them take a yellow tint. If, in a similar manner, dilute hydric sulphate be now added, this yellow tint will change to a blue one, indicating *cellulose.* The same reaction is given by cotton fibres, or the walls of yeast-cells.

Foreign Bodies, etc.—

In making microscopic preparations, certain foreign bodies from time to time become present which it is necessary to carefully distinguish from the tissues under examination. The more common of these should, therefore, be placed under the microscope, and sketches made of them, in order that their characteristics may be known.

1.—**Brownian movement.**—This vibratory movement should be carefully distinguished from any vital one. Although it is shown by some specimens of living matter, it is also observed in *non*-living matter, and is essentially a physical phenomenon. It may be studied in—

(*a*) *Gamboge.*—Grind some gamboge in water, and examine a drop under the high power. Various currents will be detected, and also this vibratory Brownian movement of the small granules.

(*b*) *Bacteria.*—Mount a specimen from a watery extract of boiled meat, which has been allowed to stand a few days. Some very fine Bacteria will be seen which will show a similar motion, and which lasts after their death, brought about by the addition of iodine or by boiling the solution. Another way is to infuse some hay in warm water for half-an-hour, filter, and set aside the filtrate; note the changes which go on in it. At first, it will appear clear; in 24 or 36 hours, it will have become turbid; later on, a scum forms on the surface, and the infusion acquires a putrefactive odour. Treat as above, with Iodine.

2.—**Cotton Fibres.**—These are one of the pests of mounters. Mount a few fibres of cotton wool in water, cover and examine under both low and high powers. They appear as long, flat threads with a distinct twist, and turn blue on the addition of iodine and hydric sulphate.

3.—**Flax Fibres.**—Examine in a similar manner some flax fibres. These are long and flat, but, unlike cotton, do not show any *twist.*

4.—**Air-Bubbles.**—Shake a solution of gum in a test-tube till a froth appears, then mount a drop of the under fluid, and examine under both low and high powers. By transmitted light, each air-bubble appears as a bright centre, surrounded by several dark rings of various depths; by alteration of the focus, these rings will change. With reflected light, a reversion takes place, the centre becoming dark and the periphery light.

5.—**Fat-globules.**—Mount a small drop of milk and compare the fat-globules with No. 4. Notice their sharp definition and variation of size. Pass in a little sodium hydrate, and they immediately run together.

Objects which have been mounted in glycerine or any media liable to evaporation, require the cover-glass to be surrounded and slightly overlapped by some cementing fluid, which will gradually dry and form a firm ring. For this purpose, zinc-white varnish, or the brown cement (prepared by E. Ward, of Manchester) are good.

These cements are best applied by centering the slip upon a *turn-table*, fixing the slide down with the clips, and while rapidly turning to gently bring a camel-hair pencil holding the cement down to the edge of the cover-glass. The object *must* be carefully centered and the slide *firmly* clamped, otherwise the rapid rotation will throw it off the turn-table. If square covers are used, the cement may be applied by gently painting it along each edge.

Dry Mounting.—The easiest objects that a learner can begin with are those that are merely mounted dry in a shallow cement-cell, such as wings and the scales removed from the wings of butterflies, delicate pollen-grains, fern-spores, fish-scales, cuticles, etc. In commencing work, it will be found advisable to prepare a number of slides by putting them on a turn-table, and with a brush charged with brown cement (Ward's), or some similar viscid preparation, the solvent of which should be spirit, run circles upon a number of slides, and put on one side to dry; those, with brown cement, will, to a certain extent, dry quickly, when, if the cell is not deep enough, another and yet other layers may be added. Now, the slides being ready, suppose we wish to mount a slide of scales from the wing of a butterfly. Cut a piece of ordinary printing paper, about 1 inch by ½ inch; fold it in the middle, and then, placing in the fold a small piece of the wing, press steadily, and with a slight sliding motion, when the scales from both sides will be pulled from the wing and remain upon the paper. If now the paper be divided, and a clean cover-glass of the chosen size be taken, it will be found that by breathing upon the cover, and then at once putting down upon it first one and then the other of the papers, scale side to the glass, the scales will adhere to the glass cover, and then, by gently warming over a spirit-lamp one of the slips prepared as described, the ring of cement will be softened, and the cover-glass with scales may be pressed closely to it, and when cold all will be found firmly fixed. If it is desired to mount a small piece of the wing, see that the cell is sufficiently deep, and then, placing the wing in the centre of the cell; by warming the cover-glass, and at once putting it down on the cement-ring, it will attach itself firmly, and may be thus put on one side. In mounting portions of butterflies' wings, it will be found that a more pleasing effect will be produced by arranging it in such a manner that the light will fall on the scales from a certain direction, which should be first ascertained, and the piece of wing arranged on the slide accordingly.

For pure diatom gatherings or deposits that it is desired to mount dry, it is only necessary, after sufficient cleaning and washing, to put a drop of the fluid containing them upon a cover-glass, and allowing this to dry, not by heat, but by slow evaporation; then warming the slide and cell as described for butterfly scales; the cover may be pressed down and securely fixed. It will be noticed that in all these processes either cover-glass or slides must be warmed. This will be found one of the most important advantages of this method, for it will prevent any possibility of fungoid growths from imprisoned moisture, and the slides will probably be permanent objects of interest.

We will now try to give a few examples of dry mounting, where a deeper cell is required than can possibly be made with cement. Make as before a ring of cement upon a glass slip, provide cells of cardboard, metal, glass, etc.; make the slip hot to soften the cement, and the cell may be pressed on, and when cold will be found fixed, and may at once be used for any object of which it is advisable to show both sides. Of this class of objects are some of the polyzoa, ferns with fructification and hairs, and leaves with hairs or scales on both sides. Should the object be such that a piece can be stamped out nearly the size of the cell, no gum will be necessary to keep it in its place; but should the object be very small, or with branches, it will be necessary to put a small spot of gum (and the gum must be rendered safe from fungoid growth by the addition of a few drops of carbolic acid) on the slip at the junctions of the cell and glass, so that it may not be seen. The object being placed in the cell, and the gum, if gum be used ($\frac{1}{2}$ gr. salicylic acid to every ounce of gum, or a little carbolic acid to keep it), being quite dry, the slide should again be placed upon the turn-table, and the top of the cell-wall coated with brown cement. In a few minutes, a warmed cover-slip may be put down upon the cell, a clip placed upon it; it may then be put on one side, to be finished at leisure. For objects having only one side to be inspected, we would always recommend a black ground, of asphaltum if a bright one is preferred, or of matt black if the ground is desired dull. This ground being thoroughly dry, the objects may be *placed on it*, and the slides finished as last described. It is much better to paint the asphaltum on the top of the slide than under, as it is less liable to be scratched off.*

Mounting in Canada Balsam, etc.—Some preparations which it is desired to keep are usually mounted in Glycerine or in solutions of Canada Balsam or Gum-Dammar. The solvent of the last two substances evaporates and leaves a clear, hard edge, so that no cement is required as in the case of Glycerine. The mounting medium should be quite admixable with that from which the specimen is last taken, it being necessary in some cases to use several fluids to obtain this result.

Tissues and sections, both stained and unstained, are, as a rule, kept in *spirit*, so the following order should be carried out:—

For mounting in Glycerine.—The objects should be removed from Spirit into Water, and then into Glycerine.

For mounting in Canada Balsam or Gum-Dammar, they must be removed from Spirit to Absolute Alcohol, then into Turpentine 4 parts, Creosote 1 part, or Oil of Cloves or Oil of Cajuput, and finally into Canada Balsam, or Balsam and Benzole, or Gum-Dammar.

* We think there is really no need for any dark-ground cell, because by proper management such a dark ground can be formed outside the glass.—Ed.

Glycerine.—Pure Glycerine may be used, or a mixture of equal parts of glycerine and water, which is somewhat preferable. For quick mounting, for specimens which are unstained or hyaline in character, and for those which require testing, it is better than Canada Balsam. A section-lifter is required in handling specimens, and great care should be taken in removing them from spirit to water, the surface-currents causing rapid movements which may lead to the breaking-up of a section. The time during which they should remain in water before removal to glycerine depends upon their size and density, from five to ten minutes being generally sufficient.

In the preparation and mounting of many things from the vegetable kingdom, as mosses, algæ, cuticles, sections, etc. ; or from the animal kingdom, as eyes and wings of insects, gastric teeth, palates of the mollusca, it is only necessary, if they are sufficiently clean and not too dark in colour, to put them for a few hours into a mixture of methylated spirit, glycerine, and water (about equal parts of each),* although exactness is not necessary, as the mixture may be varied to suit circumstances. When they are taken from this mixture, they must be placed upon the centre of the slide, and the surplus liquid absorbed by blotting-paper, and sufficient pure glycerine added to thoroughly fill the cell. The cover-glass should now be made quite moist by breathing upon it, and carefully lowered down on to the object, and secured by the spring clips.

Or, instead of pure Glycerine, Glycerine-Jelly may be used, when either of two plans may be followed. Glycerine-Jelly may be liquified by placing the bottle in hot water, and then dropping the liquid jelly upon the slide, or, as is frequently preferred, a *small* piece may be cut from the bottle, and put upon the object, and the slide gently warmed, when the jelly will diffuse itself through the object, which will be found exceptionally free

* A very excellent mixture is that known as Hantsch's fluid, and is composed of—

Alcohol	...	...	...	...	3 parts.
Water	...	...	...	...	2 parts.
Glycerine	...	...	...	...	1 part.

This fluid will also be found most suitable in which to keep all kinds of insects preparatory to mounting.—Ed.

from the enemy, "air-bubbles"; but whether or not there be air-bubbles, it is of great value to boil the jelly and object upon the slide, but care must be taken, or the mount may be ruined. If boiling be chosen, a wood clip should be used, and the slide held by it directly over, but not too close to the flame of a spirit-lamp. It will at first begin to bubble from the centre outwards. If the slide be now carefully watched, a very perceptible crack may be seen and heard at this moment, when, *without delay*, the slide must be withdrawn from the heat, and placed upon a cold surface (a block of marble, or a brick previously soaked in cold water), when the jelly will rapidly become cold and solid.

Canada Balsam has largely given place to Balsam and Benzole, Balsam and Chloroform, or Dammar, each of which medium has advantages over the others for certain objects; but our choice for general work is Balsam and Benzole, which we have used for years. For many descriptions of work, pure Canada Balsam, or Balsam and Turpentine or Chloroform, or Dammar, are used for less transparent and for stained tissues, rendering specimens which are mounted in them very clear. The media required in mounting from spirit are to be applied in the order given above, the specimen being changed from watch-glasses containing them by a section-lifter, after removing any excess of each fluid clinging to the specimen by the back of the hand or a piece of blotting-paper. The former is preferable, as less likely to cause any hairs or pieces of cotton to touch the object. The specimen may remain on the slide, and the medium applied by pipettes and removed by the hand or blotting-paper after their action. Five to ten minutes is usually sufficient time for a section to remain in each fluid.

To better explain the method of mounting, let us take some objects from the animal kingdom—say parasites. It will in most cases be advisable to put them in *liquor potassæ* for a short time. When they have been softened and sufficiently reduced in colour they must be well washed in water, and if they are brushed under water with a stiff camel-hair pencil, the legs will frequently be found right for mounting. The last washing-water having been poured off, and methylated spirit added, let them remain in this for a few hours, and then removed to absolute alcohol. After the lapse of a few more hours, pour off the spirit, and add Oil of Cloves or Cajuput. The latter is quite equal to, and much cheaper than Clove Oil ; Creosote and Turpentine may be used if preferred. From this the object may be placed upon a clean slide, and any surrounding oil should be absorbed by the hand or blotting or filter-paper; a drop of Balsam and Benzole being then put upon it. The slide may be left for a few seconds, and then a warmed cover-glass placed upon it (which must be held in position by a wire clip), and the operation of mounting is so far complete. The slide now requires depositing in a warm place for a few days before the later finishing touches can be applied to it. If it be Polycistina, Foraminifera, Sponge or Gorgonia spicules, etc., or any such object that it is wished to mount, a thin smear of gum should be placed on one side of the centre of the slip, when, if the thumb be drawn firmly over the slide, a very thin, almost invisible film will remain, which must be allowed to dry. If then a small heap of the dry material be put on the centre of the smear, and the slide, while held in the fingers at one end, be gently tapped on the other by the forceps, or anything hard that happens to be handy, the material will be seen to spread itself over the gummed surface, and its disposal may, with a little practice, be greatly controlled. The slide now requires breathing upon, and when again dry a drop of the Balsam and Benzole must be put over the object, a warmed cover-glass placed in position, and held with a wire clip. The slide should be gently heated over a spirit-lamp until the medium just begins to boil, when it must be quickly removed to a moderately cool spot. This boiling has the effect of driving out the air from in or around an object, and should any bubbles appear about the slide, they will almost invariably disappear if the slide is left in a warm place.

In mounting starches in Dammar, for polariscope, a similar plan may be adopted to spread the material ; but in this case *no* gum is required, the breath upon the slide being enough to hold the granules as they move over the slide. When the breath has evaporated, it is not advisable at once to drop on the Dammar, but, first placing over the starch a clean cover-glass, put at each edge of the cover, but not exactly opposite, a drop of Dammar, which, running under the cover from each side, will imprison the object. If the Dammar wave does not appear to travel freely, a little movement with a needle at the edge not touched by the medium will accomplish the purpose, and the slide may then be put away to dry; but in the case of starches it is not well to put them into a very warm place. The same plan may be adopted with pollens, fern-spores, &c., and the two waves of Dammar will do what is otherwise very difficult, namely, keep such delicate objects in the centre of the slide, where we wish them to be.

Farrant's medium is used in a similar manner to the above, the chief difficulty being to ring the cover, as the medium does not dry like balsam. The best way to accomplish this is to wash carefully with a soft brush all the medium from around the cover, put the slide aside to dry; when dry, ring it with white Zinc Cement. When that is dry, thoroughly wash the slide, and give it a second coat. Yet one other process, viz., Carbolised Water, which is useful in cases where the object would be spoiled by the heat necessary to melt glycerine jelly.

Carbolised Water, about one or two drops of Carbolic Acid to ten ozs. of water. Having an object suitable for this mode of mounting, it may be kept in the preservative fluid till ready, and one of the slides, already prepared with Brown Cement, may be again centered upon the turn-table, and a further coat of the same cement, or some other sticky varnish or gold size, or mastic applied. The cell must then be filled with Carbolised Water, and the object, fresh water algæ, diatoms in their natural state, starches, etc., at once put into it; a cover-glass of the right size having been previously cleaned, it may be taken up in the forceps, and one side being moistened with water, it must be gently lowered upon the convex surface of the fluid, and by its weight it will force out the surplus fluid, which must be absorbed by blotting-paper. As the cover touches the cement, it sticks, and may now be pressed closely to the cell; but in this little matter care must be exercised, as, if the pressure is applied at one side only, the opposite side rises, and the air enters; but if the points of the forceps be opened to rather less than the diameter of the cover-glass, pressure may be applied at both edges at the same moment, and repeated applications round will firmly fix the object, when another coat of the Brown Cement will make the slide secure. Great care should be taken that all needles, section-lifters, etc., are *quite clean* from one fluid before being placed in another; and on no account must the rod or brush of one re-agent bottle be allowed to touch another re-agent.

Half-an-Hour at the Microscope

With Mr. Tuffen West, F.L.S., F.R.M.S., &c.

PLATES 3, 4, 5, 6, 7, 8.

Plagiogramma.—A name first given to a species of diatoms in 1859, in a paper which appeared in the "Quar. Jour. Micro. Sci." in July of that year (p. 207). Ehrenberg appears to have previously described some forms under the name of "*Heteromphala*;" this name it would have been desirable to retain. Even Ralfs (in Pritchard) doubts the propriety of forming a new genus for it. It comes near to *Fragilaria*, *Odontium*, and *Denticula:* forming short filaments, probably attached to their entire base, at least in their early state. The first specimen which led Dr. Greville to form a new genus for its reception, was found by the late Dr. Gregory in dredgings from the Clyde, and described by him with figures in a remarkable paper on that subject. It is now dedicated to him under the name *P. Gregorianum.* Thirteen so-called species are known, with two doubtful ones; they mostly run very close, in several instances single examples only were met with, and I am persuaded the numbers will eventually have to be much reduced. *P. elongatum* does not appear amongst those enumerated by Ralfs *(loc. cit.)*, from some of which, however, it scarcely differs. It would be desirable to know where descriptions of this form are to be met with.

Most of Dr. Greville's forms were found in material obtained from the Caribbean Sea; he says in a note (p. 207):—"I take the opportunity of recommending that those who are interested in this subject, and have friends in the West Indies, should endeavour to prevail upon them to collect the smaller sea-weeds, especially such as are cast ashore in quiet bays and creeks. It should be explained to them that the object is not the sea-weeds themselves, but the diatoms to be obtained from them, and that those sea-weeds are to be preferred, which are covered with parasites, and entangled with zoophytes, forming what the mere collector of algæ would call unsightly tufts. They must on no account be washed, but dried in the rough, just as picked up, and then packed in course paper. Small parcels of this kind (a few ounces in weight), from the coasts of the different islands (and from different localities of the same island), could not fail to produce objects of the highest interest to diatomists." It should have been stated in the present instance whether the gathering was pure, or if not, what were the associated forms?

Hydrodictyon on Utriculatum (Plate 3, Fig. 2) appears to have been dried before mounting, whereby the remarkable character of the endochrome is entirely lost. It should have been mounted in a cell with Hantsch's fluid, without crushing, or no more than is absolutely necessary. In Johann Nave's "Collector's Handy-Book" it is specially mentioned as one of those puzzling forms, at one time abundant, at another entirely vanished from the spot, without any apparent reason. "It is quite astonishing in what abundance this species will suddenly fill some pond or ditch, at times almost obstructing the flow of water, only to disappear again without leaving a trace behind. So that if a person is anxious to gather a large number of specimens (for the sake, say, of making exchanges), he must be careful to do so while he has the opportunity, and not leave them to a future period, under the idea that they will await his convenience, for he is likely enough in that case to deceive himself, and, on returning to the piece of water, to find only emptiness where the year before there was superfluity. It is far better to secure the requisite number of examples on first coming across the species; indeed, if necessary, the whole stock may be taken, as there is little likelihood of extirpating any kind of algæ."—(Spicer's Translation, p. 4.)

Coleosporium tussilaginis (Plate 3, Fig. 3) is the name of the fungus on Coltsfoot leaf. Where the latter plant occurs, its special fungal parasite is generally to be found abundantly at this time of the year (July) by turning up the leaves. It does not make a satisfactory mounting when just dried on the leaf (both always losing colour and assuming a dull, dead look). Thin sections should be made with a razor, by laying a portion of the material on a glass slip, and moistening with water, holding down with the tip of the left middle finger, and drawing the razor carefully from left to right. With a little practice it is not difficult thus to obtain very thin slices, showing all the structures. The sections can be floated to where they are wanted, or removed with a very fine sable pencil, and put up permanently in glycerine.

These remarks will answer questions put some little time ago by a member as to obtaining sections of leaf-fungi. It must be remembered that the structures are exceedingly delicate, will not bear drying, and therefore cannot be satisfactorily mounted in balsam.

Early in the season the mycelium will be found bearing globular spores with a granular cuticle—the *uredo* form. These are succeeded later in the year by 3-4 septate asci; from each chamber of which is emitted in germination a long slender thread, bearing a minute reniform sporidium. The full signification of these facts is not yet ascertained.

Stellate Hairs from Niphobolus lingua (Plate 3, Fig. 4).—This fern and the *Platycerium alcicorne*, both yielding stellate hairs, belong to the Polypodieæ. I have a small portion of a New Zealand fern, kindly given me by E. G. Piper, of the Old Change Microscopical Society, widely known as the inventor of the portable horizontal slide cabinets. The piece of fern I allude to shows thickly-clustered stellate hairs amongst the fructification, very beautifully.

Maple, trans. sec. (Plate 3, Figs. 5, 6).—If an engineer were shown the ends of a number of pipes entering into some piece of complicated machinery, he would probably, almost before asking their uses, wish to learn something of the character of the tubes in their *length*; the arrangements for elasticity in the one case, for rigidity in another, for porousness in a third set, and so on. Just such explanatory sections are required, when only transverse sections are given on a slide. These merely illustrate the arrangement of the ends of the tubes (as in the above supposed case, *how they are packed*), but reveal none of the essential characters of ducts, fibres, cells. As botanical illustrations they are to that extent imperfect. These remarks apply specially to the trans. sec. of Maple before us, but not less to the major proportion of wood sections ordinarily seen.

Mercurialis, Sphæraphides in (Plate 3, Fig. 8).—Thanks to the indefatigable energy of Professor Gulliver, the importance of studying the Raphidian characters of plants is becoming increasingly recognised. He has shown (and his observations may be readily confirmed and extended) that certain natural orders are characterised by the presence of special types of crystalline matters, whilst others of these great divisions are equally conspicuous by their absence. There are, however, a few genera possessed of them amongst orders which (with these exceptions) have them not. *Mercurialis* is an example of this remark, and a very interesting one.

The EUPHORBIACEÆ being mostly free from raphides; but their nearest natural order is that of the URTICACEÆ, which are eminently raphidiferous (using the term in its widest signification). Now, Herb Mercury, though the fructification is truly Euphorbiaceous, yet undoubtedly has the habit of a nettle. Possessing such habit, and abundant "sphæraphides" as well, it forms evidently a connecting link between the two orders. It will be desirable to examine the *composition* of these crystals. In some similar instances the larger have been found to be carbonate, the smaller oxalate of lime. The gradual alteration of the crude sap by abstraction of mineral matters in the course of circulation is beautifully seen here. It will be observed that there are multitudes of Sphæraphides present in the midrib, along which the sap rushes after coursing up the stem, to the marginal parenchyma of the leaves. Some of the veins, *in the earlier part of their course*, also show raphides, but these gradually become fewer, and presently the veins are seen to be entirely free from them—thus showing clearly how the mineral matters have been successively parted with, to combine with albuminous material, for which they have a great affinity.

Cowrie shell (Plate 8, upper half).—In the *transverse* section of Cowrie, it is impossible not to be struck with the general resemblance in the structures present to dentinal tissue. Both externally and internally is a hard, glassy layer, formed of prisms placed at right angles to the varying surfaces, which may be compared to enamel. The intervening coloured portion is laminated. At the thickened bases of the hollowed cone (to which the shell in its general form may be compared), the structure closely resembles that of the dentinal tubuli, or the shell of some of the larger Crustaceans.

In the arched vault of the shell interlacing fibres are seen more or less distinctly, whose general direction is at an angle of 45° to the surface. This appears to be due to a *secondary* arrangement of the crystalline particles of the shell. The effect of such disposition must be enormously to increase the strength of the materials entering into its composition. In connection with such structural arrangement, it is interesting to recall the interlacing fibres found in *scales of fish* (Micro. Dic. *sub-lite*, and in the bony epicarp of many fruits, as may be seen on examining a cherry or plum stone, or the seed of a currant, blackberry, or hawthorn-berry. When J. Quekett first lighted on such structure in the vegetable-ivory nut, he was much puzzled at the close juxtaposition of fibre-cells running both longitudinally and transversely to the axis of the section (Lectures on Histology, Vol. I., p. 64). Further examination, especially in the early stages of its development, would have shown this acute and tireless investigator the real explanation of the fact.

Development of Culex Pipiens (Plate 4, Figs. 1—4).—The Society is deeply indebted to the contributor of this slide. Few pupæ are so well adapted to display the development of the imago as Culex on account of the transparency of the covering membrane. A full description is given in the explanation accompanying the plate.

Antennæ of Diptera (Plates 5, 6, 7).—Sixteen examples of Antennæ show well what may be done by thoughtful care and patience. Members will do well to see what they can do after this style, and even if the result should be unsatisfactory at first, time and patience will give the requisite skill in the end. May I say it is of no use wishing without pains are taken to bring about the results wished for. There is a considerable resemblance between Fig. 14 (Plate 7), and those of *Musca vomitoria*, even to the strong spine proceeding from the dorsum of the second joint; they are evidently congeneric.

Eristalis tenax is the great Drone-fly, the antennæ of which may be compared with Fig. 13 (Plate 7.) *Chrysops cæcutiens* (Fig. 5, Plate 5) is the Gad-fly. The peculiar tapering antennæ of *Empis livida* (Fig. 6, Plate 5), is worthy of notice.

It may indeed be said of the Diptera, "Their name is Legion;" but if the fine typical examples of parts, as mouths, antennæ, wings, limbs, which pass round, be carefully studied, and *Notes and Drawings made by our members*, a clue will in time be obtained through the labyrinth of forms. These would illustrate admirably what I wish so to impress, the absolute necessity of systematic work, and of doing *thoroughly* whatever is taken up.

Aleurodes Chelidonii.—This insect is not Lepidopterous, as some suppose, but truly Homopterous, as may be readily ascertained by observing the various stages of development, and the parts of the mouth in the mature insect. I do not know how the name *Chelidonii* came to be conferred on it; it is true, an occasional specimen may now and then be met with on the Great Celandine, but its natural *habitat* is on the under side of leaves of cabbage and broccoli, and their allies. Here, though not occurring in "countless thousands" (a serious exaggeration), it may frequently be met with in sufficient plenty to furnish materials for microscopic examination. The female seems never to move from her place, when engaged in the act of oviposition, till she has "had out her lay," as henwives call it when speaking of fowls. Hence the eggs, usually from 12 to 20 in number, are placed on the arc of a circle, in describing which the end of the abdomen would be the pointer; they (the eggs) are of a long oval in shape, and shortly stiptate; the young, when hatched, disperse to different distances along the leaf on its under side; they have a short and simple *promuscis*, which is deeply plunged into the tissues. They exuviate several times, moving further apart on each occasion. A delicate fringe of waxy rods is formed by exudation from openings placed around the margin of the flattened scale-like body: these doubtless serve as a protection from parasites, which are probably acarine. Both larvæ and pupæ have the strongest resemblance to *Coccus*. At maturity the imago breaks through the anterior part, leaving the pupa skin behind, still attached to the leaf. It is a most beautiful and interesting creature, which might be said to be a Coccus in its early stages, and (but for its mouth) a Lepidopteron at maturity. In this connection it may be specially noted that the feet of the adult insect conform to the Lepidopterous, and not to the Homopterous type.

The perfect insect may, as to its general aspect, be fairly displayed by killing on a slide, with the gentlest pressure, as a thin covering glass, and mounting dry. The exuvia of the pupæ also show well in the dry state. Dissections must be mounted in shallow cells, in fluid, and also the eggs and the larval condition. These latter may be detached from their connection with the leaf, without injury, by means of a dissecting knife, such as may easily be made out of a tailor's needle, stuck into a handle and ground flat towards the point, on a hone. With a watchmaker's eye-glass pass this carefully underneath for a little distance towards one end, lift gently, and then remove the insect with a fine sable pencil.

Thrips. (Plate 8, lower half.)—Examples of this insect may be obtained in abundance at the present time (July). They especially haunt flowers; those of the Great Hedge Bindweed (*Convolvulus sepium*), of the Vegetable Marrow, or *Datura stramonium*, will yield many specimens; three examples have flown on to my book lately whilst reading in the shade these blazing days. They are easily preserved by taking up with the wetted end of a finger, transferring to a slide on which a drop of glycerine has been placed, and cementing the covering-glass with gum dammar in benzole.

They form a small osculant order between Orthoptera and Neuroptera, in neither of which do they find a natural place. "The relations of this order are very difficult: the nature of the metamorphoses would unite it with the Orthoptera or Hemiptera; whilst the structure of the wings and mouth remove it from both these orders: the mouth indeed seems to be of a character almost intermediate between the Mandibulata and the Haustellata; the seti-form mandibles are very like those of the Hemiptera, whilst the other parts of the mouth, in their general distribution, are more like those of a real mandibulated insect. It appears doubtful to me, however, whether the action, even of the maxillæ, can be transverse, or whether the insect can be said to bite its food."—(Westwood's Intro., Vol. II., p. 5.)

Hairs of Antelope.—I wish to direct attention to the perfection of their structure for lightness and warmth; hollow like delicate quills; filled with air, and therefore light, and at the same time packed with layer upon layer of a felty substance, the essence of warmth. If we could but have clothes equally adapted to comfort in our present temperature (88° in the shade), we should not need to echo the Rev. Sydney Smith's merry wish that "we could take off our flesh, and sit in our bones!"

TUFFEN WEST.

Selected Notes from the Society's Note-Books.

Antennæ of Diptera (Plates 5, 6, 7).—The most noteworthy feature in these Antennæ is the large size of the olfactory capsules. A considerable resemblance will be observed between the Antennæ of *Sargus* and those of *Stratiomys*, Figs. 1 and 2, and the allied genera, although their outward form varies much. Perhaps Fig. 11 is the most interesting pair of antennæ on the slide. Figs. 9 and 10 belong to a genus very nearly related to the fly which owned the antennæ, Fig. 8. Although the antennæ are so different, the flies themselves might easily be confounded by a young student of entomology. Figs. 6 and 7 belong to flies allied to the Bombylidæ, which are described in *Science Gossip*, 1875.

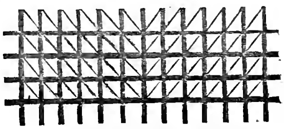
H. M. J. UNDERHILL.

Fowl Flea, showing muscles all over the body, the large muscles of the thorax and legs being particularly visible, was mounted in the following manner :—It was killed with ether, and allowed to soak in that medium for three to six days, then soaked successively for a day at a time in water, methylated spirit, absolute alcohol, and oil of cloves, and finally mounted in balsam. The process is easy, and as a number of objects may be done at one time, there is no real waste of time. Objects so prepared should be mounted without pressure, which may be effected by allowing the cover-glass to rest on three fragments of thin glass.

F. J. ALLEN.

Cowrie Shell Section.—Hugh Miller, in that delightful book, the "Testimony of the Rocks," dwells at some length on what he calls the "human cast and character" of the contrivances which the organisms of the geologic period exhibit, and familiar as I am with every kind of mechanical and structural device in the dockyard, this idea is brought frequently before me with peculiar force, and I could not help recalling it when looking at Mr. West's exquisite drawing of the section of Cowrie shell, and the description of it in the text. Every one knows that the framework of a ship is composed, so to speak, of two elements, viz., the timbers or perpendicular framing, and the horizontal planking laid thereon as indicated by the upright and horizontal lines here shown—but perhaps it is only those who have opportunities of seeing the thing who are aware that in many of our ships of war, at all events, the structure is further strengthened by diagonal tie-bars of iron inside, as indicated by the lighter cross lines, which thus answer exactly to the interlacing diagonal fibres of the Cowrie shell, as mentioned by Mr. West. See page 37.

Fig. 1.



A. HAMMOND.

Hantsch's fluid as a mounting medium, is a very valuable one for many purposes; it is composed of three parts alcohol, two parts distilled water, one part glycerine. Its density approaches closely to that of common water; hence it may be used for mounting the most delicate structures, as algæ, &c., which by osmosis become instantly spoilt by the action of pure glycerine. By repeated additions, the alcohol and water evaporating, the specimen will remain in glycerine alone. Of course it must be carefully protected from dust in the meanwhile. Rev. W. W. Spicer speaks in the highest term of this process, saying—"I have had the opportunity of examining slides of Desmidiaceæ prepared in Dresden after Herr Hantsch's method. Nothing can exceed the beauty of these preparations; the form of the plant, and the colouring of the endochrome, having undergone no change whatever."—Johann Nave's Handy-book, p. 59.

T. West.

Mounting Dry Opaque Objects without Cover-Glass.—Dr. Carpenter, in his work on the Microscope, Sec. 155, p. 209, says that he has a large collection of objects mounted in this way, and as regards myself I will add that my rather extensive collection of Polyzoa is for the most part without cover-glasses. I find that—

1st.—Objects are better seen by reflected light when there is no cover intervening.

2nd.—You avoid the condensation of moisture on the under side of the cover-glass, which, after a time, damages good slides.

3rd.—A still worse evil which, unfortunately, very frequently occurs, viz., a beautiful growth of a Fungus *(Penicilium)*, interesting in itself, but a dangerous intruder into the cabinet. When the object to be preserved is delicate, it should undoubtedly be covered, and the risk of these evils must be incurred.

[This may be in a great measure prevented by previously washing the object to be mounted in a solution of carbolic acid, and thoroughly drying before mounting.—Ed.]

But where it is of a coarser character, much is gained and nothing lost by leaving it uncovered. The slides may be laid flat upside-down in the cabinet, and labelled on the back, or, as Dr. Carpenter says, a number of them may be packed closely together in boxes or held by an elastic band. Much economy in space is thereby gained, and no dust enters, and if dust is observed, the coarser objects I speak of may be lightly brushed with a soft camel-hair pencil. I may add that the cedar slips I use are cheaper than the more complicated way of mounting; they cost 6d. or 8d. per dozen, and I make the bottom to the cell by fixing on a piece of black paper.

G. D. Brown.

False Crystals in Decolourised Leaves.—I should like to ask, Is not the process of decolourising leaves by chlorinated soda likely to produce false or unnatural crystals in them? In many leaves which I have bleached I have noticed, besides the natural Raphides and Sphæraphides, numbers of small crystals, some irregular in shape, like very small Sphæraphides and some larger, giving beautiful rosette-like appearances with polarised light. I am convinced that false crystals are produced if a solution of chloride of lime is used, particularly the rosette-shaped ones, and I am afraid that the same thing takes place sometimes with the soda solution.

W. H. HAMMOND.

I agree with the *possibility* of the above taking place, but have not yet seen any evidence of its actual occurrence. It would be more likely to happen with lime, as soda salts are far more soluble than those of lime, and would be probably washed away in the free rinsings which the process of preparing involves.

G. D. BROWN.

[We think a weak solution of acetic or nitric acid in the last washing but one, would effectually get rid of any traces of either soda or lime that might be adhering to the leaves.—ED.]

EXPLANATION OF PLATES III., IV., V., VI., VII., VIII.

PLATE III.

Fig. 1.—*Plagiogramma elongatum.*
- *a.*—Side view of an ordinary-sized specimen, mag. 250 diam.
- *b.*—Side view of another specimen (? sporangial).
- *c.*—Front view; outline of missing valve supplied.

,, 2.—*Hydrodictyon utriculatum.*
- *a.*—Natural size of the specimen. It is said to grow from 4 to 6 inches in length, and I think I have seen a pressed specimen reaching nearly to this latter size.
- *b.*—Portion magnified 15 diameters.
- *c.*—Another piece, magnified 50 diameters, to show the knots at the junction of the cells.

,, 3.—The specimen of *Coleosporum tussilaginis.*
- *a.*—Restored to its natural appearance. The outline of the leaf gives the position from which it has probably been taken.
- *b.*—Echinulate spores; the early or Uredo form of fruit.
- *c.*—Four-septate ascus.

,, 4.—Stellate hairs from *Niphobolus lingua.*

Fig. 5.—Transverse section of Maple, natural size. The regular cracking of the bark into six equal divisions is well seen.

,, 6.—Segment of the same, magnified 25 diameters. *p.*, Pith; *s.v.*, spiral vessels; *m.r.*, medullary rays, forming the means of communication between the central and outer portions; *l.f.*, liber fibres; *c.p.*, cortical parenchyma; *c.b.*, cellular layer of the bark; *c.l.*, corky layer of the bark; *w.1*, ring of wood of the first year's growth; *w.2*, ditto of second year's growth; *e.p.*, the outer layer of cells forming the cuticle or epiderm. The lines show the direction of the sections required to illustrate the subject completely. *v.r.*, Vertical radial—*i.e.*, in a line with the medullary rays; *v.t.*, vertical tangental—*i.e.*, across the medullary rays.

,, 7.—Very small leaf of *Mercurialis perennis*, natural size.

,, 8.—Sphæraphides in the same, magnified 100 diameters.

Plate IV.

Figures illustrating early stages of *Culex pipiens.*

Fig. 1.—The Larva in the position, head downwards, usually assumed by it. It is drawn from a mounted slide, and is somewhat contracted by the preservative fluid. *a.*, Antenna; *r.t.*, respiratory tube, closed at times by valves (two only of the six are here well seen); *v.*, vent, four delicate sub-triangular plates guard the aperture.

The normal number of segments in an insect's body is 13. It is necessary for descriptive anatomy, or indeed for any right understanding of what is seen, to be able to count them.

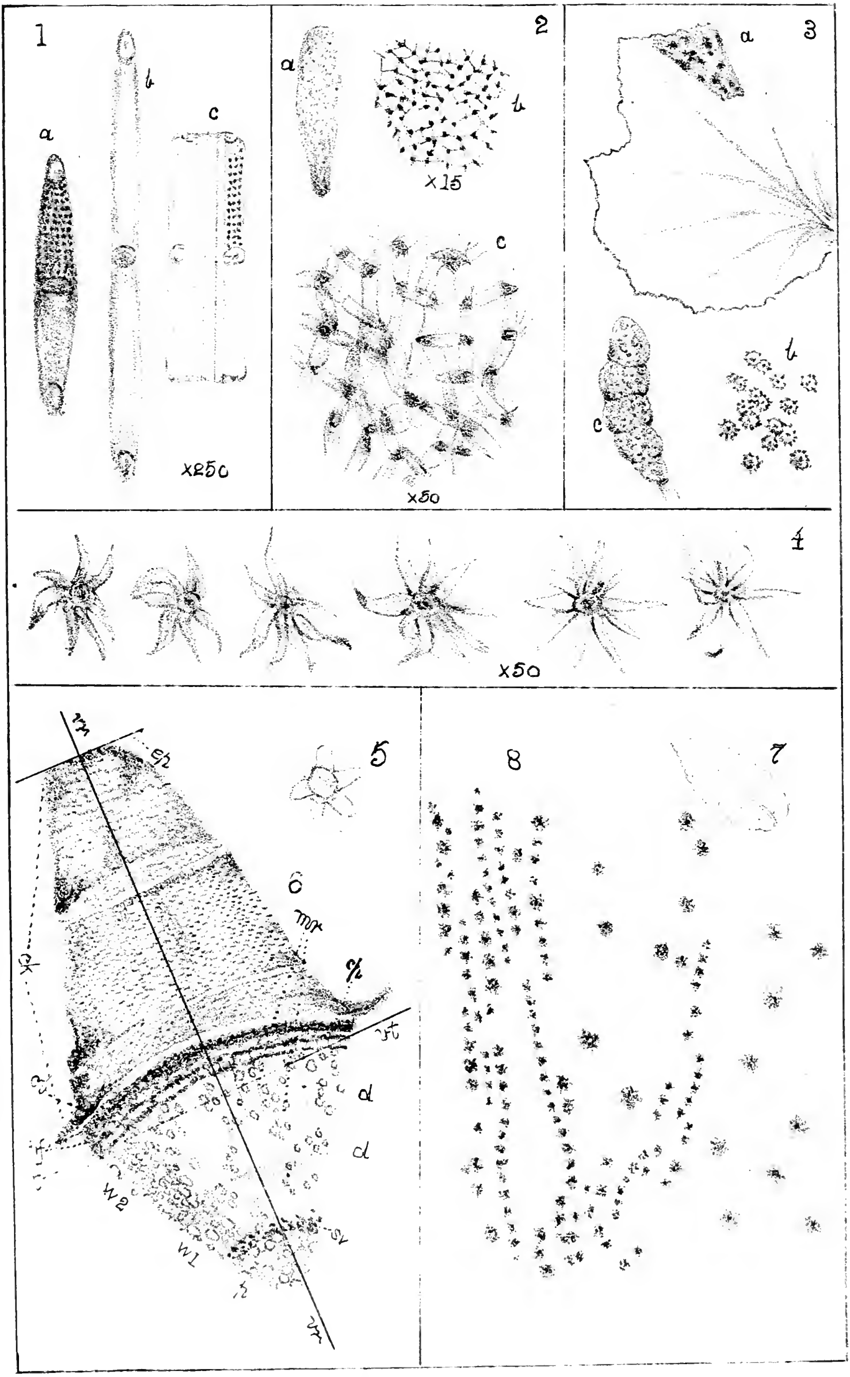
1.—The head; 2, 3, 4.—Pro- meso- and meta-thorax. The remainder are the abdominal segments. The apparent tail, *r.t.*, is thus proved not to be a tail at all, but is really a pair of members united to bear between them two large tracheæ, with their appendages.

,, 2, 3, and 4.—Three successive stages in the development of the *Pupa.*

t.r.l., in Figs. 2 and 3.—A pair of trachiferous thoracic limbs. These may be seen in life to move occasionally.

The fifth segment, or second abdominal, bears a remarkable pencil of hairs. *a.l.*, Anal limbs, arising, like those forming, by their union, the respiratory tube in the larva, from the penultimate segment. They are terminated, each, by one or two fine tactile hairs, indicated by *t.h.*, in Fig. 4. Indeed, all the hairs are tactile, or answer to the whiskers of higher animals.

In Fig. 4, the pro-thoracic spiracle, and the various abdominal spiracles of the imago are marked, as also the haltere, *h.*; *p.r.s.*, pro-thoracic spiracle; *a.s,*, abdominal spiracles.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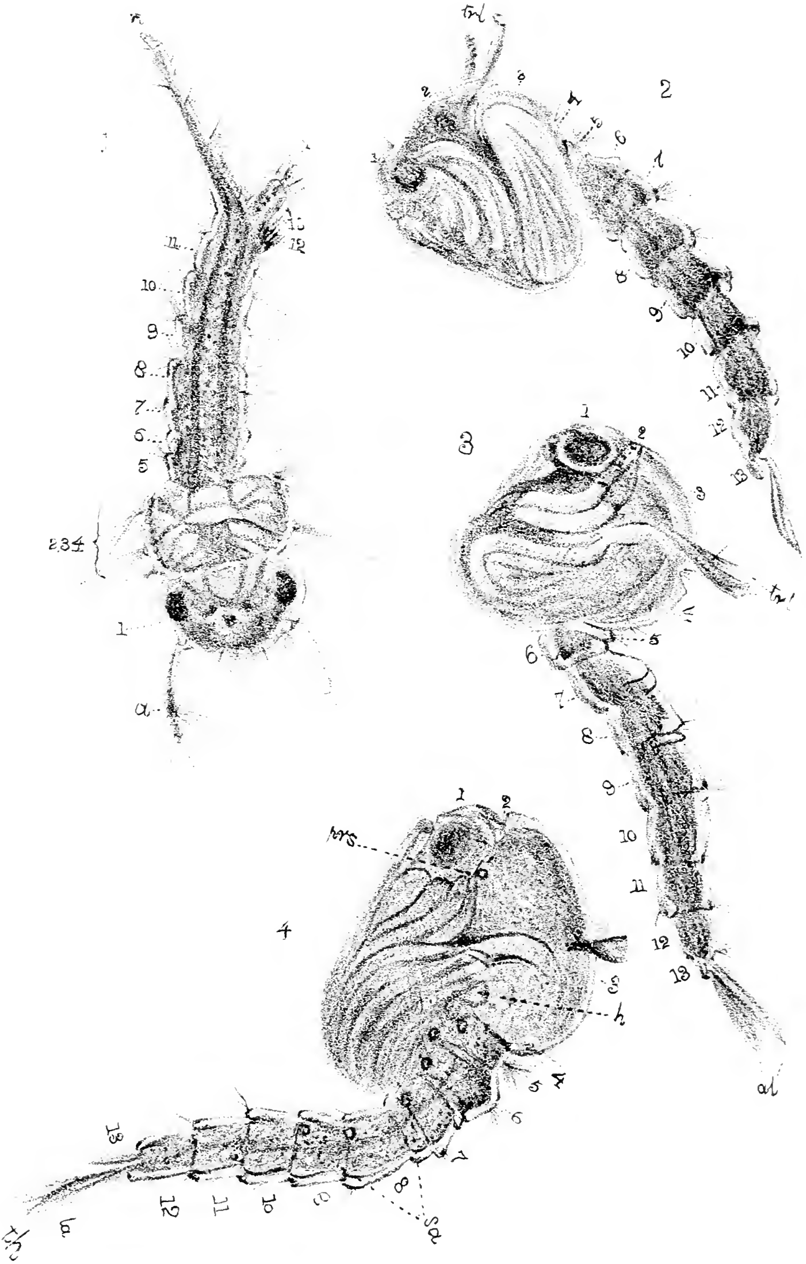
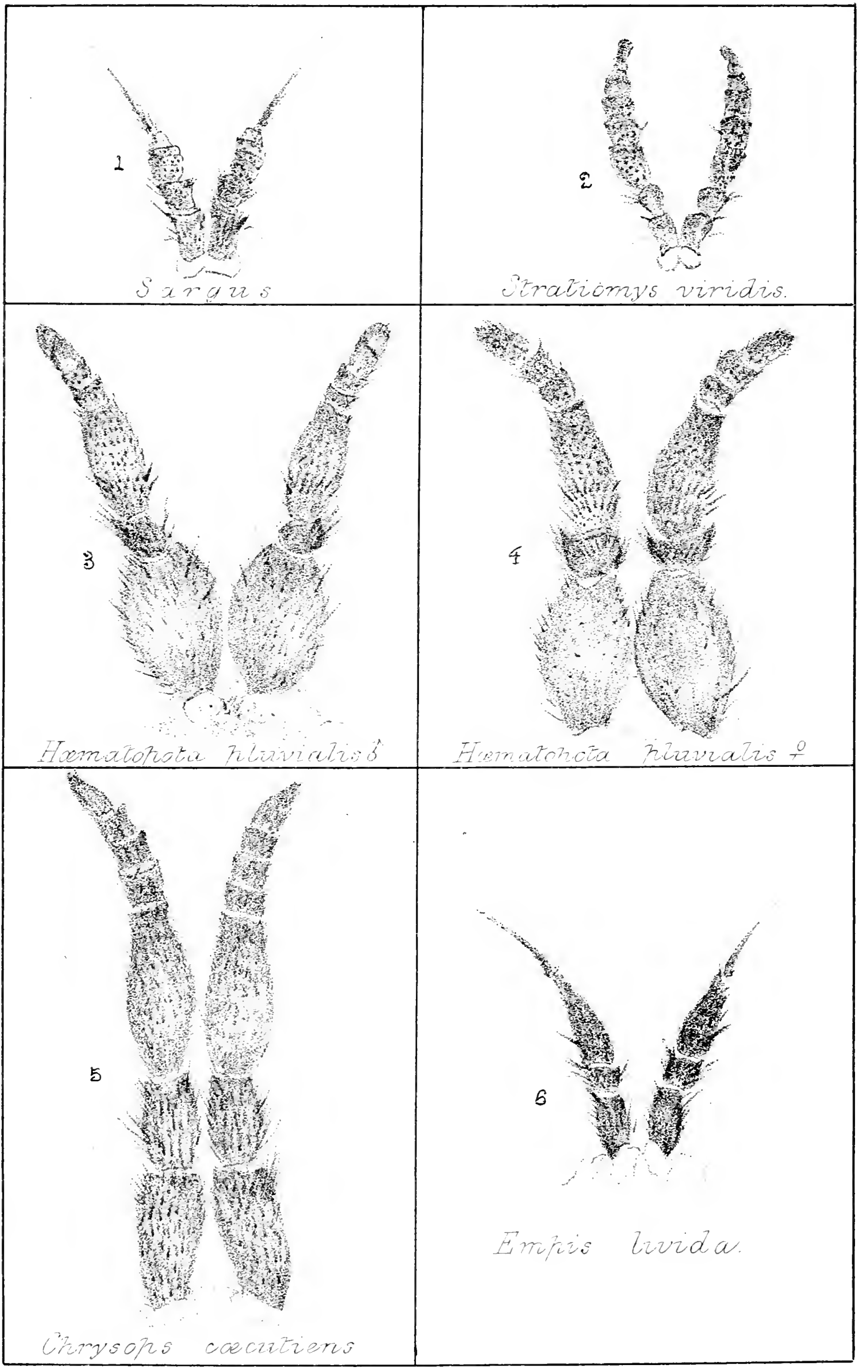
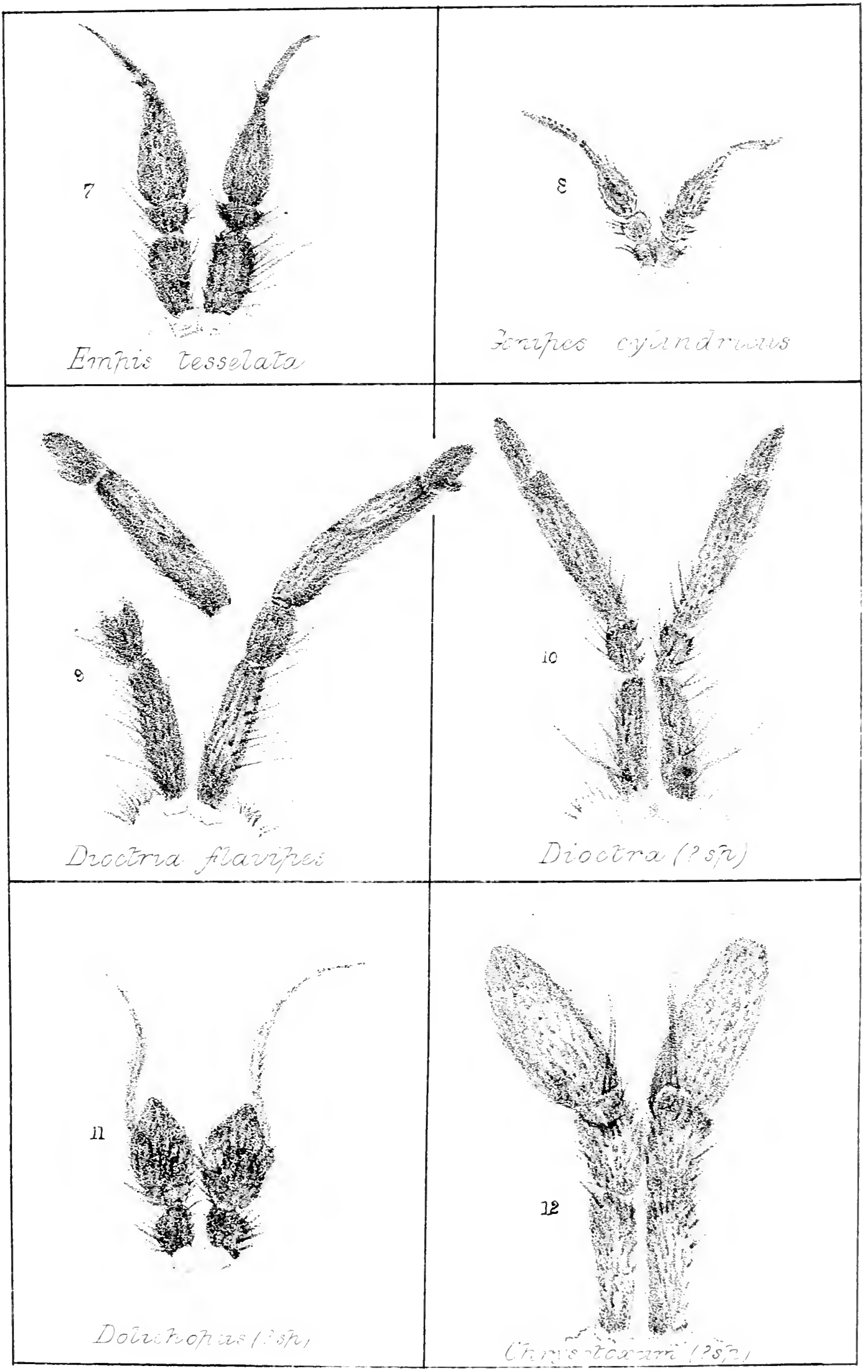


× 15

Early Stages of Gnat.

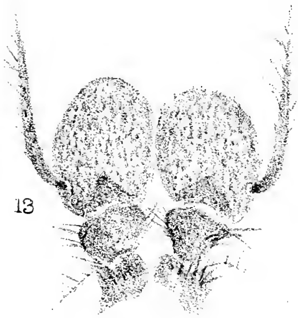


Antennæ of Diptera.



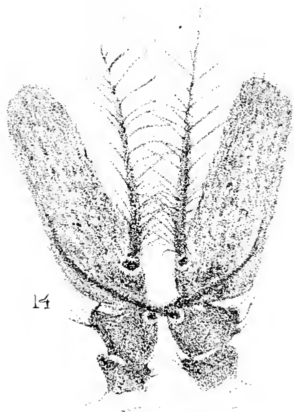
Antennæ of Diptera

13



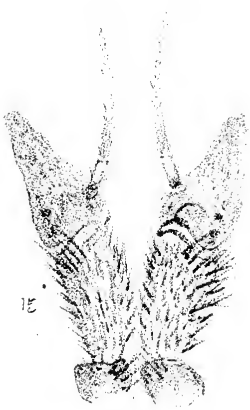
Eristalis (?sp)

14



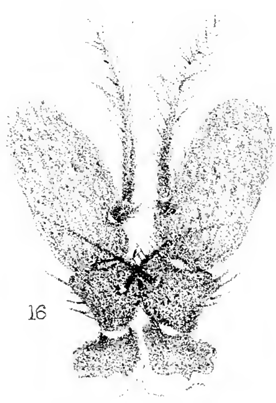
Musca (?sp)

15



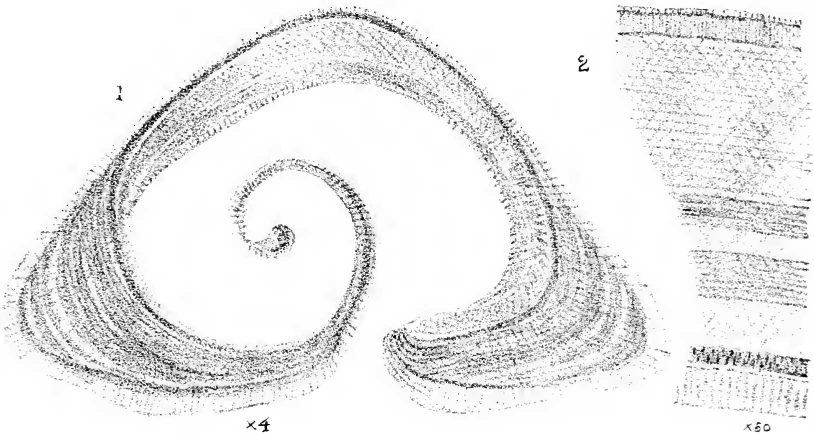
Tetanocera ferruginis

16

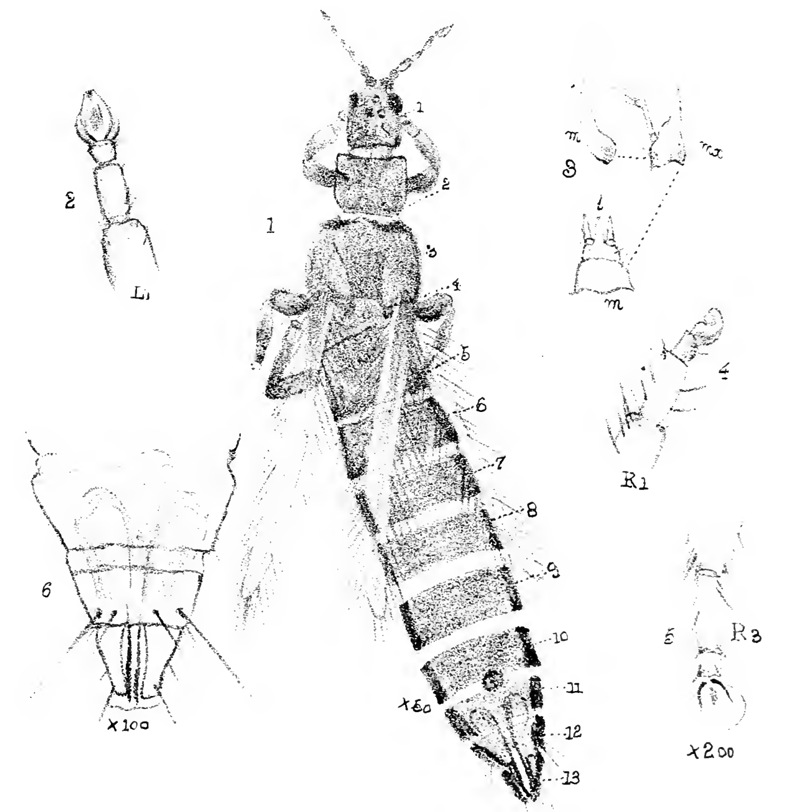


Muscidæ. Fam.

Antennæ of Diptera.



Trans. sec. of Cowrie Shell.



Thrips (?sp)

PLATES V., VI., VII.

Figures illustrating Antennæ of Diptera.

Fig. 1.—*Sargus*, species of.
,, 2.—*Stratiomys viridis.*
,, 3.—*Hæmatopota pluvialis*, ♂
,, 4.—Ditto, ditto, ♀

The differences of Figs. 3 and 4 appear to consist principally in the larger size of the latter ; the more globose outline of the basal, and smaller size of the second joint, in the female.

,, 5.—*Chrysops cæcutiens*, Golden-eyed Gad-fly.
,, 6.—*Empis livida*, Common Snipe-fly.
,, 7.—*Empis tesselata*, another species of Snipe-fly.
,, 8.—*Gonipes (leptogaster) cylindricus.*

(I do not see any reason why the name of this fly should have been altered to *leptogaster*, and prefer that adopted by Westwood, which is well known and recognised.—*Tuffen West.*)

,, 9.—*Dioctria flavipes.*
,, 10.—*Dioctria* (another species).
,, 11.—*Dolichopus* (? species).
,, 12.—*Chrysotoxum* (? species).
,, 13.—*Eristalis* (? species).
,, 14.—*Musca* (? species).
,, 15.—*Tetanocera ferruginis.*
,, 16.—Fam. *Muscidæ*, genus unknown.

PLATE VIII.

Upper Half. Transverse Section of Cowrie Shell.

Fig. 1.—Section through the entire shell to show the arrangement of the different structures.
,, 2.—Portion of the arch more enlarged.

Lower Half. Figures illustrating Thrips (species unknown).

Fig. 1.—Thrips, magnified 50 diameters.
,, 2.—The left anterior foot in its natural state seen from above.
,, 3.—Parts of the mouth, after Westwood. *m.*, Mandible ; *m.x.*, maxilla, with its palp ; *l.*, labium, with its pair of minute palpi ; *m.*, mentum.
,, 4.—Profile view of right anterior foot in its contracted condition.
,, 5.—The posterior limb of the right side, with the bladder-like foot fully expanded.
,, 6.—End of Abdomen, showing a pair of minute saws.

Figs. 2, 4, and 5 are from a Thrips infesting flowers of *Datura Stramonium.* All drawn by Tuffen West.

Our Annual Meeting.

THE Eleventh Annual Meeting of the Postal Microscopical Society was held in the Prince of Wales's Salon at the Holborn Restaurant, on Wednesday, the 8th of October, 1884.

At the meeting summoned for business purposes at 6.30 p.m., the following members were present:—Dr. C. F. George, President-Elect, in the chair; the Rev. R. K. Corser (Bath), Mr. A. Hammond (London), Dr. Kesteven (Enfield), Mr. Martin (Old Charlton), The Rev. E. T. Stubbs (Bath), The Hon. J. G. P. Vereker (London), Mr. G. H. Robinson (Huddersfield), and the Secretary.

The following report of the Committee was laid before the members:—

Your Sub-Committee have held several Meetings during the year, notably one on the 14th of March, which was attended by Dr. COOMBS, President. At that Meeting, with a view to obtain a greater increase of Members, your Secretary suggested a scheme for the admission of Members of the Medical Profession to a new section of the Society, to be called the "Medical Section." In furtherance of this scheme, the President inserted a letter in many of the Medical Journals, and several Medical men have joined the Special Section.

The Roll of Members at the present time consists of—

Members of the General Section	...	...	165
Members of the Medical Section*	...	...	9
Total ...	...	...	... 174

We believe the new method of filling the Circulating Boxes has proved in a certain degree a decided success—many Members having written very full and comprehensive Notes in elucidation of their Slides; the method also of each Member supplying at least six Slides has proved decidedly advantageous, as in most cases the Slides so contributed have formed a Series.

The thanks of the Society are especially due to those of our Members who make special efforts to render their Slides and Notes interesting.

With respect to our Journal, your Committee and the Editor are still looking forward with much faith to very satisfactory results

* Twenty Medical Members are now on the roll.

in the near future. It has not yet reached the high tide of success which we hope it is fairly on the way for, but it is confidently believed that the day is not far distant; in the meantime, your Editor assures you that he is sparing no efforts to bring it about, and he would again beg of you, not only personally, but by the help of your friends, to furnish him with suitable Papers for insertion, and by your individual influence to endeavour to promote its sale.

Owing to an extraordinary pressure of work from various sources connected with the Society and the Journal, and from an unusual share of ill-health during the past summer, your Hon. Sec. has allowed many Members to become defaulters. The Balance Sheet annexed was made out Sept. 8th. It is hoped that before our meeting the adverse balance will be considerably reduced, as the Society is really in a greater state of prosperity than at the corresponding date last year.

The SECRETARY produced his Annual Statement of Receipts and Payments, a copy of which was handed to each member present, and was as follows:—

The Treasurer in account with the Postal Microscopical Society.

DR.	£	s.	d.	CR.	£	s.	d.
To Receipts ...	96	5	0	By Balance brot. forward	13	16	9
				,, Postages, Stamps, etc.	34	11	9
				,, Journey to London for Annual Meeting ...	2	0	0
				,, Two Visitors ...	0	8	0
				,, Dinner-Cards ...	0	3	6
				,, Christmas-Box to Postman	0	2	6
				,, Printing Circulars, etc.	7	10	0
				,, New Note & Ac. Books	2	0	0
				,, Envelopes	0	10	6
				,, Repairing Boxes ...	0	12	6
				,, Circulating Journals..	6	2	0
To Balance due to Treasurer ...	16	17	0	,, 181 copies P.M.S. Jnl. to Members ...	45	5	0
	£113	2	0		£113	2	0

The Secretary explained that there were still outstanding subscriptions which he considered would reduce the deficit appearing in the balance sheet to a nominal amount. So large an amount of arrears was in some degree to be accounted for by his illness, in consequence of which some portions of his work had been allowed to fall into arrear.

The various items were then gone through and closely criticised, to ascertain if any saving in the expenses of the Society could be effected.

The SECRETARY explained that the sum of £6 2s., charged for circulating Journals, was repaid to the Society by members who received them, and who paid an extra subscription for the privilege of reading them.

The CHAIRMAN explained that the gross receipts were about the same as those of last year, because last year the cost of the Journal was not included in the subscription.

The REV. R. K. CORSER understood that the Journal was the Secretary's private account.

The CHAIRMAN replied that the Secretary was responsible in every way for the Journal, but he charged the Society for as many copies as there were members in the Society.

The CHAIRMAN thought they ought to have a clean balance sheet before starting on a new year.

MR. HAMMOND considered that the unpaid subscriptions might be treated as an asset.

A long discussion ensued on the other items in the account, and various suggestions were made; but with the exception of the new note and account books and repair of boxes, which were not likely to recur again for some years, it was not found possible to greatly decrease the expenses of the Society.

The report was then adopted.

The SECRETARY then brought up the question whether there should be a conversazione instead of a dinner at future annual meetings of the Society.

The REV. E. T. STUBBS inquired if the dinner was a loss to the Society.

The SECRETARY replied that the members paid for the dinner if 25 were present. He had made inquiries as to the cost of a room suitable for a conversazione, and he could not get one under 2½ guineas, with an extra charge if refreshments were supplied.

Some considerable discussion took place, in which it was pointed out that the question was not so much one of expense as the loss of time necessarily taken up by the dinner, which prevented the members meeting freely after the cloth was removed.

Eventually, DR. KESTEVEN proposed, "That at the next annual meeting of the Society, a conversazione should be held instead of a dinner."

The REV. E. T. STUBBS seconded the resolution.

Mr. Hammond suggested that a charge should be made for the tickets sufficient to cover cost of hire of room, etc.

The Chairman put the resolution to the meeting, which was carried; the arrangements for the meeting being left to the Committee. Mr. Hammond's resolution was not supported.

This concluded the business part of the meeting, and the members and friends assembled at the dinner-table.

The Dinner.

The following ladies, members, and visitors were present at the dinner, the visitors' names being distinguished by an asterisk: Miss Aston,* Miss S. Aston,* Mr. W. Leigh Bernard,* Mr. J. C. Christie, Mr. Thomas Curteis, Rev. R. K. Corser, Mr. James Epps. Junr., Mr. H. E. Freeman,* Dr. C. F. George, Mr. F. George,* Mr. Henry George,* Mr. Arthur Hammond, Mr. James H. Izod,* Mr. L. Jeaffreson,* Mr. F. Martin, Mr. John Martin,* Mr. H. N. Maynard, Dr. Pocock,* Dr. Malcolm Poignand, Mr. G. H. Robinson, Rev. E. T. Stubbs, Rev. J. E. Symns,* Hon. J. G. P. Vereker, Mr. B. Wells, Mr. E. Wells,* Mr. P. Wells,* Mr. B. H. Woodward,* Mr. A. R. Wright,* Mr. Alfred Allen.

In the absence of Dr. Coombs, the President, Dr. C. F. George, President-elect, was voted to the chair.

At the close of the dinner, the President proposed the first toast, "The Queen," which was received most loyally.

The Secretary then collected the votes for the Vice-President for the ensuing year.

The President announced as the result of the poll that a number of members had received one or more votes each. Two members, Dr. Measures and Mr. Elcock, had 6 votes each, and the Rev. E. T. Stubbs had received 11 votes. He therefore declared that gentleman duly elected Vice-President for the ensuing year.

The Rev. E. T. Stubbs expressed his thanks for the honour the Society had conferred upon him in electing him Vice-President for the ensuing year. The honour was exceedingly unexpected, and, he might also say, extremely undeserved. He would do his very best to fill the office to the satisfaction of the Society.

The President, in proposing the toast, "Prosperity to the Postal Microscopical Society," observed that the Society was not quite so prosperous in a monetary way as could be wished. He hoped that next year the balance would be on the right side.

The toast having been duly honoured,

The SECRETARY rose, and said he had a special duty to perform that evening. The members were aware that the late President (who, he was sure, they were all very sorry not to see with them that evening, but who was unavoidably absent), a short time ago, interested himself very much on his behalf, the result being that Dr. Coombs had recently sent him a very handsome cheque as a testimonial of the goodwill of the members towards him. It, therefore, became him that he should say something on the subject, and he did not think he could put the matter better than he did in his letter of thanks to the President, which he would now read.

MR. PRESIDENT and members of the Postal Microscopical Society :—

I feel that there is a duty devolving upon myself to perform,—a very pleasant and at the same time a very difficult one. The pleasant duty that I refer to, is to thank the many members of the Society most heartily and sincerely, who helped to provide the very handsome testimonial that was so kindly sent me a short time ago by Dr. Coombs, the late President. The difficulty of the task before me is to express in suitable terms, my appreciation of the same. That, however, I do very heartily esteem your kindness, I trust you all believe.

It is not for me to tell you how much interest I have always felt, and trust I shall always continue to feel, in the success of our Society, or of the Journal, which I look upon as an offshoot of it. That the Journal has added very considerably to my labours, you will, I am sure, all readily understand. If only I could see a very small amount of profit attached to this extra labour, I should be thoroughly satisfied. I hope, however, that the Journal is making to itself a name, and that very shortly its sale will very rapidly increase, and as one of the surest ways of accomplishing this end, I trust each member of the Society will do all he can to make it known.

It is with much regret that I am again compelled to show an adverse balance sheet. In a Society like ours, when the members are scattered throughout the length and breadth of Great Britain and Ireland, and when but few are personally known to each other, it is difficult, although I do sometimes send a "dunning" letter, to get all arrears paid up. If there were no arrears, the adverse balance of last year would be nearly cleared off.

The roll of members contains a larger number than last year, and I am looking forward to much success, both in the Society, and with the Journal in the future.

Again thanking you, Mr. President, Ladies, and Gentlemen, for the handsome manner in which you have shown your appreciation of my services,

I am, very faithfully yours,

ALFRED ALLEN,

Hon. Sec., P.M.S.

The HON. J. G. P. VEREKER begged to be allowed to propose "The Health of the President." It was he who kept the Society together, looked after the members, and saw everything went on smoothly. He need not say he was a gentleman whom they all honoured.—The toast was warmly received.

The PRESIDENT, in acknowledging the toast, said that it was with much diffidence that he accepted the honour the Society had offered him in electing him President of the Postal Microscopical Society; and after a few more remarks of a complimentary nature, the President read the address, which will be found in the present part of the Journal.

MR. HAMMOND proposed a vote of thanks to the President for his very able and instructive address.

MR. CURTIES begged to be allowed to second the vote of thanks to the President for his address, which, although brief, was most interesting and suggestive, and well calculated to be useful to the Society. He therefore hoped the President would kindly allow the address to be published in the Journal.

The PRESIDENT returned thanks for the kind way in which Mr. Hammond and Mr. Curties had spoken of him. Ever since the formation of the Society, he had done what he could to help it, and he hoped the members would all do the same. He had brought with him a few of the mites he had mentioned in his address, and he would especially direct attention to a peculiarly beautiful one, whose body was surrounded with processes shaped like Japanese fans. He hoped to show these to the members and friends present, if time permitted, at the close of the meeting.

The PRESIDENT proposed, "Success to the Royal Microscopical, the Quekett, and kindred Societies," coupled with the name of Mr. Curties.

MR. CURTIES expressed his obligations to the President for coupling his name with this toast. Having been a Fellow of the Royal Microscopical Society for nearly twenty years, and actively engaged in promoting the interests of microscopy, he was in a position to say that the parent Society was now, as in the past, doing good and useful work. Witness its Journal, which, under the present able editorship, had reached a high position, and its varied information rendered it valuable to all microscopists. He did, however, regret that the Postal Microscopical Society, the Quekett Club, and other similar local Societies, could not be more closely associated; for the Royal Microscopical Society possessed a fine library and an admirable cabinet of objects, which he would wish to see better utilised. Perhaps he might say a word for the Quekett Club, of which he was also proud to be an active member. It was an admirable Society, and if the members of the Postal Society wished to increase their knowledge, they could not do better than join it. He trusted that other gentlemen would respond for the Societies with which they were connected, and concluded by thanking the ladies and gentlemen present for the hearty way in which the toast had been received.

Mr. B. H. Woodward, in responding for the Kindred Societies, said he was called upon quite unexpectedly to say a few words. He did not know that he could add much to what had already been said. The Quekett was, of course, the older Society, but its meetings were held at too great a distance for members living in the Northern suburbs to attend; therefore, many similar Societies had sprung up. He had been secretary of the Highbury Microscopical and Scientific Society for the last four or five years. It was a small Society, but it brought men together, and induced them to take up some scientific work, and he hoped it would do still more in the future, and that these Societies would bring forward some good work and add to the knowledge which had been gained by the use of the microscope. He stated that the Highbury Society would hold their 7th annual Soiree the next evening at the Highbury Athenæum. There would be 80 microscopes and other apparatus and natural history specimens exhibited, and any members of the Postal Microscopical Society would be welcome. He thanked the members for receiving the toast so cordially.

The Rev. R. K. Corser felt very much honoured in being invited to propose the next toast, "The Vice-President and Officers of the Society." Unfortunately for him, this was the first dinner of the Society he had attended, and it was the first time he had seen so many members of the Society. They were scattered so far apart, and only meeting once a year he really felt unable to express himself as he should like to do. He, however, happened to live in Bath, and he found that the "fair Queen of the West," as she is termed by many of her inhabitants, contained rather a large proportion of the Committee, and he certainly knew that some of the most highly esteemed members, and the Secretary especially, worked very hard. He had often gone to the Secretary's house, and found him surrounded with books, and literally up to his eyes in the work of the Society and the Journal, and always most ready to give any information. It was also his privilege to know the President-elect, the Rev. Mr. Stubbs. He was quite justified in saying that if these gentlemen were a fair specimen of the other officers, it was a highly-favoured Society, and would be most useful so long as they had such gentlemen to superintend their affairs. He had great pleasure in proposing the toast, "The Vice-President and Officers of the Postal Microscopical Society."—The toast was received with enthusiasm.

The Rev. E. T. Stubbs, in acknowledging the toast, said it was his duty to thank them for so kindly receiving the health of himself and brother officers. He felt it to be a very great privilege to live in Bath because they lived in the neighbourhood of the Secretary. The Secretary must, of course, have the Committee round him; otherwise, he could not convene meetings and expect them to attend. Thus it was he was able to know a great deal of the working of the Society, and how untiring the Secretary was in the discharge of his duty. He thought that the Society was exceedingly fortunate in having a Secretary of such experience as Mr. Allen. He hoped that the other officers would please the Society as well.

The President proposed the health of "The Visitors," and especially the ladies who had honoured the Society with their presence that evening. He had hoped to have seen more ladies present. On a former occasion, a much larger number had been present. Their absence this evening was probably due in a great measure to the exceedingly unfavourable state of the weather.

Mr. W. Leigh Bernard returned thanks on behalf of the Visitors for the kind reception accorded to them. They had enjoyed the hospitality of the Society, and he hoped that it would not be the last time they would be present at a similar gathering. He was very glad to see the President in the chair. He felt it might be said of the Society with the celebrated poet—

> "On active worth, the laurel, war bestows,
> Peace rears her laurel for industrious brows;
> Nor earth uncultured yields her kind supplies,
> Nor heaven its flowers without a sacrifice."

Mr. H. George, as a visitor, also wished to thank the Society for the kind way they had drank the health of the guests. He also begged to respond on behalf of the ladies. On the last occasion he believed that several of the ladies present were members of the Society and interested in the microscope. He was much interested in his father's microscopic work, and took great delight in looking at his many very beautiful objects. He was very proud to see his father in the chair as President of the Society. He thanked them for so kindly receiving their health.

At the close of the dinner, the members and friends spent the short time remaining in examining various apparatus and objects of interest brought by the President and other friends.

The following were the principal objects shown :—

A series of mites, illustrative of the remarks in his presidential address, especially the curious nymph of *Leiosoma palmicinctum*, one of the Oribatidæ, which has plumes round the body closely resembling Japanese fans. ... ... The President.

A very large old-fashioned Microscope, chiefly remarkable for giving a field 27 inches in diameter. ... ... The Secretary.

A Portfolio of Drawings illustrative of the structure and economy of the Larva of the Gnat, *Chironomus plumicornis*. ... Mr. Hammond.

Improved form of Microtome, capable of very minute adjustment. ... ... Dr. Kesteven.

Anatomical and other slides. ... ... Dr. Poignand.

Photograph of the recent Eclipse of the Moon. ... Mr. Martin.

A variety of Crystals by polarised light and other slides. ... Mr. B. Wells.

Myobia of Bat, two new species, recently discovered by the Rev. C. K. N. Burrows ; also, several species of Plumed Mites—*Glyciphagus palmifer*, *G. plumiger*, *Cheyletus habellifer*, and Hæmatopinus of Seal, etc. ... ... Mr. Freeman.

Reviews.

THE LICHEN FLORA of Great Britain, Ireland, and the Channel Islands. By the Rev. W. A. Leighton, B.A. Third edition ; pp. xviii.—547. *(London: W. P. Collins.)*

We are pleased to learn that Mr. W. P. Collins has secured the entire edition of this important work. Hitherto it has only been privately sold by the author, the late Rev. W. A. Leighton.

It is a valuable book, and will doubtless be found of the greatest service to all those who are interested in the study of Lichens. The number of species and varieties described is 1710. The work is preceded by an introduction to the study of Lichens, with their geographical distribution, general and local, and their uses. The glossary and index at the end of the book will be found most useful to the student. Lichenologists will do well to secure a copy of the work, as we understand the stock is limited.

MANUAL OF THE MOSSES OF NORTH AMERICA. By Leo Lesquereux and Thomas P. James; with six beautifully executed plates illustrating the genera. Pp. v.—447. (*Boston, U.S.A.: Cassino and Co.*)

The manual is believed to include descriptions of all the species of mosses (about 900) that are known to occur on the North-American Continent within the limits of the United States and northwards; to which is added a valuable glossary and index. The six litho. plates show anatomical dissections of all the genera. The work will form a good addition to the library of every botanist.

AIDS TO BOTANY. By Armand Semple, B.A., M.B., etc. Pages x.—103. (*London: Baillière, Tindall, and Cox.*)

EASY LESSONS IN BOTANY, according to the requirements of the New Code. By Edward Step; with 120 illustrations by the author. Third edition; pp. 48. (*London: T. Fisher Unwin.*)

FIELD BOTANY: a Handbook for the Collector, containing instructions for gathering and preserving plants, and the formation of the Herbarium. By Walter P. Manton. Illustrated; pp. 41. (*Boston, U.S.A.: Lee and Shepard.*)

Three little books valuable and useful to the students to whom they are addressed. The "Aids to Botany" is a very concise note-book, just such a one as may be read through with profit by the student to refresh his memory on the eve of an examination. The "Easy Lessons" are well adapted for use as an adjunct to class-teaching. The book is well and copiously illustrated, and contains a large amount of information compressed into a small space.

The "Hand-book of Field Botany" is essentially a collector's hand-book, and furnishes instructions as to Outfit, Collecting, Pressing and Preserving, Herbarium, Leaf-Photography, Printing Plants, Floral Designs, and Skeleton Leaves. The aim of this little book is to render assistance to the young student in his collecting expeditions.

MICROBES IN FERMENTATION, PUTREFACTION, AND DISEASE. By Charles Cameron, M.D., LL.D., M.P. Pp. 32. (*London: Baillière, Tindall, and Cox.*)

This is a paper read before the Glasgow Philosophical Society in Dec., 1881. Professor Tyndall, writing to the author in acknowledgment of a copy, says:—"Will you permit me to thank you for the pleasure I have derived from the perusal of this article? Matthew Arnold himself could not find fault with its lucidity; while as regards knowledge and grasp of subject, I have rarely met its equal."

PETLAND RE-VISITED. By the Rev. J. G. Wood, M.A., F.L.S., etc.; with numerous illustrations. Pp. xvi.—310. 1884. (*London: Longmans, Green, and Co.*)

A charming book, giving an account more particularly of a favourite cat named Pret, and of several dogs, more especially one named Roughie; followed by the history of several other more unconventional pets, such as a chameleon, a hedgehog, rabbits, mice, etc. Their histories are told in a most amusing way. It must, however, be acknowledged that few masters would suffer their pets to take the liberties that our author allowed. One favourite trick of Master "Pret" was to put all the dead rats which he had killed into his master's bed! The book is well illustrated, and is extremely suited for a gift-book at this season.

ZOOLOGICAL NOTES on the Structure, Affinities, Habits, and Mental Faculties of Wild and Domestic Animals, with Anecdotes concerning and Adventures among them, and some Account of their Fossil Representatives. By Arthur Nicols, F.G.S., F.R.G.S., etc. Illustrated; pp. vii.—370. (*London: L. Upcott Gill.* 1883.)

NATURAL HISTORY SKETCHES AMONG THE CARNIVORA, Wild and Domesticated; with observations on their habits and mental faculties. By Arthur Nicols, F.G.S., F.R.G.S., etc. Illustrated; pp. 257. (*London: L. Upcott Gill.* 1884.)

Two interesting books not designed, perhaps, on any thoroughly scientific basis, but full of information and anecdotes, written in a very easy style, the author drawing largely on his own experience. We notice how very different an estimate is formed of the cat by the writer of these books to that of the Rev. J. G.

Wood in "Petland Revisited." Mr. Wood believes firmly in the domesticity of the cat, and its strong attachment to persons—a view that we ourselves also hold; whilst the writer of these books looks upon it as still being in a more or less semi-domesticated state. Both books are deserving of careful reading.

THE HONEY-BEE: Its Nature, Homes, and Products. By W. H. Harris, B.A., B.Sc. Pp. xv.—272. (*London: The Religious Tract Society.*)

A popular book, and well illustrated, going very thoroughly into the history of bees. Commencing with a historic sketch, it then takes up the natural history of bees, and describes the various members of the bee community, followed by their anatomy, swarming, rearing, etc. The illustrations, of which there are 82, are excellent.

OUR INSECT ALLIES. By Theodore Wood. Pp. 238. (*London: Society for Promoting Christian Knowledge.* 1884.)

This book consists of a series of short papers, giving the life-history of some of the most common insects of this country. The work is a good illustration of the truth of a remark which occurs in the introduction—"Science is no longer a mere accumulation of dry facts, complicated by pedantic and often meaningless phraseology, but has been proved capable of affording instruction and interest, not only to the few, but the many."

LEISURE-TIME STUDIES, chiefly Biological; a Series of Essays and Lectures. By Andrew Wilson, F.R.P.S.E., etc.; with numerous illustrations. Third edition; pp. xv.—381. (*London: Chatto and Windus.* 1884.)

To say that this book is written by Dr. Andrew Wilson is saying sufficient to recommend it to the notice of all students of natural history. The subjects treated in the work before us are chiefly biological, and relate to "The Study of Lower Life," "Facts and Fictions of Zoology," "Animal Architects," "The Law of Likeness and its Workings," "The Origin of Nerves," "Animals and their Environments," etc. etc. The book is illustrated with 67 well-executed engravings.

FIRST NATURAL HISTORY READER for Standard II., according to the requirements. (*London: T. Fisher Unwin.*)

This capital little book, published according to the requirements of the new Education Code, is devoted to the description of quadrupeds and birds, and contains 61 illustrations.

Practical Taxidermy, a Manual of Instructions to the Amateur in collecting, preserving, and setting up Natural History Specimens of all kinds; to which is added a chapter on the pictorial arrangement of a museum. Illustrated by Montague Browne, F.Z.S., etc. Second edition; pp. viii.—354. (*London: L. Upcott Gill.* 1884.)

We have the various methods described of trapping, skinning, and preserving fishes, birds, animals, and reptiles; dressing and softening furs and skins; collecting and preserving insects. In short, the book contains a large amount of information, and affords great assistance to the practical naturalist. The instructions given towards the end of the book on the arrangement of museums are very good. The work is illustrated with 57 engravings and 5 plates.

Taxidermy without a Teacher, comprising a complete Manual of Instruction for Preserving Birds, Animals, and Fishes. By Walter P. Manton, M.D. Second edition; illustrated; pp. 56. (*Boston, U.S.A.: Lee and Shepard.*)

Insects: How to Catch and how to Prepare them for the Cabinet. By Walter P. Manton, M.D. Illustrated; pp. 32. (*Boston, U.S.A.: Lee and Shepard.*)

These are admirable little hand-books, small enough to be carried in the pocket, at the same time giving those practical directions which we sometimes fail to find in some of the larger manuals. These are just the books to give to our young naturalists.

Beginnings with the Microscope: A Working Hand-book, containing simple instructions in the art and method of using the Microscope and Preparing Objects for Examination. By Walter P. Manton, M.D. Illustrated; pp. 73. (*Boston, U.S.A.: Lee and Shepard.* 1884.)

We only wish we could have seen this book when we first began to use the microscope. It gives a list of working tools and accessories, with instructions for making a number of them. We find also chapters on preparing, staining, and embedding objects, section-cutting and mounting, and, last though not least valuable, two chapters on "How to Work" and "What to Work with."

Vestiges of the Natural History of Creation. By (the late) Robert Chambers, L.L.D. Twelfth edition, with an Introduction by Alexander Ireland. (*London and Edinburgh: W. and R. Chambers.* 1884.)

It is now forty years since the first edition of this work appeared. The alarm and hostility which it then occasioned have died away, and in the interval a great change has taken place in the public mind, and the book will doubtless find a place in every well-selected library.

Elements of Surgical Diagnosis. By A. Pearce Gould, M.S., M.B.Lon., etc. Pp. viii.—584. (*London: Cassell and Co., Limited.* 1884.)

An excellent manual for the medical student.

Aids to Practical Physiology. By J. Brindley James, M.R.C.S. Pp. viii.—60. (*London: Baillière, Tindall, and Cox.* 1884.)

This is also intended for the use of the medical student, it being one of the "Students' Aids Series." At the end will be found a few pages for MS. notes.

Dental Caries, a Critical Summary; and the Prevention of Dental Caries. By Henry Sewill, M.R.C.S., L.D.S.Eng. Pp. 66. (*London: Baillière, Tindall, and Cox.* 1884.)

This book consists of a series of papers reprinted from the "Journal of the British Dental Association," "in the hope that they may facilitate the study of the most important of Dental Diseases."

The Brain and the Nerves: Their Ailments and their Exhaustion. By Thomas Stretch Dowse, M.D., F.R.C.P.E. Pp. 136. (*London: Baillière, Tindall, and Cox.*)

The work treats in a great degree of Nervous Energy, Exhaustion, and Fatigue.

A First Book in Geology, designed for the Use of Beginners. By N. S. Shaler, S.D. Pp. xvii.—255. (*Boston, U.S.A.: Ginn, Heath, and Co.* 1884.)

A good book for a beginner. The facts described are judiciously selected, and the author has the rare art of knowing what to leave unsaid. Thus the student is not overwhelmed with an immense mass of facts and phenomena, but is given a general view of the scope and range of the science of geology, and is better able afterwards to grasp the multitude of necessary detail.

Text-Book of Descriptive Mineralogy. By Hilary Bauerman, F.G.S. Pp. vi.—399. (*London: Longmans, Green, and Co.* 1884.)

This is one of the well-known text-books of science, another of the series being Systematic Mineralogy, by the same author. The present work is illustrated by 237 well-executed engravings.

Electricity and its Uses. By J. Munro. With numerous illustrations; pp. xxii.—180. (*London: The Religious Tract Society.*)

The recent advances made by electricity have excited much public interest; that these advances may be explained to the reader is the object of the book before us. The work is illustrated with 83 engravings and 1 plate.

Whirlwinds, Cyclones, and Tornadoes. By William Morris Davis. Pp. 90. (*Boston, U.S.A.: Lee and Shepard.*)

This is one of the Boston "Science" series. In it the author gives us a clear and popular account of the various descriptions of storms.

Photography for Amateurs. By T. C. Hepworth. With illustrations; pp. 160. (*London: Cassell and Co., Limited.* 1884.)

This little shilling book is a non-technical manual for the use of all interested in the art of photography; the instructions given are plain and simple.

Report of the Commissioners of Agriculture for the year 1883. Pp. 496. (*Washington, U.S.A.: Government Printing Office.* 1883.)

In the department of agriculture many subjects are treated having special interest for the microscopist and naturalist. Thus, we find a paper on the diseases among sheep in Texas, with five plates of the worm, *Strongylus contortus;* one on Grasses, with 25 plates; and another on Cabbage-Caterpillars and other destructive insects, in which their life-history is worked out, and in many cases their enemies are pointed out. This paper is illustrated with 13 plates, some of which are coloured.

The Stars and the Earth; or, Thoughts upon Space, Time, and Eternity. Revised and enlarged, with Notes by Richard A. Proctor, B.A. Pp. 60. (*London: Baillière, Tindall, and Cox.*)

Mr. Proctor's books are always interesting. This is no exception to the general rule, and much food for thought will be found in its pages.

The Diseases of the Will.
Animal Automatism.
The Birth and Growth of Myth.
The Scientific Basis of Morals.
Illusions, Parts I. and II.
The Origin of Species, Parts I. and II.
The Childhood of the World.
Miscellaneous Essays.

The above form ten monthly parts of the "Humboldt Library," published by *J. Fitzgerald, of New York, U.S.A.*, at 15 cents each. The complete series, of which 61 are already published, will form a very interesting set. Darwin's papers are double size, and consequently double the usual price.

Notes on Natural Selection and the Origin of Species. By Frances P. Pascoe, F.L.S. (*London: Taylor and Francis.* 1884.)

In this little pamphlet of 20 pages, the author discusses Darwin's great work, and whilst acknowledging the great principle of evolution, does not appear to accept the whole of the Darwinian theory. It is a carefully written publication.

Current Notes and Memoranda.

We have pleasure in announcing that the third volume of Mr. A. C. Cole's very valuable series of "Studies" will shortly be commenced.

The work will be divided into four divisions:—

1.—Botanical Histology, in which the descriptive letterpress will be written by Mr. David Houston, F.L.S., F.R.M.S.

2.—Animal Histology, by Mr. Frederick Greening.

3.—Pathological Histology, by Mr. W. Fearnley.

4.—Popular Microscopic Studies, in which the descriptive letterpress and practical instructions will be written by the editor.

Each series will be issued at monthly intervals, and will consist of four pages of descriptive letterpress, a lithographic plate, and a slide prepared by Mr. A. C. Cole. Mr. Cole will edit the whole series.

The Chester Society of Natural Science have favoured us with a copy of Nos. 1 and 2 of their Proceedings, together with a SHORT HAND-BOOK OF NATURAL HISTORY for use at the Annual Conversazione and other meetings of the Society. The Proceedings contain several papers of interest, and show that much useful work is done in the Society. The Hand-book will be found very suitable to promoters of microscopic soirees, exhibitions, etc., in the scientific arrangement of objects for exhibition. It is published at sixpence.

THE LINNÆAN SOCIETY.

AT the last meeting of this Society, a paper by Mr. Alfred Tylor was read in part. The whole was entitled "On the Growth of Trees and Protoplasmic Continuity." The portion of the paper which dealt with the growth of trees was that read before the Society. Mr. Tylor's chief object was to show the principles that underlie the individuality of plants, and to prove that plants have a dim sort of intelligence, and are not merely an aggregation of tissues responsive to the direct influence of light. Not only this, but that the tree as a whole knows more than its branches, just as the species knows more than the individual, and the community than the unit. The result of Mr. Tylor's experiments, which have extended over many years, has been to show that many plants and trees can adapt themselves to unfamiliar circumstances, such as avoiding obstacles artificially placed in their way, by bending aside before touching, or by altering the leaf arrangement, so that at least as much voluntary power must be accorded to such plants as to certain lowly-organised animals. Finally, Mr. Tylor contends that a connecting system, by means of which combined movements take place, is to be found in the threads of protoplasm which unite the various cells, and that this connecting system is found even in the new wood of trees. He has also observed that the new wood of nearly all trees point upwards, but that year after year it changes its direction, showing much mobility.—*The Times*, Dec. 6th, 1884.

Mounting Diatoms.—After picking out and mounting singly some specimens of *Pleurosigma*, I find that each has collected round it a small quantity of moisture, quite spoiling the markings: the diatoms were prepared with Nitric Acid, and burned on the thin glass cover, and mounted dry with a ring of gold-size. Is the moisture the vapour of the size condensed, or was the acid not properly washed away? E.

We have received Reports and Proceedings of the following Societies:—

CHICHESTER AND WEST SUSSEX Natural History and Microscopical Society.

BRIGHTON AND SUSSEX Natural History Society.

MANCHESTER Scientific Students' Association.

Specimen Numbers of THE BRITISH NATURALIST and THE CANADIAN SCIENTIFIC MONTHLY have been received from Mr. Collins, 157, Gt. Portland St., London.

Mr. John Wheldon's Catalogue has been received, in which we notice two copies of Leeuwenoek's Select Works, and many other Works relating to Microscopy and Natural History.

Mr. Fred. Enock sends us a mounted slide of the Marsh-fly, *Tetanocera reticulata*, ♂ in which the whole of the structure and the arrangement of the internal muscles are very beautifully displayed; this slide will afford many hours' profitable stndy.

MR. CHAS. COLLINS, JUN., 25, St. Mary's Road, Harlesden, London, has sent us three nicely mounted slides of Heads of Insects. These are:—Head of Earwig, showing the mouth-organs adapted for biting, and Heads of Crane-fly and Oak-fly, in which the mouth-organs are suited for sucking. These objects are mounted without pressure, and the various mouth-organs are well displayed.

Cement for Glass, Porcelain, &c.—Take soft cheese, grind and wash it in hot water, then when it is freed from all soft matter, and nothing remains but pure caseine, press it in a fine cloth so as to squeeze out all the liquid. There remains a white matter, which is to be dried, reduced to powder, and preserved in a wide-mouthed bottle, or well-fitting box.

To make use of it, it must be ground up with a small quantity of water, which makes a very adhesive paste. It must be used immediately, and in the cold.

This cement sets rapidly; when once dry, it cannot be redissolved, either by moisture or heat.—*Moniteur des Produits Chemiques.*

The above is extracted from the "Chemical Review," to which the editor adds:—"According to our experience, the dry caseine should be ground up, not in water, but in ammonia, solution of borax, or in lime-water. We prefer to obtain the caseine, not from cheese, but from butter-milk, which is precipitated with acetic acid, using as little as possible. The precipitate is repeatedly stirred up in hot water, and thus washed by decantation, until all the fatty matter is removed. It may then be dried and pressed as above."

If this cement cannot be re-dissolved either by moisture or heat, we think it will make a splendidly firm cement for affixing glass or metal cells to glass slips; at any rate, it is worth a trial.

Mr. J. Walter Fewkes, of Cambridge, Mass., U.S.A., has very courteously sent us No. 9 of Vol. XI. of the "Bulletin of the Museum of Comparative Zoology at Harwood College." This is a most instructive and exhaustive paper "On the Development of Certain Worm Larvæ." It is illustrated with 8 double plates.

Mr. Charles Bailey, F.L.S., has kindly sent us a reprint of his paper "On the structure, the occurrence in Lancashire, and the source of Origin of *Naias graminea*, Del., var., *Delilei*, Magnus," read to the Leeuwenoek Microscopical Club, and to the Manchester Literary and Philosophical Society. Some idea of the exhaustive nature and interest of this paper may be formed from its consisting of 31 pages, illustrated with 89 engravings, and 4 litho plates.

Offers of Exchange or otherwise wanted for a first class No. 11 Immersion, o.g., by Hartnack and Prazmowski. Apply to J. S. G., 14, High Street, Chelmsford, Essex.

Many notices and other important articles have been pressed out of the present issue; they will appear in the April part.

THE JOURNAL OF MICROSCOPY
AND
NATURAL SCIENCE:
THE JOURNAL OF
THE POSTAL MICROSCOPICAL SOCIETY.

APRIL, 1885.

Chironomus Prasinus.

BY A. HAMMOND, F.L.S.

Plates 9 and 10.

PART I.

THE subject of this paper has been kindly identified for me under the above title, by Mr. Kirby of the British Museum. In all its stages the *Chironomus prasinus* much resembles another very common denizen of our ponds, water-butts, etc.—*Chironomus plumosus*, the larva of which is called the blood-worm, but appears to be a distinct species. It eventually becomes a minute Tipulid fly, which is not unfrequently mistaken for a gnat; a deception which the small size of the insect and the plumose character of the antennæ favour, but a glance at the head of the insect as seen in Fig. 28, Pl. 10, will at once show, that the formidable rostrum and lancets of the gnat are replaced by a pair of fleshy lips, flanked by a pair of five-jointed palpi, forming a very harmless piece of apparatus.

In this Journal I have on previous occasions illustrated the structure and economy of three species of Dipterous larvæ,* which may form useful points of reference and comparison in dealing with our present subject. Of these, that which it most resembles, both in external form and in internal structure, is the larva of *Tanypus maculatus*, the most conspicuous difference being that of colour, for whilst the larva of *Tanypus* is colourless, that of *Chironomus* is bright red, a distinction which, I have Mr. Sorby's authority for saying, is due to the presence of hœmoglobin in the blood. As in the annelids, however, *Tubifex*, *e.g.*, the colouration resides not in the corpuscles of the blood but in the plasma itself. Like *Tanypus*, the body is furnished with two pairs of grappling feet, having coronets of hooklets. These are evidently homologous with the prolegs of the Lepidoptera. I have found a dipterous larva in which all the abdominal segments were provided with similar organs, but, like a great many others with which I am acquainted, I am quite unable to identify it. It should, however, be noticed that while the first pair of limbs in our present subject is found on the prothoracic segment, this never occurs in caterpillars, and also that as contrasted with *Tanypus*, where they are partially fused, they are here quite separate. The crop, which in *Tanypus* assumes the form of a simple enlargement of the alimentary canal preceding the proventriculus,† and in the Blow-Fly that of a pendent pouch or sac, is in the present case entirely wanting, and the œsophagus opens directly into the proventriculus, a difference which may result from the nature of the food, which in the two former cases consists of animal matter, but here is composed of fine mud and such nutritious materials as it may contain.

Another point, too, is remarkable, As contrasted with the Blow-Fly, *Psychoptera*, and most other insects, this larva is, in the earlier stages at all events, distinguished by the almost total

* On the Larva of *Tanypus maculatus*. See this Journal, Vol. I., p. 83, On the Maggot of the Blow Fly., Vol. II., p. 33. On *Psychoptera paludosa*, Vol. III., p. 69.

† Mons. Felix Plateau, in a paper on the digestion of insects in the Memoires de l'Academie Royale de Belgique, Tom. xli., 1875, advocates with considerable force of reasoning the abandonment of all the nomenclature usually applied to the alimentary canal of insects, which presupposes the existence of an organ analogous to the stomach of vertebrates. I think it best, however, to use the ordinary nomenclature, at all events for the present.

obliteration of the tracheal system. A very few tracheal branches are seen to ramify in the thoracic segments, and as the period of pupation approaches these become more conspicuous ; but with this exception, there is no appearance of a tracheal system. How, then, is respiration effected ? Partly, it may be presumed, through the general integument, but more particularly, undoubtedly, by particular portions of that integument, which seem to be specially differentiated for the purpose of supplying the deficiency of tracheæ, viz., the four finger-like processes which are appended to the penultimate segment of the larva (see Pl. IX., Figs. 2 and 3), the cuticle of which is more delicate than elsewhere, and, therefore, well adapted for the purpose. Lastly, we may notice that the antennæ which in *Tanypus* are retractile are not so here, and there is no reason to think that they act differently from the same organs in other insects.

Having thus pointed out the main outlines of agreement with, or divergence from, the subjects of preceding papers, I will now proceed to give some details of structure and other observations which seem to me of special interest, confining my remarks in the present paper to the larval condition of the insect, and reserving the pupa and imago stages, and also the egg, for a future opportunity. I may premise that these larvæ are found abundantly in muddy streams and brooks, in the mud of which they live, and where they sometimes form rough, muddy tubes ; more generally, however, these tubes are little more than tracks, consolidated by the secretion from the salivary glands, which is poured out in such quantity as to form the substance of the mud into a kind of consistent felt, traversed in all directions by their burrows. In the vessel in which I keep them, this muddy felt can be lifted out *en masse* with a pair of forceps, and the bottom of the brook where I find them has a thick carpet of it, the presence of which must materially modify the detrital action of the stream.

To commence with the integument. This consists, as elsewhere, of an external cuticle and an internal layer of hypoderm, beneath which again there is, I think, a basement membrane. These structures have been more or less observed in many Insects and Crustacea by Leydig, Haeckel, Weissmann, Grueber, and lastly by Viallanes, in an important work on the Histology of Insects.* The cuticle is a secreted layer, formed by a secretion from the cells of the hypoderm beneath it. Mr. Lowne, I may mention, considers the cuticle of the Blow-Fly as formed by the coalescence of cells; † but this view is not, as far as I am aware, supported by any other authority. It is a structureless layer, very thin in young larvæ, but thicker and presenting a stratified appearance (see Fig. 25), in older specimens. If a larva be crushed beneath the cover-glass in a drop or two of methylated spirit, the cuticle swells out almost immediately to quite ten times its thickness in some places, and the stratification is rendered beautifully apparent; between twenty and thirty stratified lines becoming visible between its inner and outer surface. Underneath the cuticle is a cellular layer, the hypoderm. Each cell of the hypoderm secretes the portion of cuticle immediately above it, and the portions of cuticle thus formed, unite together into a continuous investment. Gegenbaur says that the hypoderm is the homologue of the epidermis in the higher animals, so named from its overlying the dermis or true skin. We must bear in mind that there is no structure in insects comparable to the dermis of Vertebrates,‡ and that the cuticle does not correspond to any structure found in the latter, whether bearing that name or not, but is a super-added covering.

The transparency of the cuticle in the larva allows the hypodermis to be easily made out in many parts of the integument with a $\frac{1}{4}$-inch objective, especially in the thoracic segments, and in the aforementioned respiratory processes on the penultimate segment. A drawing of it is given in Figure *24a*,§ and an optical section together with the cuticle somewhat more magnified in Fig. 25. It will be observed in Figs. 25 that the central portion of the cells enclosing the nucleus project into the cavity of the cœlom or

* Recherches sur L'Histologie des Insectes Annales des Sciences Naturelles Zoologie, 6th Ser., tom. 14, 1882.

† Lowne's Anatomy of the Blow-Fly, p. 10.

‡ I am not aware that any such structure has been recognised.

§ Compare Maggot of Blow-Fly, loc. cit., Fig. 2, Plate XX. Although this figure undoubtedly represents the condition of the hypoderm as it may be sometimes seen, there are, nevertheless, variations in its appearance, which at present I am unable to explain.

body cavity; and in certain situations, especially along the intersegmental folds of the thoracic segments, the substance of the cells seems to be still more gathered up about the nucleus, so that the cells project more strongly, and are drawn apart from each other, thus breaking the continuity of the cellular layer. Where this occurs, too, the cells lose their regularity of outline, and assume a plastic, amœbiform appearance (see Fig. 24*b*).

These changes are not, I think, without their bearing on the processes of growth of the larva. It need scarcely be pointed out that we have not to do here with a cellular layer, whose elements are in a formed, horny condition like those of the outer layer of the epidermis in the human body. They more nearly resemble in condition those of the inner layer or *rete mucosum*. If there is a cell-wall at all, it must be of the thinnest and most delicate description; Lowne indeed describes the cellular layer beneath the cuticle of the Blow-Fly as consisting of indurated pigmented cells: and probably this is the case in the perfect insect, where the processes of growth are completed, and no further increase is required or can take place until the assumption of the imago state; we see here, at least, that the hypodermic cells are in a highly vital and plastic condition. The basement membrane of which I have spoken, is only visible in living larvæ under very favourable conditions, such as the newly forming integument of the anterior feet.

The organs of the mouth consist of a labrum, a labium, and a pair of mandibles, the maxillæ being only represented by a pair of minute rudimentary palpi. These organs are represented in Figs. 13 and 14. The labrum is furnished with a number of minute and variously formed hooklets, and with a row of very minute chitinous teeth beneath (see Fig. 14). The mandibles are strongly toothed, as is also the labium, on either side of which the integument presents a fan-like arrangement of radiating striæ. The mouth of this creature, both in its larval and perfect conditions, presents great similarity to that of the Crane-fly, as described by me some years ago in "Science Gossip." *

The alimentary canal exhibits the following parts, viz.: the œsophagus, proventriculus, ventriculus or chyle stomach, and the

* "Science Gossip," Vol. x., p. 155, and vol. xi., pp. 10, 171, and 201.

small and large intestine, the posterior part of which, surrounded by a strong muscular coat, may be considered as a rectum. With reference to the embryonic origin of this canal, it may be stated that the œsophagus and intestine (including both its divisions) are derived by invagination from the epiblast layer of the embryo, and have received the names respectively of stomodeum (fore gut), and proctodeum (hind gut), while the stomach, or mid gut, is derived from the hypoblast, and corresponds to the mesenteron or primitive digestive cavity. It has at least four coverings, though these are not equally present in every part. Its internal wall is a structureless cuticle, continuous with that of the integument, and extending the whole length of the canal. It is reflected around the termination of the œsophagus, where the latter hangs in the proventricular cavity.* It passes by without entering the cavities of the proventricular cæca and the malpighian tubes. It is this membrane which in other insects is often solidified at the upper part of the canal and developed into rows of strong, horny teeth, as is well known in the cricket, etc. Here, however, this is not the case, but it forms a smooth membrane more or less separated from the epithelial layer to which it owes its birth.†

The epithelial coat comes next in order, and is continuous with the hypodermis of the integument. It secretes the cuticular lining just described. It varies greatly in character in different parts. In the œsophagus and small intestine it is difficult to trace, having, I think, become atrophied to a great extent. The occasional occurrence of nuclei between the two membranous coats of the canal in these parts, attests the original continuity of this all-important structure.

It is, however, in the proventriculus and stomach that the epithelial coat attains its greatest development, where it functions as a glandular layer of cells, secreting probably an alkaline fluid concerned in the process of digestion.‡ The cells differ some-

* See Fig. 12, and compare this organ in *Psychoptera paludosa*, page 72 and Plate IX., Fig. 9*a*.

† This cuticle has been hitherto overlooked in the Blow-Fly by both myself and Mr. Lowne; I have, however, recently ascertained its presence in that insect to my entire satisfaction.

‡ Plateau denies the existence of an acid gastric juice in insects. He says that the contents of the alimentary canal in every case give alkaline or neutral

what in character in different parts, but are all of considerable size, nucleated, and generally polygonal from mutual pressure. In the anterior portion of the stomach some of these cells are lodged in short, dome-shaped, cæcal projections of the external membrane; which occur in the midst of square areas, marked by the crossed, longitudinal, and transverse fibres of the muscular coat—see Figs. 5, 26, and 27—and these frequently present a regularly granulated aspect, and are then more hyaline and colourless than elsewhere; but in every part of the stomach, and in the proventricular cæca the cells are frequently invested with a thick secreted envelope, through which pass a multitude of radiating pores (pore canals; see Fig. 20), by which the contents of the cells are retained in communication with the surrounding fluids, the processes of growth and secretion are enabled to be carried on.

Sometimes the secreted envelope retains its integrity while a process of cell multiplication goes on within it, the envelope increasing in size with the multiplication of its contained cells; thus, larger aggregations of cells are formed, surrounded by a common envelope, as shown in Fig. 20. I will here take the opportunity of quoting one or two extracts from Kölliker * on the subject of these cells and their envelopes :—"My observations on the cuticular structures have shown that secondary depositions from the cells, analagous to the cellulose membrane of vegetable cells are to be found in a great many places, and are often characterised by a very particular structure, especially by the existence of a large number of extremely fine pores, pervading them in the direction of their thickness." And again, Kölliker states that such cells are found on the villi of the human intestine; for in reference to this subject, he says :—"I have recently shown that the membranes of these cells" (the epithelial cells of the villi) "are thickened and very finely striated at their free surface, and that these thickened parts represent as it were, in their totality, a

reaction, and concludes that it is by the aid of these alone, that in insects the digestive process is carried on. He endeavours to show, on chemical grounds, that this is far from being so impossible as it might at first sight be supposed to be. He thinks that in insects there is nothing corresponding to the stomach of vertebrates, and that, what is usually, and as above, called the stomach, is more akin to the vertebrate intestine.

* Kölliker's Manual of Human Microscopic Anatomy, pp. 26 and 328.

special membrane covering the cells similar to the cuticula of plants." Such is the uniformity of Nature's plan in creatures so widely different. The zona radiata of many ova is, probably, also a phenomenon of this nature. The epithelium of the malpighian tubes consists also of polygonal, granular, nucleated cells lining the cavity of these organs. That of the small intestine is as inconspicuous as that of the œsophagus, but in the large intestine we again meet with a prominent epithelial covering, the large nucleated granular cells of which bulge out irregularly between the crossing fibres of the muscular coat. In general, it may be stated, that the cellular elements of the alimentary canal contrast with those of the integument, first by reason of their superior size, and secondly by the granular character of their contents.

The third coat of the alimentary canal is a very delicate, structureless, basement membrane, upon which the epithelial coat rests, and as such it forms also the investment of the malpighian tubes. We may here remark that in the integument there are three layers, viz., cuticle, hypoderm, and basement membrane; so also in the alimentary canal, there are three layers corresponding thereto, viz., cuticle, epithelium, and basement membrane. I do not know whether this last is to be regarded as a membrana propria, secreted like the cuticle by the epithelial cells, or whether it is a form of connective tissue.*

The fourth coat is the muscular one consisting of longitudinal and transverse muscular fibres. It differs much in character in different parts, being scantily represented in the stomach and large intestine, but very thick and prominent in the œsophagus and small intestine. In the stomach and large intestine it forms a loose mesh of delicate fibres crossing at right angles, and leaving square inter-spaces, where the basement membrane bulges out between. In the œsophagus and small intestine, it consists almost, if not exclusively, of transverse fibres ranged side by side, without any interval, round the canal, and is of considerable size. These fibres are shown in Fig. 15, where

* From the above it appears difficult to avoid the conclusion that the digestive juices in insects have to act upon the food through an interposed cuticular membrane, and that the chyle so prepared must pass through this membrane on its way to the blood. I do not know whether anything has been written on this curious subject, but it is eminently worthy of note.

their optical sections on either side give at first sight the impression of a row of cells, but on more careful examination their true character is revealed. They are, I believe, simple, fusiform, nucleated muscle cells, each extending for a considerable distance round the intestine.

It is said * that the muscular tunic of the alimentary canal of the Arthropoda presents an exception to the general rule, in that its fibres are of the striped variety. If these fibres are striated, the striation is very faint indeed; so much so, that I doubt whether it be striated,† and the more so as it contrasts strongly with a cincture of undoubtedly striated fibres which surrounds the rectum, whose elements resemble in all respects those of the sub-cuticular muscles. There is a distinct cell membrane enveloping the contractile substance, which forms the contour of the cell-like optical sections shown in my drawing, in which, here and there, a nucleus may be distinguished occupying the centre of the section, which is therefore evidently placed in the midst of the contractile substance and not on the surface. In certain places the pointed ends of the fibres may be seen, but I have not been able to trace the whole extent of any single fibre. Each of them however, extends, I think, at least half round the canal; at one part of the small intestine this muscular layer is double.

At times I have, I think, detected evidence of a fifth membranous investment to the canal surrounding the muscular coat, and as this observation exactly tallies with one of Newport's, I will quote what he says upon the subject ‡:—"The peritoneal coat or layer is an exceedingly transparent white, shining, and delicate membrane, and is observed only with great difficulty. It covers the outer surface of the muscular coat throughout the whole course of the canal. It is seen most distinctly extending along the sides of the canal, directly across the angles formed by the contraction of some part of the muscular coat, where this is thrown into folds or depressions." Whether or not this membrane is correctly described as peritoneal, will depend upon the view that is taken of the homologies of the cœlom or body cavity in

* Ranvier, Lecons d'Anatomie Generale, Paris, 1880, page 462.

† Since writing this, I have satisfied myself that these fibres are striated.

‡ Todd's Cyclopædia of Anatomy. Art. *Insecta*, page 99.

the Arthropoda generally. It probably belongs to the class of connective tissue structures.

[The Explanation of Plates will be given at the end of Part II.]

What is a Plant?

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Part I.

SO powerful is the influence of early education, or of any long-cherished notion on the mind, that at first sight the question forming the title of this paper would appear to many readers one almost absurd, and certainly one easily answered in a sentence.

Let us see how far this idea is a true one.

The popular description of a plant would be that it is a more or less green-coloured organism, with (in most cases) a stem and branches bearing leaves and flowers; that it is fixed in the soil, having no motile power; that it is devoid of all power of sensation or digestion; finally, that by these characters it is easily and clearly distinguished from any member of the sister kingdom.

As a rough-and-ready diagnosis between the two kingdoms, this, in times gone by, has done duty. In the present state of scientific knowledge, and in the light of later discoveries in biology, such a conception becomes not only useless, but absolutely illogical and impossible. We must abandon, not this set of characters alone, but even those distinctions which were at one time held by Cuvier himself. The result is, that as the former typical distinctions break down one by one, we find our self-set task of defining what a plant is, as opposed to an animal, by no means so easy as in our complacent ignorance we imagined it to be.

Among the higher forms on either side, no difficulty of any moment presents itself. We do not confuse the antelope with the herbage on which it browses, nor the tiny humming-bird with the foliage under which it loves to nestle. The points of agreement between the bride and the orange-blossom are not numerous. They all possess what we call "life," but in form, power of motion, and sensation, and other characters, we seem to find differences wide enough to enable us to assign to each its proper position with absolute certainty.

Now, go much lower down the scale in both kingdoms, and we are beset with difficulties on all sides. The arduous nature of our task begins to assert itself. Enter the newly-found world of the microscopist, where the width of an eye-lash is an almost gigantic measurement, and we are face to face with perplexities that baffle the efforts of even our most earnest and patient searchers after truth. Many of these lowest forms, such as the Protozoa, are certainly animals; many, such as the Protophyta, are indubitably plants. Thus, our definition, to be comprehensive and logical, must needs embrace all these forms; therefore, we must investigate them, and learn their life-history. Here it is that our greatest difficulties meet us; here it is that we find our work is hard and laborious.

Our older naturalists found similar perplexity in the case of the Sponges, which, after being buffeted about unceremoniously from one kingdom to the other, finally found rest on the animal side. The red corals were only some 170 years ago first assigned to the zoologist, who still holds claim over them. Over *Volvox globator* there waged many fierce battles, until the botanist once and for ever gained the victory. Of such cases as these the poet Crabbe wrote:—

> "Involved in sea-wrack, here you find a race
> Which Science, doubting, knows not where to place."

Professor Haeckel proposes the formation of a third kingdom, which he calls the "*Regnum Protisticum*," for the reception of those doubtful organisms which cannot be absolutely assigned to either the animal or vegetable side, under the collective title of the "*Protista*." To establish this "refuge for the destitute" is at the same time to confess the hopelessness of research and the futility of work. As Professor Huxley aptly observes, "To form this biological 'No-man's Land' simply doubles the difficulty, which before was single," because we must take a scientific census of this new kingdom, in order to define and classify its members. Still, the very proposal indicates the difficulties in which modern biologists are placed.

We will glance *seriatim* at the various distinctions, which from time to time have been supposed to exist; in so doing, we shall see how, by exceptions on one side or on both, they successively fail to be diagnostic, if we are to include all forms of life, until we are reduced to so narrow a ground, that in the lowest and most minute organisms certainly, and even among some of the higher and more complex forms, the difference between a plant and an animal comes to be one of degree rather than of kind.

I.—FORM. This, although a safe guide among the higher types, fails as we descend the scale. Thus, among animals, the *Sponges*, belonging to the sub-kingdom, PORIFERA, resemble plants in their external form, and were for some time classed as such. Among the CŒLENTERATA, we find the graceful silver *Sertularia*, or Sea-Fir; the *Pennatula*, or Sea-Pen, with its feathery branches, phosphorescent on irritation; the *Gorgonia*, or Sea-Shrub, whose spicules are familiar to all microscopists; the *Corallium*, or Red Coral, and its allies; (the term "Zoophytes," or plant-like animals, is to this day applied to these last four and others of a similar nature;) while higher still, among the Polyzoa, we find *Flustra*, the Sea-Mat, which is, perhaps, the best-known case of resemblance. *Flustra* is a pale-brown, arborescent organism gathered every summer at the seaside, and dried as a "sea-weed," usually not named by the finder, because he is unable to detect its photograph anywhere in the sea-weed books. He does not know that it is, in reality, a "colony" of comparatively highly-organised animals, each in its own cell, each provided with a crown of tentacles for seizing its prey, and each having a mouth, stomach, nervous system, and other organs!

On the plant-side, there are certain of the Algæ, or water-weeds, microscopic forms, which, during part of their life, develop tiny, hair-like processes, called cilia, by which they propel themselves through the water. In this state, they closely resemble many of the Infusoria, a group of Protozoan animals, including the so-called "animalcules." Examples of these are seen in the motile forms of *Protococcus*, residing in our water-butts and roof-gutters; in *Vaucheria*, *Coleochæte*, *Chlamydamonas*, and *Volvox globator*, the "Globe Animalcule"; notably, in *Peronospora infestans*, the fungus causing potato-disease, which, both in the development of cilia and in the use it makes of them, bears decided resemblance to an Infusorian. Form, therefore, supplies us with no distinguishing character on either side.

II.—Presence of Cellulose. Microscopically speaking, the structure of animals and plants consists of multitudes of minute hollow bodies, termed cells, seen in diverse forms. It was formerly held that the enveloping membrane, or cell-wall, of these cavities was in animals composed of gelatine, in plants of cellulose ($C_6H_{10}O_5$). A distinction was accordingly founded on this presence of cellulose in plants. It is now known that this substance exists abundantly in the outer tunic, or test, of the *Ascidioida*, or "Sea-Squirts," a molluscoid group of animals, standing, according to modern systematic zoology, next below Vertebrata. Archer, of Dublin, found it not long since in the self-secreted case of *Chlamidomyxis*, a fresh-water Protozoon.* Cienkowski, a Russian naturalist, discovered it in the inner wall of the capsule of *Vampyrella*.† This organism is seen in the shape of minute brick-red capsules attached to the filaments of the well-known water-weed Spirogyra, with whose chlorophyll it literally gorges itself, perforating cell after cell of the plant, and abstracting their green contents. In all these cases, the presence of cellulose is proved by the characteristic blue reaction under the action of iodine and sulphuric acid.

This distinction, therefore, breaks down. So constant a feature, however, of plant-life is this cellulose wall, that we may say that, *morphologically*, the most distinctive feature of plant-life is the presence of a cell-wall containing cellulose; that of animal life its absence.

* *Journal Linn. Soc. Zoology*, Vol. XIII., p. 281.

† *Ibid*, p. 419.

III.—PRESENCE OF STARCH. Protoplasm excepted, the most widely-distributed of all vegetable cell-contents is starch; still, it is not confined to the plant-kingdom. Bernard found it in the liver of the calf and pig—*i.e.*, he obtained from them a substance called "glycogen," allied to, if not absolutely identical with, starch. It is also found in the human brain, liver, and placenta; in the protoplasmic substance of *Thalassicolla* and other Radiolarians (a group of Protozoan organisms which secrete shells of exquisite beauty and delicacy), there are minute bodies termed yellow cells. These Haeckel finds to contain starch,* answering at once to the iodine test, and in some cases making up more than half the entire bulk of the animal. Cienkowski (1871) thinks these may be plant-parasites, a possibility requiring further research.† On the plant-side, starch is absent in the *Fungi* as an order, so far as we know at present. Here again, therefore, we fail in finding a distinction of any real value.

IV.—PRESENCE OF CHLOROPHYLL. This is the green colouring matter of plants, occurring usually as fine granules, these being most abundant immediately below the surfaces of leaves; it is formed only under the action of light, with two exceptions, viz.—the germinating seeds of some conifers and the fronds of ferns, where, under certain conditions of temperature, its formation goes on in the dark. Chlorophyll, however, like cellulose and starch, has found its way into the animal kingdom. Among PROTOZOA, it is found in *Stentor*, the trumpet animalcule, and as a dense layer beneath the body-surface in two of the Heliozoa—*Raphidiophrys* and *Heterophrys*, discovered by Archer, of Dublin.‡ Among PORIFERA, it is abundantly present in *Spongilla*, the fresh-water sponge. Among CŒLENTERATA, we find it in *Hydra viridis*, the green fresh-water polype. Among Turbellarian worms, Mr. P. Geddes discovers it in *Mesostomum viridis*, and again in *Convoluta*, the little green Planarian that basks in the sand, and ooze on parts of the Russian coast.§ It has also been thought to exist

* *Journal Linn. Soc. Zoology*, Vol. XIII., p. 427.

† *Ibid*, Vol. XIV., p. 145. *Vide* note at end of Part II. of paper.

‡ *Journal Linn. Soc.*, Vol. XIII., pp. 292, 297.

§ Royal Soc. Proc., No 194.

in *Anthea*, the common green anemone; in *Bonellia*, one of the Spoon-worms (Gephyrea); and as high up as Crustacea, in *Idotea*, a member of the Isopoda, or the wood-louse order.*

Chlorophyll, like starch, is absent in the *Fungi*. No less is it absent in many higher plants, when parasitic, as in *Broom-rape*, *Fir-rape*, and some *Orchids*.

However, although its presence fails as a diagnostic feature of plants, we may take that presence as a pretty safe indication that the organism possessing it is a plant.

V.—FUNCTION OF LOCOMOTION. For many years this was held to be peculiar to animals alone. Cuvier himself, in 1828,† speaks of "animated beings" possessing sense and motion, and "inanimated beings" possessing neither, but simply "vegetating"—a term, by the way, not wholly misapplied to many members of the genus "Homo" in our own time. But the rapid progress of science during the last fifty years has done away with motile power as a distinctively animal function. True, the upward or downward movement of stem or root, and the various motions of leaves and other organs of certain plants cannot be said to be voluntary; but there are many cases of movement in plant-life that have their counterpart among animals, and that place the existence of this function among plants beyond scepticism.

Upon this power of movement in plants, Cuvier, as we shall presently see, *founded* his first great distinction between them and animals. His argument breaks down, however, in this its first link. We note four kinds of movement seen in plants :—

1.—We see in the *protoplasm* of many of the lower forms of *Algæ* the phenomenon of "rhythmical pulsation"—(*i.e.*, periodic movement of certain spaces called the "contractile vacuoles")—which is characteristic of Amœba and other animals.

2.—There is motion, undoubted and regular, of the granular *contents of cells* in many plants. For example, in the *Stoneworts* (Characæ), first noted by Corti; in *Stratiotes*, the water-soldier; in *Anacharis* (the American water-weed, which is the pest of our canals and ditches); in the well-known *Vallisneria;* in the hairs

* *Vide* note at end of Part II. of this paper.

† "Règne Animal," 2nd ed.

of *Urtica*, the stinging-nettle ; in the beautiful purple hairs growing in the centre of *Tradescantia*, the spider-wort, a discovery due to Robert Brown fifty years ago, and in many other cases.

3.—Certain Algæ give rise to bodies known as *zoospores*, from their likeness to some Infusoria ; these are embryonic forms of future adult Algæ, and being set free, move rapidly by the aid of their cilia, already named. Good examples of these are seen in the motile forms of *Protococcus*, *Vaucheria*, our old friend, *Peronospora*, and others.

4.—Many *entire plants* spend their whole life in a state of brisk activity. For example, the *Desmids* and *Diatoms*, microscopic organs of wonderful variety, beauty, and delicacy, found in fresh-water pools, show this power, and the closest attention of such observers as Huxley and Dallinger has so far failed to detect either the mechanism of the movement, or the distinction (if any) between it and the motion of Infusorians. *Volvox globator* is a kind of hollow sphere, formed of numerous green bodies, each owning two vibrating cilia. By means of these it rolls over and over, hither and thither, paddling with great rapidity, as if it were a kind of " Queen's messenger " in the plant realm.

On the other hand, many animals spend all their lives in a fixed condition. Such are the *Sponges*, the *Corals*, and many of the *Polyps* (therefore once thought to be plants) ; many Rotifera, as *Floscularia*, *Melicerta* the building rotifer, and others, termed " tube-dwellers " ; *Flustra*, and most of the Polyzoa ; some Crustacea, such as *Balanus* (acorn-shell), *Lepas* (Barnacle) ; finally, some MOLLUSCA, such as the *Oyster*, *Mussel*, and *Ship-worm*, and the *Ascidioida*, or sea-squirts, our supposed ancestors. Locomotive power, therefore, as a distinctive character of animals, being brought up before the Bar of Science, must have the verdict given against it, let the counsel for the defence say what he may.

VI.—FUNCTION OF DIGESTION. The presence of a digestive cavity formed, in Cuvier's judgment, the most important character of animals. He made this therefore his *primary distinction.* He held that they must needs possess it, because, being more or less constantly in motion, they needed some internal compartment, or digestive cavity, whence their food might be taken by the blood-vessels to be sent to the various organs. We have seen that Cuvier's argument for the existence of this cavity has failed; his deduction, we shall now see, fails also, *i.e.*, as a diagnostic character, if we apply to it our strict and universal test.

The *Amœba* and many of its allies, little masses of soft, gelatinous matter found in our fresh-water ponds, possess neither mouth nor digestive sac, but are able to take in solid food, and, so to speak, form temporary "stomachs" at any part of their bodies. Again, many animals are parasites, *i.e.*, they reside in or on other animals, feeding on their substance; examples are seen in the *Gregarinidæ*, which are Protozoa parasitic in the Earth-worm, Lobster, Frog, Rabbit, and in the intestine of the much-despised Cockroach; in the *Opalina*, a Ciliate Infusiorian, living in the intestine of the Frog and Toad; in the *Tœnia*, or Tapeworm, resident in warm-blooded Vertebrata. All these are devoid of mouth and stomach, living wholly by imbibition of the juices of their hosts, through their body-walls; their food being already cooked and digested for them, they need no digestive cavity; it therefore disappears, and the parasite assumes a degraded form, subsisting entirely by a "sponging" process, which, together with the degradation in nature, is very often seen in the "parasite" among the human race. Among the *Rotifera*, the males are nearly all destitute of the digestive function, their existence being almost wholly given to the reproductive function.

On the other side, we now know of very many plants that "digest" the solid matter of animal food, only their digestion goes on *outside* the organism, the nourishing material being then in some way absorbed. Darwin's researches on this subject are well-known to all lovers of science, and are clearly set forth in his wonderful book on "Insectivorous Plants." *Drosera*, the Sundew of our peat-bogs and heaths, is an excellent example. Its red-tinted leaves are covered with hair-like bodies, called tentacles (they are not true hairs), whose tips secrete a viscid fluid on being touched by an unwary insect alighting on the leaf. The leaf-edges and tentacles then bend over towards the centre of the blade, the insect being now in a kind of hollow basin, held fast and sure there, and bathed in the copiously-secreted fluid. After some hours the leaf opens again. What has happened? All the nutrient matter of the intruder has been absorbed (a fact easily proved by familiar experiment), while the harder, non-edible parts are cast aside, and the plant is ready for another meal! We can try this experiment for ourselves by using minute pieces of cheese, meat, or egg, when similar results will be obtained. If we use bits of china, coal, or stone, the leaf responds slightly, and secretes some fluid, but it rapidly ceases to do so, the articles being not to its taste. *Dionæa*, a member of the same order, known as Venus' Fly-trap, possesses leaves formed of two halves connected by a hinge; on each half are three filaments, while around the edges is a row of long spikes. Let a fly touch one of the filaments; the two halves close with a snap, the insect is caught, and detained until fully digested by a fluid secreted by the numerous glands on the leaf's surface. Here we note that rapidity of action takes the place of viscidity. The *Pinguicula*, or Butterwort, acts in a similar way to that of *Drosera*, *i.e.*, by secreting a sticky fluid: and the Laplanders use the leaves of these plants as a strainer for milk, the secretion rendering it solid.

Utricularia, the Bladderwort, possesses small bladders attached to its branches; these bladders, by a delicately-arranged mechanism, form traps for aquatic insects, and even for minute Vertebrata in the shape of tiny fishes.* Whether in this case nutrient matter is digested, or only the products of decay absorbed, we do not at present know. We must not omit to name *Nepenthes*, the Pitcher-plant of tropical Asia, where brilliant colour and attractive odour first lure the victim to its fate at the hollow end of the pitcher formed by the metamorphosed tip of the leaf. Moore, of Dublin, found in one pitcher, 91 ants, 16 wasps, 4 flies, 1 cockroach, 5 earwigs, 7 wood-lice, besides a putrid mass quite beyond recognition! In *Sarracenia*, the side-saddle flower of N. America, Hooker speaks of the attractive, conducting, glandular, and detentive surfaces, words grimly significant of their functions in respect of intruders on their domain. Beside these we have *Drosophyllum*, the Fly-catcher of the Oporto villagers, the African *Roridula*, the Australian *Byblis*, and others, while some of our own genera, such as *Lychnis* and *Saxifraga*, have similar relation towards certain insects. All these

* Observations on the Bladderwort, G. E. Simms, *The Field, June* 26, 1884.

cases furnish good examples of digestion by plants.

There are two more recent discoveries to which we must briefly refer. Mr. Francis Darwin has found, by a series of ingenious experiments, that the protoplasmic filaments protruded from the glandular hairs on the leaf of the *Common Teasel* * are able to absorb nutrient matter from the bodies of insects drowned in the water which lies in the cup formed by the opposite leaves at their base. In young plants, these filaments absorb Ammonia from the rain and dew, a not less interesting discovery made by experiments on *Dipsacus pilosus*, a Teasel not possessing connate leaves, and therefore unable to entrap insects, as the *Dipsacus sylvestris*, or Common Teasel, can do.

The other experiments to which we must direct attention were made by Reiss and Will, of Erlangen,† on *Drosera*, and by Dr. S. H. Vines, of Cambridge, ‡ on *Nepenthes*. These observers found in the glands of both these plants a digestive "ferment" *soluble in glycerine, and exerting its action only in the presence of an acid*, *i.e.*, a ferment precisely resembling those of the pancreatic and peptic glands of animals, namely "pancreatin" and "pepsin"; moreover, just as, according to Heidenhain, the animal glands do not directly secrete these ferments, but *a neutral body called Zymogen*, and only when this is decomposed by acids, are the respective ferments set free in an active state, so Dr. Vines finds in Nepenthes a neutral body resembling Zymogen, the decomposing of which by acids sets free the digestive ferment. The characteristic odour of pepsin can be detected in the secretion of Drosera, and Prof. Boulger tells us that the glands of Nepenthes pitchers, after having absorbed nitrogenous matter, become bright red, a process strikingly akin to the blushing of the walls of the stomach after the action of the peptic glands.

All these researches show the solution of protein, or nutrient matter, by plants, to be a process resembling in minute detail a similar process in the animal economy.

Thus we see that Cuvier's primary test will not hold good as he states it; but just as the presence of Cellulose or Chlorophyll

* "Quarterly Journal of Microscopical Science," 1877, p. 245.

† Bot. Zeitung, Oct., 1875, No. 44.

‡ Journ. Lin. Soc. Botany, Vol. XV., p. 472.

would indicate a plant organism, so the presence of an alimentary cavity, more or less complex, is a fairly constant feature of animal organisation. We may state the case thus :—*Animals can take solid food into the body, and there digest it ;* and as Huxley says—"The definition so changed will cover all animals, except certain parasites, and the few and exceptional cases of non-parasitic animals which do not feed at all ; on the other hand, it will exclude all ordinary vegetable organisms."

Plants get their food from the soil, or air, in a liquid or gaseous state, by absorption through their surfaces ; *animals* obtain theirs from plants, or plant-feeders, taking it into their bodies, and there digesting it. The solvent process in plants, although corresponding accurately with that process in animals, is carried on *outside* the body, the resulting matter being afterwards absorbed, so that the carnivorous plants are really included in our summary, only in their cases, the food is animal in constitution, and not derived from either air or soil.

Animal Metamorphosis.

By J. B. Jeaffreson, M.R.C.S., etc.

Plate 11.

Part I.

THE subject selected for consideration in the present paper is that of Animal Metamorphosis. By the term Metamorphosis we understand the series of changes undergone by many creatures after their exclusion from the egg, and before they assume the characteristics of their adult condition ; changes which frequently alter extensively the general form of the individual, or so modify its functions that its appearances and mode of life, at different periods of its existence, are totally dissimilar.

We are so used to seeing that "the child is father to the man," and that the young of most of the animals with which we are acquainted differ only from their adult representatives in size and some trifling peculiarities, that we are in the habit of regarding it as a law of nature, that the offspring of any animal shall, at birth, resemble its parent in form and structure, needing only to increase in size to assume all the parental characteristics. Nothing, however, can be more erroneous than such a supposition. On the contrary, we find that the large majority of the lower animals, at some period of their existence, differ so vastly from their adult condition that we can hardly conceive them to be the same creatures; and indeed, in many cases, the immature or larval forms have been looked upon and described as distinct organisms until more careful study has traced out their life-history, and proved them in reality to be only transitional stages leading up to the mature individual.

Every creature in journeying through the successive phases of its embryonic development assumes an immense variety of forms; but in the higher orders of the animal world, these changes are concealed from the view of the ordinary observer, and occur before the individual is capable of existing as an independent being. No change can be more decided than the transformation which a mammal undergoes at its birth; when, owing to modifications of its respiratory and circulatory systems, it ceases to depend for its nourishment on its parent, and becomes capable of enjoying an independent existence. But this is not the change to which the term metamorphosis is properly applied. Here the newly-born animal at birth has all the parental features in miniature, and has only to increase in size until it attains its full development. The mode of performance of the principal functions is definitely fixed, and though some of the organs may still be imperfectly developed, yet all are there and none disappear. But in many members of the animal kingdom important changes take place after complete separation from the parent has occurred: modification either of external form, or of some important organs directly influencing the mode of life. We may find in the offspring some complete apparatus undiscoverable in the parent; or, on the other hand, the parents may have organs which are entirely absent in the offspring.

Closely connected with metamorphosis, though differing from it in the fact that one animal does not undergo the series of changes in its own person, is what is called alternation of generation, where the parent does not produce an organism like itself, or one which even ultimately develops into a form like itself, but something entirely different, which acts merely as an intermediate or "nurse" form, furnished with the necessary organs to preserve its existence until it is able to mature the reproductive elements, or to produce in its substance a young organism which, after various changes, assumes the form and characteristics of the original parent.

Strange would our experiences be if the processes of metamorphosis and alternation of generation were adapted to our terrestrial zoology. A popular writer recently suggested, "It would be as though rats produced mice and mice rats; in fact, that every two sets of animals combined to maintain each other's species, neglecting their own. To obtain sheep we should have to keep goats; to breed horses, donkeys. Or supposing we had animals that were never the same thing for four and twenty hours together. The cat that sat down on the hearth-rug would gradually develop a multitude of legs and absorb its own head till it looked like a furry crab. Looking round by-and-bye, we should find it in a snake-like form, delicately fringed with alternate ears and tails. Half-way down the street, the cab-horse would become completely spherical, and round the next corner would become elongated microscopically." And, strange as these suggestions seem, they are not more wonderful than what we find actually occurring in the animal world. Organisms in their infancy swimming about merrily, lose their active locomotive powers, and creep about upon the ocean floor, some of them at an intermediate stage of their existence being for a time fixed to the bottom like a stony plant. Others, which, when young, possess eyes and locomotive organs, lose them in advanced life, and become simple, sac-like parasites, or, encasing their body in a shell of many valves, are rooted for the remainder of their existence to the rock on which they happen to settle. The same creature which at one time has all the characteristics of a fish, at another exists as a four-footed amphibian. Eyeless, footless grubs develop into lively insects sporting in the sunshine; while others, again, passing their infant days crawling on the bottom of a muddy pond, which they match in colour, take on the glittering colours of the emerald and turquoise, and on gauzy wings flit over the surface of their aqueous birthplace ;—transformations more wonderful than those produced by the fairy wand of Cinderella's grandmother.

We will now consider, as far as space will permit, some of the most striking instances of metamorphosis in the different divisions of the animal world.

Many of the earlier forms of animal life possess various modes by which the reproduction of the species is effected. The simplest methods are those technically known as "fission" and "gemmation," the former of which consists in a gradual division or cleavage of the body into two parts, each of which then develops into a separate and independent individual exactly like the parent form; while in the case of gemmation or budding, the animal throws out buds from some part of its body, which, after a more or less complete development into the parental form, are detached to lead a separate existence. Both these processes are non-sexual, and as they are exhaustive to the parent they cannot be carried on indefinitely. In order to ensure the continuance of the species, the sexes must present themselves, and ova and sperm-cells must be developed and allowed to come into contact with each other. And it is in this mode of development that we meet with the variations we are now considering.

In the development of the lowest forms of the Protozoa—those minute organisms which appear to exist on the confines of the animal and vegetable kingdoms—in many instances reproduction appears to take place only by gemmation and fission, no differentiated sexual organs having at present been discovered. In these cases, as we have seen, the young immediately grows up into the likeness of the adult, no metamorphosis being apparent, but in others, the changes are so various, that at one period of their life they exhibit an aggregate of phenomena, such as to justify us in speaking of them as animals, while at another they appear to be as distinctly vegetable. This is strikingly the case with some of the Myxomycetes, which were formerly considered as plants, but since the discovery of their life-history it has been proposed by Saville Kent to transfer them from the vegetable to the animal world under the name of Mycetozoa. Here, on the rupture of the spores, the protoplasm escapes, forming uniciliate zoospores, which are indistinguishable from certain of the flagellated monads. These soon lose the cilia, and pass through an intermediate form, in which they closely resemble an ordinary amœba. Ultimately, these amœboid particles run together, forming a compound zygospore, from which fresh spores are again developed. Other forms, though passing through an equally distinct series of metamorphoses, retain their animal characteristics throughout life.

Among all animals of higher organisation than the Protozoa, we find that the processes of gemmation and fission are almost invariably accompanied by the production of ova. The first step in development after the fertilisation of the ovum by the sperm-cell is the division of the yelk into two. In like manner, these two cells, by continued sub-division, separate into four, these into eight, and so on. Each of the outside cells now puts forth a minute cilium, or lash, so as to form a fringe round the whole body, and the embryo, known as a "primula," is capable of free locomotion, and so exceedingly like an infusorian that there is no doubt many of those supposed organisms are nothing more than the early condition of more advanced forms into which they ultimately develop themselves. In the next stage the cilia vanish; a central cavity is formed, which communicates with the exterior by an aperture placed at one end. It is now called a gastrula. The gastrula stage, according to Haëckel, is passed through during the development of all tribes of animals, (the lowest group of the Protozoa alone excepted) but in the higher orders it is only an embryonic condition, before the individual is capable of a separate existence; while the Sponges, Hydrozoa, Cœlenterata, and Annulosa all spend the first independent stage of their life as free-swimming planulæ and gastrulæ, passing by various processes of metamorphosis to their full development. Thus the ciliated embryos of Sponges and Hydræ, after freely swimming about for some time, find a suitable locality, and fix themselves to some solid object. In the young sponge, spiculæ begin to appear and to be aggregated into bundles, and they are ultimately developed into perfect Spongillæ; while the young Hydra developes a row of tentacles round the mouth, and takes on the form of the adult animal.

In some of the Compound Hydrozoa the process is still more complicated. These animals, which by those unacquainted with their true nature, are often mistaken for seaweeds, consist of a number of hydra-like creatures, which, instead of separating from each other, and living an independent existence, like the pond Hydra, continue to multiply by budding, the separate members being united together into a plant-like colony by means of a common flesh or cænosarc. In many of these organisms there are two distinct sets of zoöids : one devoted to the duty of providing food for the colony; the other generative buds or gonophores (whose office is the production of ova and spermatozoa), and are altogether unlike the nutritive zoöids. In some cases they remain permanently attached to the parent organism, as in the Sertularia or sea-firs ; but in others, the generative buds become detached from the colony, and develop into free-swimming, bell-shaped organisms, which are identical, structurally, with the jelly-fish, or Medusæ, and sometimes attain a comparatively gigantic size ; individuals having been found as much as seven feet across, with tentacles over fifty feet long, though the parent from which they were produced was only a minute fixed polype, not more than half-an-inch in height. At certain seasons of the year, these huge jelly-fish drop from their under surface a vast number of minute ova, which, after passing through the planula stage, settle down upon the rocks, and develop, not into the free-swimming, bell-shaped organism, by which they were actually produced, but into the plant-like, rooted zoophyte from which the buds were originally given off.

Sea-anemones are also able to increase in three ways : either by fission, gemmation, or, as is most common, by hatching the young from ova within the body of the parent. Nothing can be more unlike the parent *Actinia* than their minute embryos, some flattened, some elongated, and others with irregular prominences as if composed of two or more unequal spheres, but all are covered with cilia, and it is not until they are eighteen or twenty days old that the rudiments of tentacles are visible, and they settle down and gradually assume the adult form. By carefully watching an anemone, the young may often be seen coming out of the mouth of the parent, sometimes in the shape of little ciliated swimming bodies, but more often they are hatched within the body-cavity of their mother, and retained there until they have developed their tentacles. The same process of development takes place in the Corals.

The Echinodermata, which include the sea-urchins, star-fishes, crinoids, and sea-cucumbers, constitute one of the most interesting divisions of the animal kingdom, and undergo some of the most extraordinary changes in the passage from the ovum to the adult animal, these changes forming one of the most remarkable sets of objects to the microscopic enquirer. Their early history was for a long time unknown, but the problem was solved with great skill, industry, and success by Johann Müller. The striking characteristic of their development is the formation of an intermediate or "nurse" form—often wrongly called a larva—which is totally unlike the parent, and does not attain the adult form by a process of metamorphosis, but exists solely to give origin to the young Echinoderm by a kind of internal gemmation (see Pl. XI., Figs. 1, 2, 3).

Take, first, the Echini, or sea urchins. Here, as with all the Echinodermata, the first condition developed from the egg is a ciliated, free-swimming Planula, which, by the formation of a mouth and intestinal cavity, becomes a Gastrula. Presently, from the gastrula is produced the intermediate form, which exists as a sort of scaffold, on which the young Echinus is built up. So different is it from the parent that it was originally described as a distinct organism, under the name of Pluteus, so called from its resemblance to a painter's easel (Fig. 1). The body is composed of colourless, transparent jelly; it is dome-shaped behind, expanded, and slightly hollowed out in front, and prolonged inferiorly into straight, slender legs, in which delicate rods of calcareous matter are perceptible, forming a kind of frame-work not unlike the French clocks which we see on our mantel-pieces. It has a distinct internal cavity, and propels itself by powerful cilia grouped in two bunches on the sides of the body, resembling epaulettes, and also by a fringe encircling the dome, and continued on all the columns up one side and down the other. After a time, at the upper part of the body, a number of fine plates of lime begin to form in the shape of a tiny round box. This gradually extends over the gelatinous mass, and developes tubercles which push through the transparent dome of the Pluteus, which gradually disappears, and the transformation is complete. The remarkable point is that the young Echinus is developed out of only a portion of the Pluteus, and the greater part of the latter, including the skeleton, is cast away as useless.

In the Brittle-stars the growth of development is sometimes direct, the young commencing life at once in the parent form, but more commonly they start from the egg as the same ciliated, jelly-like substances. As they proceed to develop, four long calcareous rods are formed—two in front and two behind—with connecting pieces going across in a peculiar manner, and meeting at the top in a slender head (Fig. 3). On the upper part of this delicate framework are placed the soft parts of the body, a clear gelatinous flesh, which displays a large cavity, into which a sort of mouth ever and anon admits a gulp of water. The lower parts of the rods are merely encased in the flesh without any mutual connection. Delicate cilia cover the whole integument. Its appearance is most beautiful, its colour pellucid white, except at the summit and extremities of the rods, which are of a lovely rose colour. Its length is about one-fortieth of an inch, and it swims in an upright position, with a calm and deliberate progression. Meanwhile, a small round disc is gradually produced in a particular part of the body of the Pluteus; by-and-bye, a trellis-work of lime is formed over this disc, and from it five arms begin to grow out like the rays of a star. A stomach, mouth, and set of water-tubes are formed within the disc, the rods drop off, and a complete Brittle-star is formed. Strange to say, the plane of the future star-fish is not even the same as the plane of the larva, but one quite independent of it and oblique to it; and, as with the Echinus, the young star does not absorb into itself the body of the larva, but throws it off as so much useless lumber, flesh, rods, and all.

The Asteroidea, or ordinary star-fishes, show the same general phenomena as are characteristic of the class; but the larvæ possess no calcareous frame-work as do the Echini and Ophiuroidea. In some the larval form possesses six or more fin-like lappets, fringed with cilia, and the posterior part is prolonged into a sort of pedicel, which is also covered with cilia. This was formerly described as a distinct organism under the name of *Bipinnaria* (Fig. 2).

The common five-fingered star-fish, immediately after exclusion from the egg, presents an ovoid, sub-spherical shape. It remains for some time attached to the sides of the incubatory cavity of the parent. After a few days, four club-shaped appendages begin to appear, sprouting, as it were, from the anterior extremity of the body. It swims about vivaciously, with the four arms in advance, by means of vibratile cilia. By degrees, the body assumes a pentagonal outline, from the angles of which five blunt rays begin to grow. It now ceases to swim, and sinks to the bottom of the sea, where it goes on increasing in size for two or three years, the blunt knobs gradually lengthening out into pointed rays, and the animal takes on the form of the ordinary star-fish, with which we are all familiar.

When first seen, no one could suspect that the *Pentacrinus Europeus* was the young stage of a star-fish, the *Comatula* or feather-star. In its first stage, the larval *Comatula* presents itself as a cylindrical, jelly-like body, furnished with an alimentary canal having a lateral aperture, and four transverse bands of cilia. It swims about freely in this condition for some time, when lime-plates begin to form, in the shape of a cup, in the upper part of its body; while below these, other and smaller plates take the form of a stalk (Fig. 4). After a time, the whole sinks to the bottom of the sea, and attaches itself, by a strong lime-plate, to some marine object, where it remains, looking like a stony plant (Fig. 5). From the cup are developed ten radiating arms, produced by the splitting into two of five primary rays, and it is thus transformed into a *Pentacrinus*, or stone-lily. When sufficiently matured, the body drops off the stalk, and again assumes a free condition of existence as a fully-developed *Comatula* (Fig. 6).

The last order of the Echinodermata comprises the Holothurians, or sea-cucumbers. The young Holothurian, on leaving the egg, develops into a barrel-shaped, transparent larva (Fig. 7), without any skeleton, but surrounded by transverse rows of cilia, by means of which it swims about, rapidly rotating on its long axis. In this stage it used to be described as a distinct genus, under the name of *Auricularia*. As it advances in growth, it elongates itself into a long, sausage-shaped body, develops a series of feathery tentacles round the mouth, and five rows of tube-feet along the sides of the body, by means of which it draws itself along the bottom of the sea.

The changes which take place in the members of the next sub-kingdom, the *Scolecidæ*, or worms, are, in many respects, the most curious and interesting in the animal kingdom.

The simplest worms with which we are acquainted are the Turbellarians. They are small, ciliated, flattened, soft bodies, mostly aquatic in their habits, which glide along with a slug-like motion over wet surfaces, or swim by the vibration of their cilia. The egg of the Turbellarian gives rise to a larva, totally unlike the parent, from which the adult is developed in a manner closely analogous to that of the Echinodermata. This early form is often a small, helmet-shaped organism, ciliated on the edges and side-lobes, with a long flagellum attached like a plume to the summit of the helmet. It was described by Johann Müller, under the name of *Pilidium* (Fig. 8). After swimming about for a time, a worm-like body forms on the side of the larva; eventually, it grows round the alimentary canal, which it appropriates, and detaches itself from the *Pilidium*, and develops into the perfect adult.

Many species of worms are parasitic, and not only undergo various metamorphoses in the processes of their development, but are also obliged in each stage to become the tenants of a different host, in which alone that particular stage can be carried out. The tape-worms and the cystic or bladder-worms were formerly supposed to be distinct animals, but it is now known that the latter are merely immature forms of the former. The egg of the tape-worm, on reaching the digestive organs of a suitable animal, sets free a little oval body, armed in front with hooks or boring-spines, by which it travels through the tissues till it reaches a suitable site, where it anchors, and developes from its hinder end a kind of bladder filled with fluid. It is now a cysticercus, or bladder-worm (Fig. 9), and in this condition may remain stationary for any length of time, but for its further development it must be introduced into another host. If, then, the flesh of an animal containing such cystic worms be eaten by another (of a suitable species), the young tape-worm is liberated from its cyst; attaches itself by its head to the mucous membrane of the intestine, and develops to its perfect form, consisting of a minute rounded head (Fig. 10), with organs of attachment, which are a crown of hooks and suckers, followed by a long-jointed, tape-like body (Fig. 11), which is produced by a process of budding from the head, each joint containing both male and female reproductive organs, and producing innumerable eggs, which, under favourable circumstances, again go through the life-circle we have just been considering.

The Trematodes, or Flukes—another order of parasitic worms—also undergo transformations as various and strange as those of their relatives, the tape-worms. As an illustration, we may take the *Fasciola hepatica*, or Liver-Fluke, which in its adult form is a flat, lozenge-shaped organism, about an inch long and half-an-inch broad, furnished with two suckers, inhabiting the gall-bladder or biliary ducts of sheep, and giving rise to the disease known as the "rot." When a sheep is affected with flukes, the eggs, to the number of several hundred thousands, pass with the bile into the intestines, and so on to the fields. Under suitable circumstances, these eggs are hatched, producing a minute, conical, ciliated embryo, which swims about until it comes into contact with a special water-snail (the *Limnæus trunculatus*), into which, and which alone, it bores its way till it gets into the pulmonary chamber or body-cavity, when it undergoes metamorphosis. It loses its external layer of ciliated cells, changes from the conical to the elliptical form, and becomes a *sporocyst*, or mere brood-sac, in which the next generation is produced. This next generation—the members of which are called "rediæ"—burst through the wall of the sporocyst, and migrate to other parts of the snail, especially the liver, on which they feed. The adult rediæ may develop daughter rediæ for one, two, three, or even four generations, but ultimately each redia produces in itself about a score of germs, which develop into the next stage, called "cercariæ." The free cercaria has an oval body, about one-thirtieth of an inch long, provided with two suckers, the anterior part covered with spines. Two lobed, lateral masses extend the whole length of the body, on each side of the middle line. It has a tail, and is exceedingly active, but soon comes to rest, and encysts itself on surrounding objects, when it is taken up by the sheep as it grazes on the damp roots of the grass, and in them ultimately reaches its stage of maturity.

We next come to the *Tunicata*—the Ascidians, or sea-squirts—many of which undergo a very definite metamorphosis. These marine animals, which have been compared to a double-necked leathern bottle, are found immoveably attached to rocks, stones, and weeds on the sea-bottom (Fig. 12). They are protected by a tough elastic integument, with two openings, situated close together at the free extremity of the animal, through which a constant current of water passes. The egg of the Ascidian gives rise to an active, free-swimming organism shaped very much like the tadpole of a frog, which it resembles not only in general form, but also in its internal structure (Fig. 13), the only important difference being in the position of the two mouths, and in the fact that the Ascidian has one eye, while the frog has two. The axis of the tail consists of a cartilaginous or gristly rod (Fig. 13*a*), thus foreshadowing the notochord or primitive backbone of vertebrate animals, on which account it has been proposed by some zoologists to raise the Ascidians to the rank of a sub-kingdom. Button-like warts bud out from the fore-part of the head, by which, when the time for its transformation arrives, the infant *Tunicate* cements itself to some fixed body. The tail atrophies, the body grows, and gradually changes, its shape becoming wide and sac-like, a large cloacal chamber forms, the eye disappears, the outer skin becomes tough and leathery, and from being a free-swimming, active tadpole, it becomes a mere stationary sac, absorbing nourishment and laying eggs (Fig. 12).

EXPLANATION OF PLATE XI.

Fig. 1.—Larva of *Echinus* (after J. Muller). *A*, Anus; *F*, Mouth processes; *B*, Posterior side-arm; *a*, Mouth; *a′*, Œsophagus; *b*, Stomach; *b′*, Intestine; *d*, Ciliated bands; *f.f.f.*, Ciliated epaulettes; *c.*, Disc of future *Echinus*.

,, 2.—Larva of Star-fish, *Bipinnaria asterigera*. *a*, Mouth; *a′*, Œsophagus; *b*, Intestinal tube and Anal orifice; *c*, Furrow, in which the mouth is situated; *d,d′*, Bilobed peduncle; 1, 2, 3, 4, 5, 6, 7, Ciliated arms.

,, 3.—Larva or Pluteus form of the Brittle-star, *Ophiolepis*. *m.*, Mouth; *s.*, Stomach; *c.*, Calcareous skeleton.

,, 4.—Larva, with rudiments of the stem-joints of *Comatula*.

Fig. 5.—Fixed young of *Comatula rosacea* (after Forbes).
,, 6.—*Comatula rosacea*, free adult.
,, 7.—Young stages of *Holothuria tubulosa*, one of the Sea-cucumbers.
,, 8.—*Pilidium*, the "pseudembryo" of a Nemertid. *a*, Alimentary canal; *b*, Rudiments of the Nemertid.
,, 9.—*Cysticercus longicollis*, or Bladder-worm.
,, 10.—Head of adult, *Tænia solium* enlarged, showing the hooklets and cephalic suckers.
,, 11.—Portion of a Tape-worm (*Strobila*), showing the alternate arrangement of generative pores.
,, 12.—Adult Ascidian, Sea-Squirt, *Molgula socialis* (after Lacaze Duthiers).
,, 13.—Tadpole of Ascidian, showing—*a*, Notochord; *b*, Spinal cord; *c*, Brain; *d*, Mouth; *e*, Gills.

The Microscope and how to use it.

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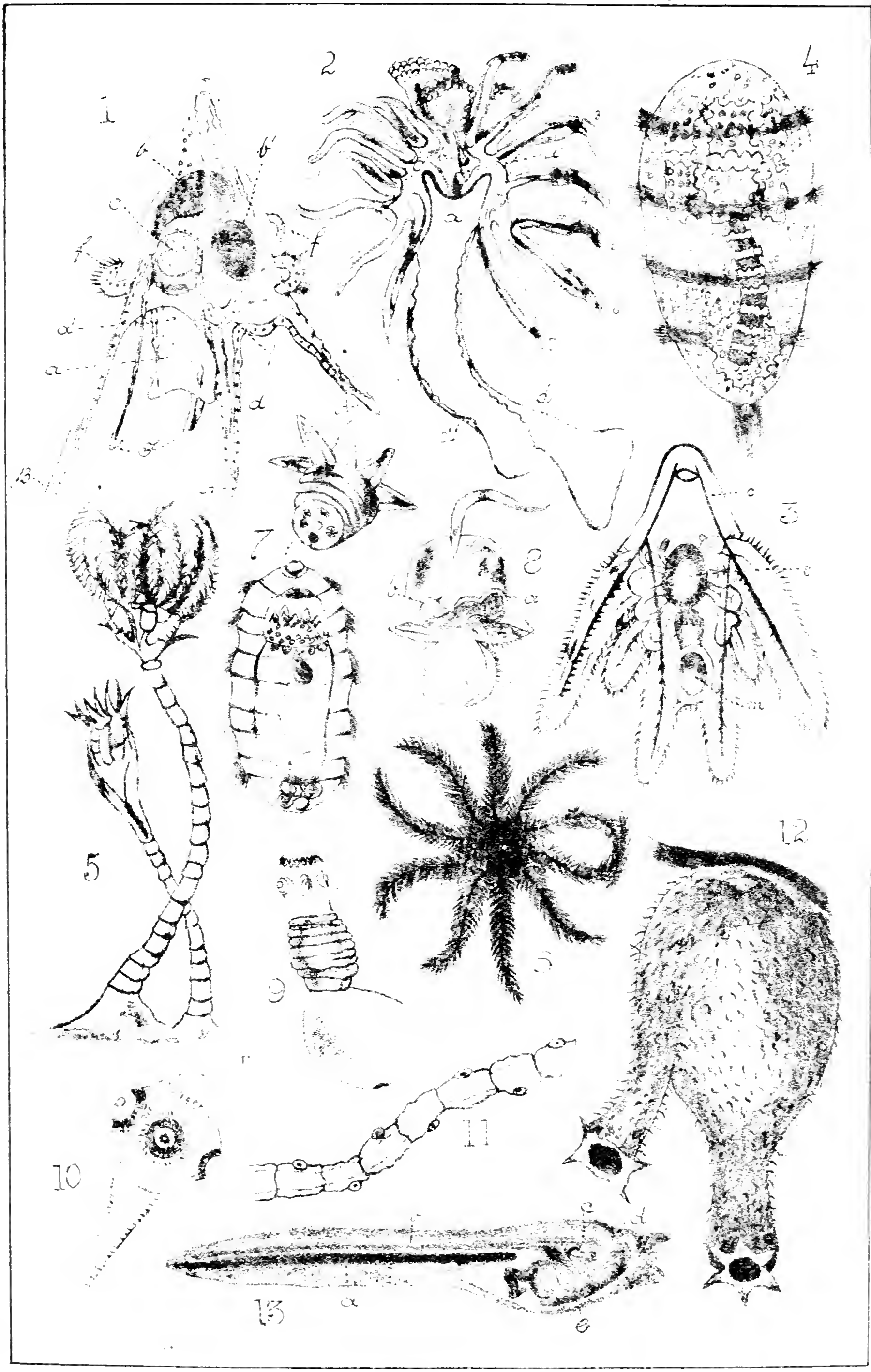
PART II.—ON MOUNTING MICROSCOPIC OBJECTS.

FUNGI.—If good mounts of the spores of fungus—such as, for example, the *Puccinia*—are wanted, the spot should be removed from the leaf by means of a very sharp-pointed scalpel, and then, the slip being breathed upon, the fungus will adhere to the glass; but in some few cases, as in *Xenodochus*, the spores are so dense that it is not well to add Dammar immediately; but in such a case, a drop of Benzole, placed by means of a piece of rolled paper or a match by the side of the spores, will quickly penetrate them. When this has nearly evaporated, a drop of Dammar may be put direct upon the spores, after which the cover-glass should not be placed upon it for half-an-hour, and it will be found that, when warmed and put down, it will not move the objects so easily as it would have done if this plan were not followed. A short list of the Puccinias may be of use.

Puccinia graminis (Wheat Mildew), common on grasses and straw in the autumn, forming long, blackish lines. The spores are two-celled, borne on a slender, colourless stalk, and accumulated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in tufts, bursting through the cuticle.—*P. coronata*, a very distinct species from the last, and occurs on the leaves of more delicate grasses. The apex of the spore bears three or four tooth-like processes.—*P. Apii*, a similar brand, with two-celled spores, is found on the wild and cultivated celery-leaves. The entire leaf is generally closely sprinkled with patches of coffee-coloured spores. —*P. Anemones*, very common in the spring, on leaves of wood anemone, or wind flower. The surface of the spores is rough, with little points or projections. Other brands, with two-celled spores, occur on willow-herb, thistles, ground-ivy, violets, bedstraw, primroses, knot-grass, asparagus, etc., but all are similar in character.—*P. straminis*, on wheat, rye, etc.—*P. Menthæ*, on various mints.

Meadow-sweet Brand (*Triphragmium Ulmariæ*).—This Brand has a similar habit to the foregoing, but the spores are divided into three cells. The meadow-sweet is common by the sides of streams and ditches everywhere, and the brand is nearly as common in autumn on the under surface of the leaves.—Bramble Brands, (*Phragmidium bulbosum*), common on bramble leaves in autumn. The black patches are good objects, *in situ*, viewed opaque with the 1-inch objective. The spores are borne on a transparent pedicel in tufts. Each spore has three or four divisions, and the surface is rough with projections.* Amongst other fungi may be mentioned strawberry, raspberry, rose, and great burnet Brand; nettle, buttercups, white-spotted gooseberry, coltsfoot, bedstraw, violet, berberry, goatsbeard, buckthorn, daisy, and dock Cluster-cups; with those from other plants, all similar in their general character.

Wheat Bunt (*Tilletia caries*) fills the whole interior of the grain of wheat with a fœtid olive powder, which, viewed with the ¼-inch objective, is found to consist of globose, reticulated spores, mixed with branched threads. Rye Smut, on leaves and sheaths of rye, consisting of many-celled spores; interesting as the type of the so-called "Cholera fungus." Wheat-Rust is the "Red rust" of farmers, and is but too common on the green leaves of growing corn.

* Some of these Brands are shown on Plate XIII.

Star-spotted fungus (*Asterosporium Hoffmanni*).—The beautiful stellate spores of this fungus ooze out in a black mass from orifices in the bark of the beech, forming sooty patches. They have three or four separate rays, and may be mounted in Glycerine, or Canada Balsam and Benzole. Grape-fungus, found in damp weather oozing from bark of the beech in a black gelatinous mass, something like printer's ink. Cabbage Mould (*Macrosporium cheiranthi*), on decaying leaves of field beet, and those of some other plants. Common Plant-Mould, found on almost all damp, decaying vegetable matter. Potato-Mould appears on the stems and leaves of the potato in the form of delicate branched threads.

The mycologist is advised to make drawings of all fungi, or at least of the principal forms which come under his notice. Those species of fungi which are parasitic on the leaves of phanerogamous plants must be treated in a different way. The leaf itself, not giving sufficient support to the cutting instrument, must be laid between two pieces of cork—a common wine-cork, divided longitudinally, answers perfectly well. Then, by cutting clean through the cork and leaf, sections of the required thinness may be obtained without difficulty. To keep the two pieces of cork from shifting during the operation, they may be thrust through a metal ring of suitable size, or a piece of gummed paper may be affixed round them; a still simpler plan is to tie them together with strong thread or thin string. The section can be placed at once on a slide with a fine-hair pencil. The following re-agents may be used with advantage in the examination of the spores: sugar, sulphuric acid ($H_2 SO_4$), iodine, and caustic potash in solution (see Dr. Beale, "How to Work with the Microscope").*

Examination and Preservation of Fungi.—The examination of Fungi scarcely requires any special remarks. They should be viewed, first, as opaque objects under a low power, and then sections should be made, or the textures separated with mounted needles. There is some difficulty in moistening the filamentous

* Always apply water by capillary attraction when examining Fungi, as, from some unknown cause, the "pedicels" no sooner come in contact with water than they "lose their heads." The fruit drops off, and the observer misses the chance of ascertaining the way in which the pedicel and acrospore were united.

Fungi with water, which is requisite in the determination of the arrangement of the spores upon the branches. Hence we find the best plan is to lay the Fungus upon a slide, apply a cover, then add a drop of spirits of wine (*sp. Vin. rect.*), and afterwards a little water to the edge of the cover. When thus wetted, the spores may be more or less removed with a wet hair-pencil, when the ends of the branches will become perfectly distinct. In examination of the dried smaller Fungi, as the *Sphæriæ*, the capsules should be macerated for a time in water. The softer Fungi are very difficult of preservation in the entire state ; but the sections or minute structures may be mounted in chloride of calcium or glycerine. The harder and drier Fungi may be preserved by drying and gentle pressure between coarse, absorbent paper. They may then be glued to pieces of paper and labelled, in the same manner as the flowering plants. Specimens of the capsules—as of the *Sphæriæ*, etc.—may also be mounted in the dry state, the asci being preserved in the chloride of calcium or glycerine, in which liquids most of the smaller Fungi will keep extremely well.

Higher orders of the Vegetable kingdom.—A few choice specimens only are described. The spiral vessels of plants can, in many instances, be obtained by boiling the stem of the plant for some time in water. Those of rhubarb are very large, and may be selected for examination. The spiral vessels in leaves may be beautifully shown by allowing some coloured fluid to enter them. If the stalk be placed in the fluid, and evaporation from the surface of the leaf be encouraged by exposure in a warm place, the fluid will enter the vessels. If the carmine fluid (see Part III.) be used, the germinal matter of the cells near the vessels is stained at the same time that the tubes are injected. Thin sections of soft vegetable tissues in any direction may be very easily obtained with a very sharp knife. The method of cutting thin wood sections is as follows :—Various woods and other vegetable textures of a certain degree of firmness may be cut with the aid of the hand-microtome. A piece of wood, after having been allowed to soak for some time in water, is placed in the well, and kept in position by the side-screw. Upon turning the lower screw, the wood is forced above the brass plate. A clean section may now be made with a strong, sharp knife or razor. By thus turning the screw beneath very slightly, sections of any degree of thickness can be obtained.

The cellular tissues of plants (certain leaves, flowers, and fruits) are softened, and at length destroyed by weak nitric or hydrochloric acid (1 part acid to from 20 to 50 of water), while the fibrous and vascular textures remain behind, constituting the skeleton of the leaf, flower, calyx, or fruit. Almost all vegetable tissues are more easily investigated when they have been preserved for some time in viscid media, which are admixable in all proportions with water. Leaves and stems, when well saturated with syrup or glycerine, are easily dissected into their component tissues. They must first be placed in very dilute solutions, which may be concentrated by very gradual evaporation, or the strength of the solution may be increased by the addition of small quantities of strong syrup or glycerine from day to day. The beginner is advised to examine various specimens of jams and preserved fruits, as they, having been long soaked in syrup, have become exceedingly transparent, and are admirably fitted for microscopic demonstration. The spiral vessels, woody and cellular tissues, can be obtained without any trouble, and the minute structure of the different vegetable tissues may be most clearly demonstrated.

Pollen Grains are among the most interesting objects. They can easily be obtained by shaking the anther of any fully-expanded flower upon a glass slide, and may be mounted dry in aqueous fluids, or in Canada Balsam and Benzole. The external markings of seeds of plants are deserving of attentive examination. They may be examined as dry objects without any preparation whatever, by reflected light.

Seaweeds, to be preserved permanently, should be allowed to soak for some time in pure water. Small pieces may then be removed and transferred to glycerine.

Some of the most beautiful vegetable sections which we have seen have been mounted in glycerine. The mixture of gelatine and glycerine, or gum and glycerine, will also be found good media for mounting many vegetable structures; chloride of calcium forms a useful preservative fluid in many instances. Creosote fluid, carbolic acid water, very dilute spirit and water, and even distilled water, will preserve some vegetable tissues for a great length of time. The pith from the stem of various plants, the epidermis, and many other vegetable tissues may be preserved as dry objects very satisfactorily.

Preparation of Vegetable Sections.—Not only do we find, as a rule, that the texture of many vegetables is of too great density to be readily cut in the natural condition, but they also contain much resinous and other matter, of which it is highly desirable to get rid. Let us take a stem or root, and first cut it into short lengths, which are to be placed in water for three or four days, by which time all the soluble, gummy matters will have disappeared. The pieces are now transferred to a wide-necked bottle, containing methylated spirit, which, in the course of a few days, will dissolve out all the resin, etc. Many kinds of woody tissues are by these processes reduced to a fit condition for immediate cutting. Others, however, are so hard as to render it necessary to give them another soaking for some hours in water, to bring them to a sufficient degree of softness to cut easily. If the wood (as will happen sometimes) be still too hard for cutting sections, a short immersion in warm, or, if necessary, boiling water, will not fail effectually to soften it.

Unprepared Vegetable Tissues.—Special directions are given in text-books on the subject. For instance, it is recommended to lay the leaf, etc., on a piece of fine cork, and with a sharp knife to shave off thin slices, cutting down upon the cork, etc. No method, however, is at once so simple and successful as the process of imbedding in paraffin. To do this, it is necessary to make a paper mould, by twisting a strip of stout writing-paper round a thin ruler, and turning in the paper over the end of the ruler. This mould, the height of which may vary from an inch to an inch and a-half, should now be half filled with melted paraffin-mixture, which is made by mixing paraffin with one-fifth its weight of common, unsalted lard, a gentle heat applied, and the two substances thoroughly stirred together; the leaf or other object plunged into it, and held in position by forceps till the paraffin has become sufficiently solidified to yield it a support. Take care that the mixture is *not too* hot when the stem is first dipped in; it is best to dip the stem in and withdraw it again for a minute, and then finally plunge in and proceed as above. More of the paraffin mixture is now poured in, until the specimen is thoroughly imbedded. The whole is to be put away in a cold place for an hour or so, when the mass will be firm enough to be cut with ease. Sections may be made with a razor, kept constantly wetted with water; or, if the preservation of colour be no object, methylated spirit may be employed for the purpose.

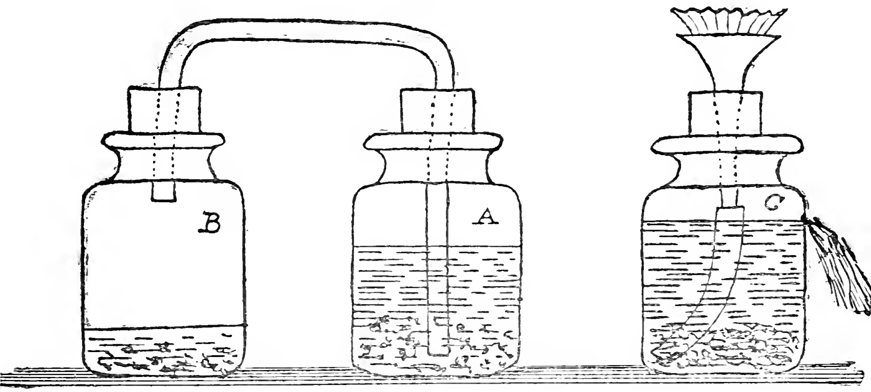
Embedding Agents.—Insects enclosed in chitinous cases may, according to Hyatt,* be advantageously embedded in shellac. For this purpose, the insect is to be placed in alcohol, and allowed to remain there until it is thoroughly permeated by the spirit. It must then be removed to a clear alcoholic solution of shellac, in which it may remain for a day or two. A cylinder of soft wood is now to be so prepared that it will fit accurately into the tube of the microtome. This cylinder is now to be split longitudinally down the middle, and a groove cut into one or both half-cylinders sufficiently large to admit the object without pressure. The two halves, with the object enclosed between them, are now to be fastened together with thick shellac varnish, and a thread passed around them to keep them in position. In a day or two the shellac will become quite hard. The cylinder is then to be soaked in warm water to soften the wood, then placed in the microtome, when thin sections may readily be obtained from it. If the sections should be rendered so opaque by the presence of the shellac as to interfere with their satisfactory examination, the addition of a few drops of solution of borax will soon render them transparent.

Bleaching Vegetable Sections.—The agents most commonly used for bleaching are:—(1) Alcohol; (2) Solution of Chloride of Lime; (3) Labarraque's Solution of Chlorinated Soda, made by decomposing Lime Chloride by the action of Sodium Carbonate. There are, in certain cases, objections to these methods, and we much prefer the plan recommended by Dr. Marsh, which is as

* "American Monthly Microscopical Journal," 1880.

follows :—Apparatus required—(1) Two small, wide-necked bottles (those in which chemists sell one ounce of Citrate of Iron and Quinine are very suitable); (2) perfectly sound corks, accurately fitting the bottles; (3) 6 or 8 inches of narrow glass tubing; (4) some shellac varnish. By means of a cork-borer or a rat-tail file, a hole is to be made through the centre of each cork, just large enough to grasp tightly the glass tubing. With the aid of a spirit-lamp, the tube is to be bent at right angles at each end, as shown in Fig. 2. The

Fig. 2.



two arms are not to be of equal length; one should be about 1 inch and the other about 2½ inches. These arms must now be passed through the holes in the corks themselves, then made air-tight by a liberal application of the shellac varnish. A notch having been cut in the edge of the cork carrying the longest arm of the glass tube, the apparatus shown in the figure is complete. To use it, proceed as follows :—About three parts fill bottle *A* with *filtered rain-water*, and to this transfer the sections to be bleached. Into bottle *B* put a sufficient quantity of crystals of chlorate of potash just to cover the bottom, and pour upon them one drachm or so of strong Hydrochloric Acid. Fit in the corks, taking care that the one carrying the long arm of the glass tube be applied to the bottle containing the sections. Immediately, the yellow vapour of chlorine (or, strictly speaking, of euchlorine) will be observed to fill the bottle *B*, whence it will pass along the connecting tube into the water contained in *A*, and effectually and safely bleach the sections. When the water becomes super-saturated, the excess of chlorine will accumulate in the bottle above the liquid, and find an exit through the notch in the cork. As to the time required for bleaching, this will vary in accordance with the nature of the sections operated upon. As a rule, if the apparatus be set to work at night, putting it out of doors in a covered place to avoid the smell of escaping chlorine, the bleaching will generally be found to be complete in the morning; if not, further time may be allowed without any danger to the sections being incurred.

Washing the Sections.—Decolouration having been effected, nothing now remains but thoroughly to wash the sections, for it is necessary to eliminate all trace of chlorine before employing any staining agent. The usual method is to put the sections into a large basinful of water, and to repeatedly change the water. Dr. Marsh's way is much the best—*i.e.*, *continuous washing.* A small, wide-necked bottle (*C*), similar to those already described, must be procured. Into the side of this, half-an-inch or so below the bottom of the cork, a small hole, about an eighth of an inch in diameter, must be drilled (any tinman will do this for a few pence). A well-fitting cork being provided, this must be pierced through the centre, so as to allow the stem of a small funnel to pass through it. By means of small India-rubber tubing (feeding bottle-tube), the funnel-stem is to be prolonged till it reaches the bottom of the bottle on the side *which is opposite to that side containing* the perforation. All being ready, half fill the bottle with filtered water and put the bleached sections into it. Fit in the cork carrying the funnel, and place a disc of filtering paper into the funnel; put this beneath the water-tap, and allow a *gentle* stream to trickle into it. The water will pass to the bottom of the bottle, gradually ascend, and then pass out at the hole in the side, by which means a constant change of water and a continuous washing system is established. Do this at night. Set the tap running when you go to bed, and the washing will be effectually accomplished by the time you get up in the morning.

* This process was described in No. 43 of the "Quekett Journal," p. 54, &c.

Pond Life. *

Lectures delivered to the Albany Naturalists' Club, Edinburgh,
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First Lecture, Nov., 1884.

Plate XII.

IT is not necessary for me to commence this Lecture by defining a pond. The definition of a lake, which you can find in any of the geography-books, will do as well if you add the words "a little smaller." It is possible that many of you may have thought that a pond was here, there, and anywhere, because it happened to be placed there when the world was made. But if you look at any of the ponds that you know, you will see that there are certain conditions which are essential to there being a pond in any particular place. You will find that there is water falling, as rain, upon all the country round about, and as this water falls upon the hills, it runs down their sides into the valleys, where it forms streams: and then you can easily imagine that there will be certain places where, owing to the valley being partly filled up, the water will collect; and this is the manner in which every lake and every pond is formed. If you will remember the Braid Hill pond, there are hills all round it, and from these hills little streamlets trickle down into the pond. But even on the low part where the road runs, the road is higher than the pond, and so it keeps the water in. There is only one small channel where the water runs out and finds its way down into the valley.

The surrounding hills, too, determine the nature of the bottom of the pond, which consists simply of small fragments which have been washed down from them, so that it contains the

* The reader is requested to look upon this Lecture not as a contribution to knowledge, but merely as an attempt to describe a few natural phenomena in language as simple and free from technicality as possible. The fact that it was delivered as a lecture, and is now printed from the reporter's notes, must excuse the many deficiencies in literary style.

substances which are most easily washed away from the hills. If these be of red sandstone, you may expect to find a red sandy bottom to the pond; if the hills be of blue or of grey clay, the bottom of the pond will consist of a similar clayey mud.

Now we may attack the question, how did life get into ponds? There must have been a time when there was a pond without anything living in it. It is not my intention to tell you how living things came to be in the first instance; that is a question upon which we can only speculate. We have no knowledge about it. But we may assume that there is plenty of life in the world, and that there is a pond left to itself, and we can try to ascertain how it would become stocked with living animals and plants. In the first instance, the air is not pure, even in the country, but is full of dust of all kinds, amongst which a very careful examination reveals living organisms. Many different kinds of these germs are to be found in the atmosphere, so that the very fact of rain falling through the atmosphere into a pond, will bring living things into it. But these are exceedingly small, and if our pond depended simply upon them we should not have any of the higher forms of life in it. You will have noticed that many plants have exceedingly small seeds, so small indeed that they can be carried about by the wind; some of these might reach the pond. Again, many seeds are eaten by birds, and thus carried away and dropped in various places, and often in ponds or on their banks. Animals, too, can be carried in a similar manner. There are instances of birds caught at sea, far from land, which, when examined, have been found to have small snails, frog-spawn, and other similar matters sticking to their legs. So that it is easy to see how by these means many animals could be transferred from one pond to another. These facts are interesting, not principally as regards our pond, but most especially when we come to consider similar questions in relation to islands which are situated far out in the ocean, and to find out how they have been stocked with plants and animals.

The fact of plants and animals living in the water has a great influence upon their structure, and modifies them in many ways, so that those which live in the water are, in general, fitted to live nowhere else. Not many animals, and still fewer plants, can live both on land and in water.

However, I have occupied enough time in speaking of ponds in general, and so will now proceed to the immediate subject—the living creatures which are found in them; and I will venture for one moment to dwell on the question, what do we mean by living creatures? I do not intend to give a learned disquisition on life, but there are certain points in which you can easily see that a living thing differs from a not-living thing, and it is just as well that these should be very briefly put before you, so that you may have clear ideas regarding living animals, and their relations to other things about them. In the first instance, most of you know that living things *move;* that is the ordinary test of life. We instinctively poke the body of an animal we have found to see whether it move or no, and if it do not, we say "It is dead." Of course there are instances in which this test will fail. You do not expect to see an egg or a seed move, yet an egg is alive, and so is a seed. Again, there is another point in which all living things agree, and in which they differ from not-living things; they take in substances which are about them, and convert them into a part of themselves, or, in one word, they *feed.* Now, no living thing can exist for more than a very limited time without food, and every living thing feeds at some period of its life. So that what we do when we eat our dinner is precisely analogous to what the plant does when by its roots it sucks up nourishment from the earth, or takes it in from the atmosphere by means of its leaves.

Then a third, and perhaps the most characteristic of all the points of difference is that living things have somehow or other the power to bring about a reproduction of themselves; that is to say that each plant produces seeds, or spores, or something of that kind, which give rise to a new plant exactly resembling the old one; and each animal lays eggs, or something of that kind, and has young which grow up exactly to resemble their parents. So that each living being has the power by some means or other of reproducing a being similar to itself. Living things therefore *move*, *feed*, and *reproduce* themselves, and in these three points they differ most clearly and most definitely from any not-living thing.

I shall come now to speak more especially about the plants which we find in our fresh-water ponds. First, however, I wish you to bear in mind that plants and animals are really parts of one great whole, and that the inanimate world is to be put on one side, and the living or animate world on the other. You are not to go away with the old nursery division of the whole universe into animal, vegetable, and mineral, because that is unscientific. The division is not into three, it is only into two; the *animate* and the *inanimate*. Plants and animals are very closely related, they are distant cousins. So that if you had the first living thing, you would find it had reproduced itself, and these reproductions diverged into a family tree with two branches, the one of which became plants and the other animals. The truth of this is very easily seen when we come to study the lower forms of animal and vegetable life. Of course, it is very easy to separate the higher forms from each other, but when we come down to where the two branches begin to diverge, we shall find that we cannot tell whether a given form is a plant or an animal. In other words, we get a group of forms that are equally related to animals and plants, and it is very much more reasonable to regard them as all belonging to one big family, rather than to separate them into two families, and they thus form a group which has been called *Protista*, from the Greek, meaning "the most primitive creatures." One of these is a creature which is sometimes found in the fresh-water pools; it is known as *Protamœba* (Plate XII., Figs. 25, 26). It consists simply of a lump of protoplasm (the name given to living matter). If we examine this *Protamœba* with the microscope, we shall find that it is a pulpy, almost colourless, shapeless substance.

Now, how do we know that this creature is alive? We apply our three tests to it. First of all, does it move? You watch it and it appears to be quite still, but if you make a drawing of it and look at it again in a few minutes, and make another drawing, you will find it is not the same shape as it was before. It shrinks a little at one side and expands at the other, so that it is continually pushing itself out in certain directions, and so moves along. Secondly, does it feed? There are in the water in the ponds numbers of very small plants (Diatoms), of which I shall have more to say by-and-by. The *Protamœba* puts out these feelers until they quite enclose the unfortunate Diatom, and presently it has in a very literal sense surrounded its dinner. Now as to the third question, does this little creature produce beings similar to itself? At times there forms a groove all round it, and by-and-by it becomes completely split across, and we have two creatures where there was only one before (Fig. 25). But that is not the only way in which this takes place. Our *Protamœba* draws itself up into a kind of globule, and then shrinks together, forming on the outside a knob, the protoplasm inside of which divides into a large number of portions, and each of these forms a fresh creature. So that in these two ways creatures are formed like the original. The *Protamœba*, therefore, fulfils the three distinctions between living and not-living substances. Now, is it an animal or a plant? It is very difficult to say; this species has always been placed in text-books of Zoology rather than of Botany, but it seems, on the whole, advisable to regard it as one of a group intermediate between the animal and vegetable kingdoms. It is, in fact, a representative of the very simplest form that a living being can exhibit. Much more common, however, is a creature which makes a step in advance upon *Protamœba*, inasmuch as the central part of its body seems to be drawn together into a more solid mass than the rest, called a "nucleus." This is the *Amœba*, and when it is about to split into two, and thus reproduce itself, the nucleus divides before the rest of the body.

Now, there is a curious plant which is a step in advance of the *Amœba*, sometimes found in the water and in damp places. It forms a kind of jelly, and on examination with the microscope, is seen to consist of a number of little cells, arranged in strings, twisted and curled about in a serpentine manner (Pl. XII., Fig. 24). This is just one step in advance of the form we have been considering, for that consisted of only one cell, but here a number of cells are produced. Originally, however, it consisted of one cell only, which split up and became two, and these in their turn formed new ones, and so on.

Another very curious plant is the *Spirogyra* (Pl. XII., Figs. 19—23), which occurs very abundantly in the green scum on the surface of ponds, and consists of a long string, divided into cells by a number of partitions; it is crossed by green colouring matter which is spirally arranged. In each of the cells is a nucleus, and certain fibres or strings, which are the protoplasm—the living matter of the cell—so that it consists of four parts. First, the *nucleus* (*a*), in the centre of it; secondly, the living *protoplasm* (*b*), round the nucleus; third, the green colouring matter, which is the same as the green matter of leaves (*c*); and fourthly, the *husk* (*d*), or "cell-wall," which is formed or excreted by the protoplasm. It grows in the following manner:—First of all the nucleus divides, just as in the case of the *Amœba*. The protoplasm which forms the substance inside the cell also divides, and while this is going on the wall gradually begins to draw in, until at last it forms a division quite across, so that where there was only one cell before, there are now two, which soon attain the same size as the original.

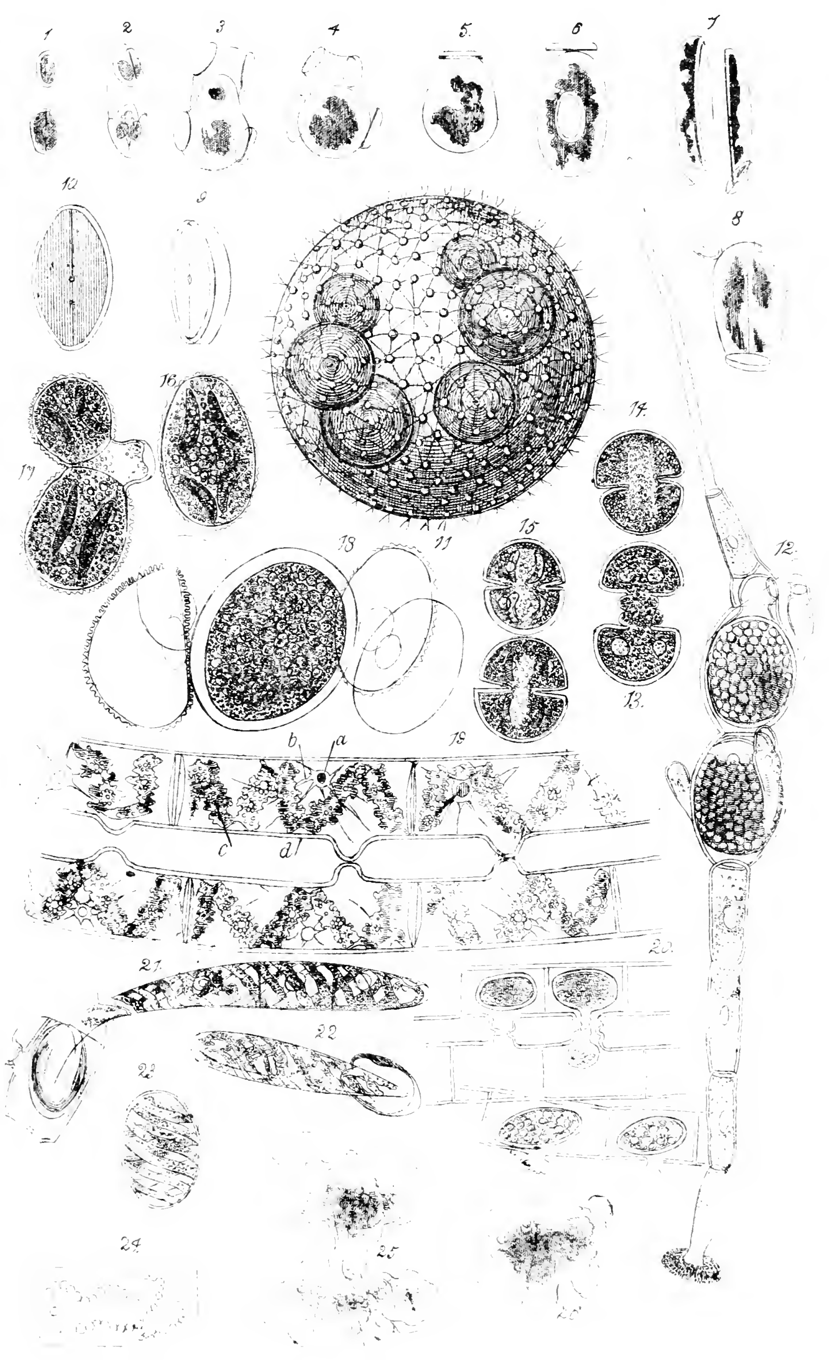
But more than this may be observed in this plant. Most commonly in the autumn, and at night, where these thread-like plants form a thick mat, two cells, side by side, will put out certain processes, which presently come into contact, and form a tube connecting the two cells (Fig. 19). All the substance from one cell collects into a ball, and passes over into the other (Fig. 20). After this it forms an outer coating, like the *Amœba*, and remains thus throughout the winter (Fig. 23.) In the spring it buds out again, to form a new filament like the parent (Figs. 21, 22), so that this plant has the power of doing two different actions. First, by the process of "cell-division," it grows, that is to say, producing a larger plant; and, in the second place, by means of two elements which unite together, it forms an entirely new plant. By the one process the plant is enlarged, and by the other a new one is produced.

There is another interesting plant which may be found pretty commonly in ponds about Edinburgh, and is called *Volvox globator* (Pl. XII., Fig. 11). It is always turning and twisting itself about when alive, by means of a number of hair-like threads, projecting from it on all sides. It is really a colony; that is, each of the little green bodies which bear the hairs is a cell, and the whole round body a mass of cells. Inside it you may notice a small yellow globe, covered with wart-like projections resembling a raspberry. Each wart afterwards becomes separated, and then has two fine hairs. In the colony there are also other plain, round, green globules, and after a time the yellow bodies have become scattered, and the little things inside it go swimming about by the aid of their long tails, like tadpoles. They collect round the green globules, into which some of them penetrate; then a kind of husk grows round the globule, which rests for a time and afterwards divides into a number of smaller spores, each of which is competent to reproduce a colony just like the original one. So that here again we have small plants budding off from each other, and also the union of two parts to produce a spore which gives rise to a new plant exactly like the parent.

But these are not the only plants in our ponds. There are a number called Diatoms (Fig. 1—10), because they consist of two equal parts; in fact, they are constructed very like a pill-box, one of these parts being a little larger than the other. In many cases the walls are very beautifully sculptured, the pattern varying so much that several thousand species have been described, which can be distinguished by their different markings. Now, these creatures have a habit of expanding, very much as a pill-box would do if you lifted the lid partly off it, and when the depth of the box had been about doubled, a division takes place, and the two halves separate and form two Diatoms, where there was only one before (Figs. 9, 10). Of course, the one just formed is not quite so large as the original. But this process goes on again and again, until a very small one indeed is formed; two of these meet together and split into halves, their contained protoplasm escaping and fusing into a single mass (Figs. 2—6) with a husk about it, and remains still for a time, and then grows to the same size as the original Diatom, thus constituting what is called an "increasing spore" (*auxospore*) (Fig. 6), and furnishing a means for restoring the plant to the same size as the parent of the family (Figs. 7—10),

There is one other family of these low plants, which we call *Desmidiaceæ* (Figs. 13—15), and which are found in enormous numbers in our ponds. The Desmid, like the Diatom, is divided into similar halves. When reproduction is to take place, the two halves separate a little from each other, and each one bulges out in the centre (Fig. 13). Then a partition divides the bulged part into two prominences, which grow gradually larger, until finally each becomes as large as the original half of the cell (Fig. 13); so that instead of one creature there are two. But these plants can reproduce their kind in another way. Two of them, each consisting of two similar halves open a little and a very thin portion of the internal green matter projects out (Figs. 16, 17). These two projections gradually meet, and form a peculiar round mass in the centre; and around it may be seen the four halves of the two original Desmids, each of which shows a hole out of which all the contents of the cell has come (Fig. 18). This round, green globule, with its protecting husk, now remains for some time, after which it starts afresh and produces a new plant like the parent. So that we have here also two means of reproduction: one of them by dividing across in the middle line, and the other by two individuals joining together, and producing a kind of spore.

Now, there is just one more instance that I should like to bring before you, and that is a plant which goes by the name of *Œdogonium* (Fig. 12). It grows generally upon some other plant, and it will be seen that it consists of small cells, one of which forms a kind of root, and the others form the stem; there are no branches, but there is a long hair at the top. When the plant grows a little, a large round cell forms here and there in it. To this becomes attached a minute cell, shaped like an urn, having a curious lid upon it; by-and-by the lid comes off, the contained substance passes through a hole formed on the top of the large round cell. The protoplasm of the two cells mixes together, and forms a kind of spore inside the large cell which remains for a while, and then gives rise to a new plant or plants, going through the same process. So that here the same process which we have seen before, takes place, but in a modified fashion. Instead of two individuals uniting to produce a spore, we have a large round cell, and a small urn-shaped one, and the result is a plant just like the original. These are some of the most interesting of the lower plants found in ponds, and I have brought them under your notice, not simply because they are interesting and curious in themselves, but because they illustrate general laws which run through the whole animal and vegetable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kingdoms; because they enable us to see what are the characters which distinguish living things from not-living things, and because they show us, in simple organisms, laws which will be found carried out in a more complete fashion in the higher groups of plants and animals.

EXPLANATION OF PLATE XII.

Figs. 1—10.—Reproduction of a Diatom (*Cocconeis pediculus*, Kg.), after Carter. Two small diatoms, one less than the other (Fig. 1) become united by a mucous-like excretion, and the valves open (Fig. 2); the contents fuse (Fig. 3); become spherical (Fig. 4), and afterwards elliptical in shape (Figs. 5 and 6); a line then appears, dividing the spore into two halves (Fig. 8), which completely separate (Fig. 7); and in their complete condition are seen in Figs. 9 and 10.

,, 11.—*Volvox globator*, after Nave.

,, 12.—*Œdogonium ciliatum*, after Pringsheim. The stem consists of four cells, above which are two large, oval, spore-forming cells. Attached to these are the small, urn-shaped cells, in which the small, moving, fertilising spores are formed.

,, 13—15.—Reproduction of a Desmid (*Cosmarium botrytes*), by division, after De Bary. The two halves of the cell (Fig. 14) commence to separate a little, and a division (Fig. 13) runs across the intermediate part, which gradually enlarges until two cells, each as large as the original one, are formed (Fig. 15).

,, 16—18.—Conjugation of the same Desmid, after De Bary. Two cells, each like Fig. 16, lie together in a mass of jelly, and its contents protrude (Fig. 17). The contents of the two cells mix together, and form a round spore with a gelatinous wall, beside which lie the four empty halves of the two original cells (Fig. 18). The round cell eventually forms in its interior two bodies like the original *Cosmarium* (Fig. 14).

,, 19—23.—Conjugation of *Spirogyra longata*, from Sachs. A small prominence protrudes from each of two cells lying near each other (Fig. 19). These unite and form a communication between the two cells, through which the contents of one cell passes into and mixes with the contents of the other (Fig. 20). The result is the formation of a spore (Fig. 23), which germinates into a new plant (Figs. 22, 21).

,, 24.—*Nostoc*, sp. Showing the strings of cells lying in a jelly-like mass.

,, 25—26.—*Protamœba Schulzeana*, after Hæckel. Fig. 25.—The *Amœba*, undergoing division; Fig. 26.—One of the young *Amœbæ* formed by the process.

Half-an-Hour at the Microscope
With Mr. Tuffen West, F.L.S., F.R.M.S., &c.

Crystals of Strychnine.—This slide is not interesting. Lists of excellent objects for the polariscope are to be found in all good text-books on the microscope. It is well that all who work with this instrument should have a good knowledge of them, and have in their cabinets a good illustrative series, but they are *not* desirable subjects for our boxes. They reduce to child's play what should be considered as valuable opportunities for mutually imparting and gaining knowledge. Writing as I am now doing, far from home, books, and specimens, I would not be positive, but my belief is that there is nothing specially distinctive in these needle-shaped crystals, and, therefore, no knowledge whatever is to be gained from the inspection of this slide.

Crystals of Oxalic Acid.—I am quite sure of the correctness of my proposition in this case, which, for anything that here appears, might just as well be crystals of any other salt, so many, when rapidly crystallised from weak solutions, form just such as we see here, and which have nothing whatever of the forms whereby crystals of oxalic acid, or salts isomeric with it, may be recognised when present. Our readers may remember some interesting descriptions, with figures by Lewis G. Mills, LL.B., of Armagh, of crystals found by him in the fang of a spider and in the sting of a wasp. The accounts of these appeared in parts of *Science Gossip* of a few years ago, and I have myself remarked in these "Notes" on similar crystals present on a slide of "Sting of Scorpion."* These, though probably not exactly oxalic acid, were "isomeric"—that is, identical in form with the typical crystals of that salt, and, as I have already pointed out, illustrate well the application of the polariscope as an adjunct, at times of much importance in scientific investigation.

Crystals of Sulphate of Cadmium.—The quadrifid, petraloid character of the crystals is, so far as I know, unique, and may, therefore, be considered to have a claim to admission into our boxes.

Batrachospermum moniliforme is a very remarkable form of alga, and might be compared to such fungi as *Penicillium* or *Oidium*, borne in dense whorls; both stems and branches ex-

* See this Journal, Vol. III., pages 113, 251; also, on Fang of Viper, with plate, Vol. III., Pl. 28.

tremely slender and transparent, the latter short, closely borne, and either alternate or opposite. I should have liked to have seen fruit on the specimen. The interest of this slide is increased through its having also some good illustrations of such Diatomaceæ as grow along with it, in small boggy streams. Amongst them may be noted *Himantidium pectinali*, *Melosira varians*, *Meridion circulare*, and *Synedra radians*. I suppose the specimen to be mounted in one of the camphor solutions, which really seems to me to be disposed rather than otherwise to favour the growth of that tiresome fungous mycelium, which is such a plague to some of our best slides. I should be disposed to try if a weak, spirituous solution of corrosive sublimate could not be introduced at one edge of the covering glass, so as to stop the inroads of the pest, and so save a valuable mounting.

Aregma bulbosum (Pl. XIII., Figs. 1—8).—This fungus (in a way not yet sufficiently understood) gains access to the interior of the plant appointed for its "host." At the seat of development (the leaves) a cushion of mycelial filaments is formed; numerous branches appear, the tips of which swell, become constricted, and the separated portions are cast off as "protospores," capable of an independent vegetative existence. These protospores have their analogues in the "bulbilli" of mosses, jungermaniæ, ferns, and the "gonidia" of lichens, as also in the "bulbs" of the tiger-lily, and a few other of the higher plants. They differ from true "spores" and seeds in not being products of generation, but simply portions of tissue specialised to a sufficient degree to be capable of independent life. By rapid internal growth of the fungus, the epidermis of the leaf is raised in blisters, and bursts. The earlier condition adverted to receives in the bramble the name of *Lecythea ruborum*. After this, more branches, swollen at their tips, are formed. The contents become increasedly granular, and mapped out more and more distinctly into four portions, the "endochromes," in each of which appears a clear vacuole, the "nucleus." The subsequent changes consist in increased differentiation of structure, the formation of a horny, brown outer coat around the cell-contents, but within the original cell-wall—*i.e.*, the branch. The distinct appearance of "pearly beads" form corrugations on the outer cell-wall. It is hoped that by the aid of the figures on Plate XIII., these various processes will be understood.

The plan of duplex mounting adopted by some of our members is worthy of high commendation. In the Plate, figures of related forms have been added, to tempt members whose attention has not yet been turned to these beautiful and interesting objects to collect and study them.

Willow Branch, transverse section.—I simply remark on this section that Raphides in great quantities will be found in the bark of Willow as Crystal prisms and Sphæraphides, also Crystal-dust. Query—Are not these larger Crystals in course of formation?

Sclerogen from Pear.—I recommend the following plan for preparing this object:—Cut sections and dry between slips of glass tied together; then mount as you would a section of bone, of plum- or cherry-stone, of cocoa-nut shell, or of vegetable ivory, in hard balsam. This will just make the object sufficiently transparent for comfortable examination, but will not obscure the canaliculi by running into them. The result will be found very striking and satisfactory.

Palate of Helix aspersa, and

Palate of Periwinkle (Littoria littorina) form a choice pair that will be best considered together, forming, as they do, so striking and interesting a contrast. The one (comparatively) so short and many-toothed; the other is very long, and having, in comparison, so few teeth. Better types could not have been selected. And they have the further advantage, that both the animals whence they are taken are readily to be procured by other members for their own study and comparison. For whatever may be said to the contrary, it is the fact that the common objects wherewith we are surrounded are those whose structure it is most important we should be conversant with, as they are those which are almost invariably selected for typical illustration by the Masters in Science.

Palates should be mounted in cells, and not pressed flat. In the mouth of the snail two muscles will be seen: one of these draws the tongue up, the other is employed in drawing it down. The forward part is drawn alternately up and down, the leaf being held firmly by a large, strong tooth, represented by the *labrum* in insects. The forward portion of the dentigerous cartilage rasps off pieces of the leaf, which are then swallowed. It is very interesting to notice the surprising rapidity with which this is effected. The tongue is somewhat spatula-shaped, both in front and behind, the intermediate and larger portion in length being much bent down at the sides. The hinder expansion represents the lower portion of the walls of the pharynx. See Plate XIII.

In the **Periwinkle** things are very different. Here the front (acting) teeth are seated in a narrow band along the centre of a delicate, elongated cartilage, the remainder extending, in coil upon coil, some distance behind the front of the head.

In the **Whelk** the lingual band is short, but very strong, and the fore-part closely doubled down to fit it for its own work of an auger.

These remarks are made to point out that it is necessary, in the study of these mollusc's tongues, to closely investigate arrangements connected with the actions of the parts during life, as well as the number, form, and arrangement of the teeth, in which a most inviting field, scarcely touched upon, lies open.

Bed-Bug, Cimex lectuarius, ♀.—This insect, though not a typical Heteropteron, is still, in most respects, a good example of the important Natural order to which it belongs. The peculiar arcuate hairs, serrate on the outer margin of the curve, with three points at the tip, are well shown. In a consideration of the structure of insect hairs they possess considerable value. As special points of interest in this object may be mentioned the various parts of the mouth and some delicate organs of taste, resembling the "barb-shaped appendages" to Lepidopterous tongues. There are appendages of a very curious nature at the wrist-joints, which are particularly deserving of attention. Their presence or absence and exact structure denote powers of climbing over smooth surfaces; in some instances, the sexes are thus defined, and they furnish recondite characters, easily read by aid of the microscope, whose value will become increasingly apparent as that instrument comes more and more to be applied in a sensible way in the progress of research.

Tortoise-Tick (Pl. XIV.).—From drawings made when this was given to me, I have copied the accompanying figures as well as the remarks attached to the original drawings. I wish to point out the necessity of studying and recording minute details accurately; the value of this habit will become more evident with every accession of knowledge. For 22 years this drawing slept in my portfolio. But the mind had been prepared for the reception of further facts bearing on the subject, and my satisfaction was great when, some seven or eight years ago, the opportunity occurred for examining living specimens. None of the feet in this mounted specimen were perfectly shown, but sufficient appeared to justify the formation of an hypothesis as to their structure, which was recorded in the bit marked "supposed from the above." I thus found what had been a supposition proved to be really correct.

[Further researches into the general structure and life-history of various ticks is desirable, and we shall be glad to offer facilities for their free discussion.—Ed.]

EXPLANATION OF PLATES XIII. AND XIV.

PLATE XIII.

Figs. 1, 2, and 3.—*Aregma bulbosum*, from specimens on the slide under examination.

Fig. 1.—*p.s.*, *p.s.*, protospores—bulbilli, or buds thrown off in the early stage of the plant, and capable of independent growth. The letters in sequence, *a* to *e''*, illustrate the process of development, and the sequence of changes therein.

a, Swollen termination of a branch, with colourless granular contents. *a'* shows mapping out of these contents into what will afterwards become the four "endochromes," that being the normal number in this species. At *c.d.* the walls of the spore are seen acquiring a brown colour; the part which is farthest from the seat of attachment being the earliest and most advanced, as indicated by the increasing depth of colour.

,, 2.—Developing spore, seen with a higher power, to show how the spore is formed, as are "asci" in the "*Ascigerous Fungi*," and the formation of pearly beads by nodular corrugations of the outer cell-wall.

,, 3.—The same facts illustrated in diagram. *sp.*, *sp.*, spermatia.

,, 4.—*Aregma macromatum*, from the Rose.

,, 5.— ,, *bulbosum*, from the Bramble. This figure was taken from a freshly-gathered specimen, and has the "pearly beads" well developed.

,, 6.—*Aregma gracilis*, from the Raspberry.

,, 7.— ,, *obtusatum*, from the Barren Strawberry, *Potentilla fragariastrum*.

,, 8.—*Triphragmium Ulmariæ*, also showing the pearly beads.

LOWER PORTION—DIAGRAMMATIC SKETCHES.

Fig. 1.—Tongue of Snail, showing—*a*, Tooth by which the leaf is held whilst being eaten; *b*, Muscle for drawing the tongue up; *c*, Muscle for drawing it down.

,, 2.—Tongue of Snail, seen from above.

,, 3.—Ditto Periwinkle.

,, 4.—Ditto Whelk.

,, 5.—Flagellated Spermatozoa of Oyster.

,, 6.—Early stage of same before the formation of tails.

PLATE XIV.

Illustrating Tortoise-Tick.

The Figure in the upper portion is a fac-simile on a smaller scale of a drawing made by me (Tuffen West) many years ago, the original drawing from which it was taken being × 25 diameters of Tortoise-Tick.

[illegible] & other "Fronds," &c.

Ixodes from the Tortoise

The intention of giving it here is specially to show the value of careful drawings, which need not, however, always be *finished* throughout. This has been lying by in my portfolio for nearly thirty years, and only now finds its value in connection with the slides of Ticks recently circulated by members of the Society.

The notes are copied *verbatim* from the paper (half sheet of blue foolscap), on which the original drawings are made. It may be amusing to note that "$\frac{1}{2}$ P" was intended evidently to denote that the purple colour there is only half the strength it has in the other parts where it occurs, and is so indicated in the original; but this had been forgotten, and was overlooked in making the copy, until it was thus recalled to memory.

The lower portion of this plate illustrates details of Tortoise-Tick; the figures have had to be reduced to suit the modest size of our note-books, but are otherwise fac-similes of the originals, as are also the notes jotted down at the time near the drawings.

One of the feet on either side is gone; it is interesting to note that it is in both cases the (apparently) second foot, the *real* first. What appear to be the first limbs *corresponding to the antennæ in true insects.* What appear to be antennæ here, being not really so, but *palpi*—authors differ much as to their identification. The fact is, the homologies have not yet been worked out.

The special design of these figures is to show the importance of making out details clearly and accurately with higher powers than are requisite for the entire figure. It is upon such minute details that specific and generic characters depend.

[This plate is, we believe, an accurate copy of two of the small plates which were drawn in one of our note-books by Mr. Tuffen West, and dated 20 | II. | '75, except that the shaded portion of the body of the Tick is coloured in Mr. West's drawing.—Ed.]

Selected Notes from the Society's Note-Books.

Batrachospermum is a special favourite of mine, and I never see a specimen but it calls up my first acquaintance with it and its *slippery* tricks. Standing at the edge of a small pool, fed by a pipe of clear water, I put my stick under a little patch of floating green weed to lift it out, but it slipped off; I tried a second and third time, and each time failed. I then coaxed it near enough to grasp it with my hand, but could not hold it. I then tried the open palm, but it would not stay. I ultimately captured it by closing my palms in a cup-shape, and thus got the better of its slippery tricks. My cabinet specimen is mounted in a water-cell, and exhibits to better effect than any others I have seen.

A. NICHOLSON.

Generative Gland of Oyster.—We have in this slide a very early stage of egg-formation of the oyster, *Ostrea edulis*, not many eggs being yet present. Those present may be readily recognised by the germinal vesicle being coloured, while the surrounding yelk has remained free, or nearly free, from colour. The oyster is considered to be truly hermaphrodite, the bundles of spermatozoa and eggs being produced in the same animal. I believe eggs such as are present in this section to be the result of impregnation, the true impregnation occurring between a clear germinal vessel and sperm-cells before the formation of the yelk. In the spring months, the oyster is a very interesting object of study, the peculiar bundles of spermatozoa (see lower portions, Pl. XIII., Figs. 5 and 6), with their moving tails, being pretty objects; before the formation of tails, these spermatozoa are seen as in Fig. 6. Given an oyster, the contents of whose generative gland you have examined, a section may easily be made by hardening in spirit or in any other way preferred, and making sections with a Valentine's knife, staining with carmine (Ammoniacal solution), and mounting in glycerine or glycerine jelly.

D. MOORE.

Pro-Leg of Larva of Lucanus cervus is a curious object, and the fleshy-like hairs, smaller at the base, are striking. When I first came to Croydon it was a very common occurrence to dig up these larvæ in the garden, but of late years they have become scarce, but as these larvæ are some years before they attain maturity, they cannot be expected to thrive in soil that is being dug and cultivated every season; so I fancy that as the perfect insect appears as common here as formerly, the ova must be deposited in some undisturbed localities in the neighbourhood. I have seen drawings in which the larva of *Lucanus cervus* has been shown in the solid wood of trees, but have never found it in such situations. I have turned up numbers in the earth; it is by no means an inviting-looking insect; it is, however, very local, and it is a curious fact that the first appearance of the insect is very regular, and does not appear to depend on the season, as is the case with most insects. *Lucanus cervus* is a remarkable-looking insect when seen flying steadily along in the dusk of the evening, with its head and horns perfectly erect; it flies so steadily and slowly that it can be very easily captured. They vary much in size. I have two specimens in my cabinet in which the contrast is so great that the *horns* of one are as long as the whole of the other, body and horns together. The large one is certainly the largest I ever saw. From personal observation, and from the condition of some I have caught, I have come to the conclusion that these beetles fight, and that, too, seriously ; I once found one with an old wound in his elytron, exactly corresponding to the tip of a horn, or, rather, to such a hole as the horn would make, and another had lost half a horn, although I can scarcely think that it could have been broken off by another beetle. As regards their powers of biting, it has often been stated that they will not and cannot bite, but having myself had very convincing proof to the contrary, I can safely assert that they both *can* and *do* bite. I was once bitten quite through the fleshy part of the middle finger of my right hand by one, and did not quickly forget it.

EDWARD LOVETT.

Amphiocus lanceolatus (tr. sec.) from the Coast of Norway. There is a short description, with figure of this fish, in Gosse's "Marine Zoology of Great Britain." He classes it in the Order CYCLOSTORNATA of the Cartilaginous Fishes, and gives the generic characters as follows :—"Skeleton rudimentary, spine an unjointed column of cartilage ; no ribs ; no pectoral or ventral fins ; mouth a sucking disc, surrounded by a ring of cartilage." Of *A. lanceolatus*, the only known species, he further gives the characters as :—"Body compressed, doubly pointed ; mouth a long slit, with a row of filaments on each side ; dorsal fin along the whole length of the back." The average length is only from one to two or two and a half inches. It is found, though rarely, on the British coasts ; usually lurking under stones in pools left by the ebbing tide. Its true position has been much debated ; it was once looked on as a mollusc, but Yarrell, Agassiz, and others, consider that the most recent information leaves no doubt as to its claim to be regarded as a fish ; its peculiarities of organism, however, separate it from most other members of its class. The nervous system consists almost solely of a spinal cord, inclosed in a fibrous sheath, with scarce any traces of a brain or of other organs of sense. The blood is colourless, like that of Invertebratæ ; and instead of being propelled through a single heart, we find numerous bulb-like enlargements scattered over the system of blood-vessels. The mode of respiration, too, is altogether abnormal. The alimentary canal is lined with cilia, and there is no distinct trace of a liver. In all these points the "Lancelet"

(A. lanceolatus) differs from other fishes of the present day, and may, perhaps, be regarded as a relic of some ancient order of fishes now all but extinct; which, from the softness of their skeleton, have left no fossil traces of their existence.

J. H. GREEN.

Spine of Dog-Fish.—This fish belongs to the family, *Scylliidæ*, and is peculiar in having a sharp spine for defence or attack in front of each of its dorsal fins. While the fish is contained in the mother, she is protected from injury by the spines of the young, by a knob of cartilage, secured by small cartilaginous straps to the point of each spine. This protection is detached at birth. A drawing and further description of this spine will be found in Vol. I. of this Journal, p. 38, Pl. III.

C. P. COOMBS.

Marine Aquarium.—To those interested I may mention that I have had eight sea-anemones, and one or two other live specimens, such as crabs, etc., which I have kept in a small quantity of sea-water, with sand, shingle, and shells to form a bottom, for upwards of a month, and the water is still perfectly clear, and three young anemones have been born since I captured the old ones. Although it is only such a small affair (about a quart), it affords a considerable amount of pleasure and instruction. If the water is disturbed (by wind, for instance), the anemones unfold their beautiful tentaculæ, and when in the sun are indeed a beautiful sight.

E. LOVETT.

Varnish for "Ringing" Slides.—Evaporate Canada Balsam (old is best) by gentle heat until, when allowed to get cold, it sets hard; then dissolve it in as much Benzole as will allow it to flow freely from the brush. This transparent and perfectly smooth varnish looks better in my idea than any coloured rings.

EDWIN SMITH.

Reviews.

INORGANIC CHEMISTRY. By Edward Frankland, Ph.D., D.C.L., LL.D., etc., Professor of Chemistry in the Normal School of Science, and Francis R. Japp, M.A., Ph.D., F.I.C., Assistant-Professor of Chemistry in the Normal School of Science; pp. XIX.—805. (London: J. and A. Churchill, 11, New Burlington Street.)

This is a work which should be carefully read by every thoughtful chemical student. The first twenty chapters are entirely devoted to theoretical chemistry, and in them we have an excellent resumé of modern chemical theories, embracing well-written chapters on Chemical Nomenclature, the Atomic Theory, the Laws of Boyle, Charles, Gay-Lussac, and Avogadro, etc., Methods of Determining and Controlling Molecular Weights, the "Periodic Law," General Classification and Thermo-Chemistry, together with others on the more purely physical side of the science.

Of course, the system of notation adopted in the work is that invented by Dr. Frankland, and used by him for many years past in the Normal School of Science. Dr. Frankland, as a pioneer, in attempting to formulate a concise theory of the constitution of chemical compounds, has done good service to chemistry; yet this system, like the work of most pioneers, we anticipate, will have to give way to a truer expression of fact.

In page 69 the authors admit the existence of another mode of combination, not the "atomic," which they term the Molecular, and it is especially in this direction we consider that the theory and notation advocated in this work requires much further development.

Every teacher carefully points out to his pupils the distinction between fact and theory, and till we know infinitely more than at present of the real nature of the forces acting in the first place between Molecules containing similar, and in the second between those containing dis-similar atoms, a constitutional formula of whatever kind can only be accepted in so far as it expresses some particular mode of synthesis or of decomposition. The descriptive and technical portion of the work is lucidly written; descriptions of the more important substances being in bold type, whist those of more rare or less important substances are in smaller type. The information given in the book appears to be brought well up to date. The work is illustrated with two plates and 50 or more engravings.

LESSONS IN CHEMISTRY. By W. H. Greene, M.D., Professor of Chemistry in the Philadelphia High School; pp. 357. (Published by J. B. Lippencott and Co., Philadelphia, and 15, Russell Street, Covent Garden.)

This is a work on Elementary Chemistry, containing a well-arranged course adapted for use in schools where this science is taught as a part of the regular course, not with the intention of making trained chemists of the pupils, but with the object of increasing their powers of observation, and giving them some insight into some of the more important natural phenomena.

A very good feature in the arrangement of the work is the study of some of the more important carbon compounds in their natural connection with that element itself, thus forming a good preliminary basis for the study of organic chemistry. The illustrations are good.

THE ELEMENTS OF CHEMISTRY, Inorganic and Organic. By Sidney A. Norton, Ph.D., LL.D., Professor in the Ohio State University; pp. 504. (New York: Van Antwerp, Bragg, and Co. 1884.)

The arrangement of this work is that of a series of chemical experiments, which will prove useful to pupils who, after attending a course of lectures on experimental chemistry, wish to repeat the lecturer's demonstrations for themselves. A short explanation is given of the meaning of each experiment.

The work would have been far more valuable to young pupils than it is even now, had the experimental method been adhered to in the organic as well as in the inorganic sections.

ELEMENTARY TEXT-BOOK ON PHYSICS. By Professor William A. Anthony, of Cornell University, and Professor Cyrus F. Brackett, New Jersey College; pp. IX.—246. (John Wiley and Sons, New York. 1884.)

This is the first part of a work on physics. The present volume contains a description of measuring instruments, the mechanics of masses, universal attraction, molecular and fluid mechanics, and heat.

Each subject is treated mathematically; a knowledge of plane trigonometry being presupposed. We shall await the publication of the concluding numbers of the series with much interest, as the work will be of great value in education, especially for students after a preliminary experimental course, before proceeding to a more rigid mathematical investigation of the same subjects.

THE STUDENT'S MANUAL OF HISTOLOGY: For the use of Students, Practitioners, and Microscopists. Third edition, entirely re-written, greatly enlarged, and newly illustrated. By Chas. H. Stowell, M.D., F.R.M.S., etc.; pp. 368. (Ann Arbor, Mich., U.S.A.: Chas. H. Stowell. 1884.)

This valuable work commences with a description of the microscope, which is followed by a great number of methods for preparing microscopic objects, formula for making the various stains, preservative fluids, etc.; the greater portion of the book being taken up with Histology, principally human. Five new chapters have been added to the present edition. There are 178 good illustrations.

FICHTE'S SCIENCE OF KNOWLEDGE: A Critical Exposition. By Charles Carroll Everett, D.D.; pp. XVI.—287. (Chicago, U.S.A.: S. C. Griggs and Co.)

This is one of the German Philosophical Classics for English readers and students, and those who take an interest in metaphysical studies will welcome Dr. Everitt's book. The mere names of some of the subjects treated of will sufficiently indicate their interesting matter: The I; Unity of Self; Consciousness; the Infinite I; etc. Pantheist the author is not, Theist he is; but, in fact, the plan of his book could not lead him further into the nature of God.

PHOTO-MICROGRAPHY, including a description of the Wet-Collodion and Gelatino-Bromide Processes, with the best method of mounting and preparing Microscopic Objects for Photo-Micrography. By A. Cowley Malley, B.A., M.B., etc. Second edition; pp. IV.—166. (London: W. K. Lewis.)

We are pleased to notice the altered, and, as we think, more correct title of the new edition of this very useful book. The instructions given will be found plain and practical, and we have little doubt but that the book will be eagerly bought by many microscopists. The book contains three fine photomicrographic plates, in addition to a number of wood engravings.

Manuel du Touriste Photographe, par M. Leon Vidal, Premier Partie. Couches sensibles Negatives ; Objectifs ; Appareils portratifs ; Obturateurs rapides ; Pose et Photométrie ; Développement et Finage ; Rexforçateurs et Reducteurs ; Vernissage et Retouche des Négatifs ; pp. XIV.—348. (Paris : Gauthier-Villars, Imprimeur-Libraire. 1885.)

The work before us will doubtless prove of much service to the photographic tourist. We have submitted it to one of our most successful landscape photographers. He assures us of its great practical value ; he tells us that the remarks found on pp. 9 to 13 inclusive, which relate to the preparation of the emulsion, are especially worthy of notice. The book is illustrated with a phototype frontispiece and 60 engravings.

The Year-Book of Photography and Photographic News Almanack for 1885. Edited by Thomas Bolas, F.C.S. ; pp. 216.—Contains in a condensed form a summary of the photographic work of the past year, and deserves a place in the laboratory of every photographer.

The Magic Lantern and its Management, including full practical Directions for Producing the Lime-Light, making Oxygen Gas, and Preparing Lantern Slides. By J. C. Hepworth ; pp. VIII.—75. (London : Chatto and Windus. 1885.)

In addition to all that is set forth in the title, we have an account of the Lantern Microscope and many other matters, which every amateur exhibitor eagerly desires to know. The instructions throughout are plain, and will be found valuable. There are nine illustrations.

Natural Law in the Spiritual World. By Henry Drummond, F.R.S.E., F.G.S., etc. Fourteenth edition ; pp. 414. (London : Hodder and Stoughton. 1884.)

The object of the author of this interesting book is to prove the harmony of religion and science, and to show that the system of law which is established in the natural world holds equally true in the spiritual world. We have read this book with much pleasure.

Evenings at the Microscope ; or, Researches among the Minuter Organs and Forms of Animal Life. By Philip Henry Gosse, F.R.S. A new edition, revised and annotated ; pp. X.—422. (London : Society for Promoting Christian Knowledge. 1884.)

It is a pleasure to call attention to a new edition of this very popular book, every word of which the author assures us has passed under his eye, and has been examined with earnest care, and that many new facts have been added to enrich the work.

The Formation of Poisons by Micro-Organisms : A Biological Study of the Germ Theory of Disease. By G. V. Black, M.D., D.D.S. ; pp. 117. (Philadelphia, U.S.A. : P. Blakiston and Co. 1884.)

In the volume before us, the author traces the history of the Germ-Theory of Disease from the days of Homer to the present time ; he also suggests theoretically the manner in which the germs act in producing disease.

THE SPEAKING PARROTS: A Scientific Manual. By Dr. Carl Russ; pp. VI.—296. (London: L. Upcott Gill. 1884.)

This book gives full instructions, not only with regard to purchasing parrots, but also for taming and training them, the preservation of their health and treatment of their diseases; followed by descriptions of nearly 100 varieties of parrots. The book is illustrated with several beautifully-coloured plates.

GEOLOGY OF WEYMOUTH, PORTLAND, AND COAST OF DORSETSHIRE, from Swanage to Bridport-on-the-Sea; with Natural History and Archæological Notes. By Robert Damon, F.G.S.; pp. XII.—250. (London: Edward Stanford. 1884.)

This is a new and enlarged edition of an exceedingly interesting handbook to the coast of Dorsetshire, so rich in its geological treasures. The book is well got up, and illustrated with a good coloured map of the locality, besides a number of well-executed engravings. No geologist should visit this attractive neighbourhood without possessing a copy of this book.

THE FOSSIL FISHES OF THE CARBONIFEROUS LIMESTONE SERIES OF GREAT BRITAIN. By James W. Davis, F.G.S. From the Scientific Transactions of the Royal Dublin Society.

The work before us is one of immense research, the observations and descriptions having been based on material principally derived from the collection of the Earl of Enniskillen, which has since been removed to the Natural History department of the British Museum at South Kensington, whilst several other local museums and private collections were studied. There are 24 fine coloured litho. plates, several of them of unusual size.

WONDERS AND CURIOSITIES OF THE RAILWAY; or, Stories of the Locomotive in Every Land. By William Sloane Kennedy. Second edition; pp. XIV.—254. (Chicago, U.S.A.: S. C. Griggs and Co. 1884.)

We have here a very interesting account of the history and development of railways and of railway travelling, both at home and abroad. The book is beautifully printed and the engravings are good.

NATURE'S HYGIENE: A Systematic Manual of Natural Hygiene, containing also an Account of the Chemistry and Hygiene of the Eucalyptus and the Pine. By C. T. Kingzett, F.I.C., F.C.S. Second edition; pp. VIII.—343. (London: Baillière, Tindall, and Cox.)

The first portion of this book is devoted to hygiene proper, and comprises nine chapters, which treat of water supply, sewage, infectious diseases, treatment of the sick, micro-organisms, disease, etc. The second portion treats of the sanitary properties of the Eucalyptus, etc.

ANATOMY, PHYSIOLOGY, AND HYGIENE: A Manual for the Use of Colleges, Schools, and General Readers. By Jerome Walker, M.D.; pp. XII.—415. (New York: A. Lovell and Co. 1884.)

In the preparation of the work before us, the author was fortunate in securing the co-operation of men distinguished in special lines of work. The book is divided into 20 chapters, each of which is followed by a series of questions. The chapters on emergencies will be found valuable. The illustrations, of which there are 89, are good.

Comprehensive Anatomy, Physiology, and Hygiene, adapted for Schools, Colleges, and Families. With 140 Illustrations by John C. Cutter, B.S., M.D.; pp. 376. (Philadelphia, U.S.A.: J. B. Lippencott and Co. 1885.)

The author, who is Professor of Physiology and Comparative Anatomy in the Imperial College of Agriculture, Sapporo, Japan, tells us that this book has sprung from his talks with his pupils. It is divided into fifteen chapters, in which will be found outlines of the science, directions for preparing dissections, microscopical work, etc. Questions are inserted at the bottoms of the pages. At the end of the book is a very useful glossary occupying 23 pages. The engravings are well executed.

A Treatise on Physiology and Hygiene, for Educational Institutions and General Readers. By Joseph C. Hutcheson, M.D., L.L.D.; pp. 320. (New York: Clark and Maynard. 1884.)

In this work the author has unquestionably condensed a large amount of information into a comparatively small space. The book is divided into twelve chapters; to which is added an appendix, treating of Poisons, Drowning, Care of Sick Room, etc. etc. To assist the memory of the student, a number of topical questions are inserted at the foot of each page, and will doubtless prove of great help. The work is illustrated with 5 coloured plates and 71 engravings.

We can recommend either of the above books with much confidence.

Heroes of Science: Botanists, Zoologists, and Geologists. By Professor P. Martin Duncan, F.R.S., F.L.S.; pp. X.—348. (London: Society for Promoting Christian Knowledge. 1882.)

The book commences with a history of the science of plants, into which is introduced the lives of John Ray and Joseph de Tournefort, followed by the life of Linnæus and of De Candolle. In Zoology we have the lives of Buffon, Pennant, Lamarck, and Cuvier; and in Geology of Hutton, William Smith, Murchison, and Lyell. The book is both instructive and entertaining.

Correspondences of the Bible: The Animals. With Additions by John Worcester; pp. 295. (Boston, U.S.A.: Massachusetts New Church Union. 1884.)

We have here many particularly interesting natural history anecdotes of some of the animals named in the Bible. Some of the "Correspondences" appear to us somewhat fanciful and imaginative; this may, perhaps, be owing to our imperfect knowledge of the doctrines of the New Church. So far as we understand the book, we like it well, and of the rest there is nothing of which we disapprove.

Origin of Cultivated Plants. By Alphonse de Candolle; pp. IX.—468. (London: Kegan Paul, Trench, and Co. 1884.)

This interesting and valuable work deals with a kind of plants little noticed except in works on gardening. The question of the origin of cultivated plants is one involving immense research, and M. de Candolle has carefully distinguished the respective value of the means employed, giving the first place to Archæology and Palæontology, as the representation of a plant on old monuments, or its actual remains in deposits (as in the lake dwellings) as indubitable proof of its cultivation at a given epoch. Botany is also a valuable aid to the discovery of the origin, and historical records with the common names are also important, though by no means infallible. M. de Candolle gives an extensive list of 240 plants, discussing their origin in each case, and arranging them under the heads of plants cultivated for their subterranean parts, for their stems and leaves, their flowers, their fruit, and their seeds.

THE ORCHIDS OF NEW ENGLAND: A Popular Monograph. By Henry Baldwin; pp. 159. (New York: John Wiley and Sons. 1884.)

This work, well and profusely illustrated, has evidently been a labour of love to the author. He has plucked with his own fingers all the specimens of which he speaks, and seen with his own eyes the exquisite forest-nooks which he so graphically describes. The curious flowers of which the book treats, with their peculiar modes of fertilisation, are well described in popular language, enriched with quaint fancies and charming scraps of poetry. New England appears to possess more plants of this order than our own country, especially in the genus Habenaria, of which they have thirteen species, while we have but three; and, on the contrary, the beautiful and quaint forms of the bee and fly orchids seem to be absent from the New England flora. This choice work deserves a place in our libraries.

STUDIES IN LIFE. By H. Sinclair Paterson, M.D.; pp. 187. (London: Hodder and Stoughton. 1884.)

The author of the book before us unmistakeably shows us that the book of Nature and the book of Scripture are in harmony with each other. This fact is well argued out in the eight chapters into which the work is divided, viz.:—Nature and the Study of Nature; Life and its Characteristics; The Origin of Life; Varieties of Life; The Record of Life; The Natural History of Life; Enemies of Life; and Results of Life. Having led the reader on by these easy stages, he concludes by the statement that "Nature craves for a Revelation, and the revelation which God has given us in Scripture explains, completes, and dignifies the lessons which we have learned in the lower school." Too much cannot well be said in commendation of this little book, the price of which is only one shilling. We hope to notice two others of the same series in our next.

HELPS TO HEALTH: The Habitation, the Nursery, the Schoolroom, and the Person; with a Chapter on Pleasure and Health Resorts. By Henry C. Burdett. With 19 illustrations; pp. X.—252. (London: Kegan Paul, Trench, and Co. 1885.)

The aim of the present volume is to give with sufficient amplitude, but in the fewest possible words, precise information concerning matters which affect the health and comfort of every class, from childhood to old age. This has been well carried out in the book before us. Several chapters are devoted to the Choice, the Structure, the Interior arrangements, and the Ventilation of the House. The author's purpose has been well carried out, and the book will doubtless be welcomed by the housekeeper.

THE DIET QUESTION, giving the Reason Why. By Susannah W. Dodds, M.D.; pp. 99. (New York: Fowler, Wells, and Co. 1884.)

This little book is taken from a larger work, entitled "Health in the Household, or Hygienic Cookery," and strongly advocates food reform, in which all kinds of animal foods are to be utterly renounced, preference being given to Fruits and to "Whole Meal," prepared in various ways.

There is, no doubt, much good sense written on the subject of food reform, but many of our carnivorous friends will require far stronger arguments to convince them of the error of their ways.

BIOGRAPHIES OF WORKING-MEN. By Grant Allen, B.A.; pp. 191.

THE GUILD OF GOOD LIFE: A Narrative of Domestic Health and Economy. By Benjamin Ward Richardson, M.D., F.R.S.; pp. 202.

THE COTTAGE NEXT DOOR. By Helen Shepton; pp. 192.

THRIFT AND INDEPENDENCE: A Word for Working-Men. By the Rev. William Lewery Blackley, M.A.; pp. 189. (London: Society for Promoting Christian Knowledge. (1884.)

Four very interesting books, well suited as presents for working-men, or as prizes to senior boys in our board schools. In the first of these will be found biographies of Thomas Telford, stonemason; George Stephenson, engineman; John Gibson, sculptor; William Herschell (a citizen of Bath), bandsman; Jean François Miller, painter; James Garfield, canal-boy; and Thomas Edward, shoemaker.

SKETCHES IN NATURAL HISTORY, with an Essay on Reason and Instinct. By the Rev. J. C. Atkinson. With 82 illustrations by W. S. Coleman; pp. XII.—340. (London: Geo. Routledge and Sons.)

The first half of the book before us is taken up with a series of papers on many interesting objects of natural history, respecting which any additions to our knowledge is always most welcome. The first paper is on the Ephemera; the others, with three or four exceptions, are on birds. These papers first saw the light in the "Zoologist," and are now revised and in a great part rewritten for the present book. The chapters on "Reason and Instinct" are good, and we commend the book to the notice of our readers.

SKETCHES OF ANIMAL LIFE AND HABITS. By Andrew Wilson, Ph.D.; pp. 208. (London and Edinburgh: W. and R. Chambers.)

These sketches have been compiled with a view of affording to general readers, and especially to the young, some popular and at the same time trustworthy ideas respecting some of the most interesting groups in the animal world, and we think the author has very satisfactorily accomplished his purpose. We have chapters on Animalcules; Life in the Depths; Sea Anemones; Sea Eggs; Crabs, etc. etc. The papers are popularly written, and are illustrated with 81 engravings. We are sorry to find no general index at the end of this book.

INTELLECTUAL PRINCIPLES; or, Elements of Mental Science: Intuitions, Thoughts, Beliefs. By John H. Godwin; pp. XII.—275.

ACTIVE PRINCIPLES; or, Elements of Moral Science: Mental Feelings, Volitions, Moral Perceptions, and Sentiments. By John H. Godwin; pp. XII.—304. (London: James Clarke and Co. 1885.)

The two works above mentioned will well repay a careful perusal. They are pregnant with deep thought, the object of the author being not so much to give information as to offer aid to observation and reflection on objects near to all and open to all. He has endeavoured to show that the old lesson, "Know thyself," is of universal application and importance; that it is the beginning of all knowledge, and is requisite for all right thinking, feeling, and conduct.

EXCURSIONS OF AN EVOLUTIONIST. By John Fiske. Fourth edition; pp. 379. (Boston, U.S.A.: Houghton, Mifflin, and Co. 1884.)

This is a work of great thought, is well written, and exceedingly interesting. We have space to mention only a few of the subjects treated of, viz.—Europe before the Arrival of Man; The Arrival of Man in Europe; Our Aryan Forefathers; Was there a Primeval Mother Tongue? etc.

Mr. Fiske is undoubtedly a splendid writer. His arguments are clear, thoroughly comprehensible, and worthy of careful reading. By the perusal of this book we have learned more of the supposed date of the "Glacial Age," its natural causes, etc., than we knew before.

THE DESTINY OF MAN VIEWED IN THE LIGHT OF HIS ORIGIN. By John Fiske. Third thousand; pp. 121. (Boston, U.S.A.: Houghton, Mifflin, and Co. 1884,)

This work affords us a good view of the doctrine of evolution in its highest aspects, as throwing light on the origin and destiny of man, and is a book that will doubtless be read with much thoughtful interest. In his preface the author states that "The question of a future life is generally regarded as lying outside the range of legitimate scientific discussion. Yet while fully admitting this, one does not necessarily admit that this object is one with regard to which we are for ever debarred from entertaining an opinion."

THE MAN WONDERFUL IN THE HOUSE BEAUTIFUL: An Allegory; Teaching the Principles of Physiology and Hygiene, and the Effects of Stimulants and Narcotics, for home reading. By Chilion B. Allen, A.M., LL.B., M.D., and Mary A. Allen, A.B., M.D.; pp. 336. (New York: Fowler and Wells. 1884.)

We have here an account of the Structure and Economy of the Human Body most charmingly conveyed in the form of an allegory. The value of the work is much enhanced by the many beautiful engravings with which it is illustrated, and by the great number of questions, occupying 38 pages at the end of the book, by which the reader's mind is intended to be refreshed.

The book is well suited for reading both by young and old, and all may find profit in its perusal.

TENANTS OF AN OLD FARM: Leaves from the Note-Book of a Naturalist. By Henry C. McCook, D.D. Illustrated from Nature; pp. 460. (New York: Ford, Howard, and Hulbert. 1885.)

The Rev. Dr. H. C. McCook, who is also the author of "A Natural History of the Agricultural Ants of Texas," "The Honey and Occidental Ants," etc., has given us here one of the most charming books it has been our good fortune to read for a long time. In the present work, the author introduces us to various species of spiders, moths, ants, crickets, beetles, etc. In many instances he conducts us straight to the homes of these creatures, which he describes with great accuracy of detail, and on returning to the old farmhouse we meet the whole family circle, who join in a general discussion concerning their habits; the interest of these discussions being much increased by the quaint sayings and superstitious lore of two coloured servants, named "Old Dan" and "Sary Ann."

We feel that we cannot say too much in hearty appreciation of this book, Dr. McCook being a naturalist of no mean order.

A DESCRIPTIVE ASTRONOMY. By Joel Dorman Steele, Ph.D.; pp. XII.—326. (New York: A. S. Barnes and Co. 1884.)

"The Story of the Stars" is one of Steele's Science Series. The author, believing that natural science is full of fascination, has sought to weave the story of those far-distant worlds into a form that may attract the attention and kindle the enthusiasm of the pupil, and we most certainly think he has succeeded.

The book before us is illustrated with 113 engravings and 4 plates, some coloured, also a map of the stars of the northern hemisphere. At the end of the various chapters we have a number of practical questions, and as an appendix at the end of the book, Questions for Classes, a key to which may be had of the publishers.

A FINAL REPORT OF THE CRUSTACEA OF MINNESOTA, included in the orders Cladocera and Copepoda; together with a Synopsis of the Described Species in North America, and Keys to the known species of the more important Genera. By C. L. Herrick, Assistant-in-Zoology; pp. 191.

This wide-ranging treatise on the Crustacea is divided into several chapters: —1. The Enemies of the Entomostraca. 2. Order CLADOCERA. 3. Order COPEPODA. 4. Collecting, Preservation, and Miscellaneous Notes.

This splendid work is illustrated with about 24 plates, photo-printed from the author's own drawings. These, if they have not the finish of well-executed lithographs, yet admirably serve the purpose of explaining points of structure which could not be communicated verbally.

THE AGRICULTURAL GRASSES OF THE UNITED STATES. By George Vasey, Botanist to the United States Department of Agriculture; also

THE CHEMICAL COMPOSITION OF AMERICAN GRASSES. By Clifford Richardson, Assistant-Chemist Washington Government Printing Office. 1884.

In the book before us we find a very careful description of about 160 of the grasses of the United States, their mode of growth, locality most suitable, etc., with 120 full-page lithographic plates of the same, thus forming a very valuable addition to our knowledge of this interesting order of plants.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION: Showing the Operation, Expenditure, and Condition of the Institution for the year 1882; pp. 855. (Washington: Government Printing Office. 1884.)

The first 264 pages only of this bulky work are occupied with the Report of the Secretary of the Institution; the remaining 500 form the General Appendix, and are devoted to the Record of Recent Scientific Progress in Astronomy, Geology, Geography, Meteorology, Physics, Chemistry, Mineralogy, Botany, Zoology, and Anthropology; thus giving us a very large amount of information relating to the various sciences. The value of the work is further increased by a well-arranged index.

Correspondence.

To the Editor of the Journal of Microscopy and Natural Science.

SIR,—

Till I read the pleasant "Rambles of a Naturalist," by Miss A. M. Charlesworth, at p. 12, I never heard of any other plant being connected with Danish blood-spilling than the Dwarf Elder, *Sambucus ebulus.* In Smith's "English Flora," Vol. 2, one of its names is given "Danewort," and the following note added:—"Our ancestors evinced a just hatred of their brutal enemies the Danes, in supposing the nauseous, fetid, and noxious plant before us to have sprung from their blood." I may mention that this plant is not common either in England, Scotland, or Ireland, and curiously enough, two localities that I know of in the last, are spots where history records bloody fights to have occurred in days of yore.

H. W. LETT.

To the Editor of the Journal of Microscopy and Natural Science.

DEAR SIR,—

We are so much pleased with our Journal, that we feel like the little boy about the Christmas plum pudding, that it does not come often enough. We would like to have it once a month, and not be "wearying" all through the quarter for another part. Don't you think you could manage it? not, of course, as bulky as it is at present, but, perhaps, a third of the size, and price sixpence. I am certain it would increase its popularity. To be sure, it would also increase your work, but what of that when we have such a willing editor! And then, if space could be provided for Query and Correspondence Columns, which are a necessity in every magazine of the present day. There is just one thing more I would like to see in your pages: the price of each book you review; I never could understand the reason of suppressing this most important item, and surely it would not be more troublesome than giving the number of pages in each volume. Many a time I see books noticed which I long to order, but hesitate lest I should be incurring too great expense.

You are to be congratulated on the issue of the January Part of the Journal, which is by far the best and most readable we have yet had.

I am, yours truly,

H. W. LETT.

Current Notes and Memoranda.

The Annual Report and Proceedings of the Belfast Naturalists' Field Club has reached us ; in addition to the Report, we find Notes on the Irish Coleoptera, a paper on the Cromlechs of Antrim and Down, and on Pre-historic Monuments at Carrowmore ; this last is by our valued member, Mr. Charles Elcock. We are glad to notice that the Club boasts a goodly array of Members.

HISTOLOGY.—We are very pleased to have received two instalments of Vol. III. of Mr. A. C. Cole's valuable studies. These are divided into four sections, as follow :—Sec. 1—Animal Histology. which is accompanied by plates of *Mesocarpus* in conjugation, and *Vaucheria racemosa ;* Sec. 2—Animal Histology, by plates of Cornea of Cat and Ovary of Kitten ; Sec. 3—Pathological Histology, by plates showing Alveolar Pneumonia, in its first and second stages ; and Sec. 4—Popular Microscopical Studies, with plates, one showing the Spinneret of Garden Spider, and the other the Foot of Garden Spider, *Epeira diadema.* The slides by which they are accompanied are some of Mr. A. C. Cole's best mounts.

Collectors of Land and Freshwater Shells will do well to procure a copy of THE COLLECTOR'S MANUAL OF BRITISH LAND AND FRESHWATER SHELLS, by Lionel E. Adams, B.A., published by George Bell and Son, London.

Two Numbers of the Journal of the New York Microscopical Society, edited by Benjamin Braman, have been received. The Journal contains papers read to the Society, Reports of Meetings, &c. We notice in this Journal that the editor has struck out a somewhat new course in the form of a Bibliographical list of articles of interest relating to Microscopy which have appeared in recent journals, the date, volume, and page being given. The Journal, which will be published during nine months in each year, promises well.

We have pleasure in directing the notice of our readers to the Practical Naturalists' Society ; a copy of the Rules is now before us. Like our own, this Society is essentially a Postal Society, the members being very widely scattered. We observe the names of several of our own members amongst the number. The fees are merely nominal, and we wish the Society every success.

A BOOK OF PLANT DESCRIPTIONS, or Record of Plant Analyses, prepared for the use of Teachers and Students, by George G. Groff, A.M., M.D. (Science and Art Publishing Company, Lewisburgh, Pennsylvania. 1883).

We have here first a list of Botanical Terms, followed by a few pages of instructions for laboratory work ; the greater part of the book is filled with printed forms in which blanks are left for the student to fill in his descriptions. These forms may be bought separately of the publishers.

The following valuable and interesting Pamphlets have been received from the authors :—

The Relation of Micro-Organisms to Surgical Lesions: a Paper read to the Section of Surgery and Anatomy of the American Medical Association, May, 1884, by Henry O. Marcy. A.M., M,D., of Boston, U.S.A.

The Relation of Bacteria to Infectious Diseases, read before the American Academy of Medicine, Baltimore, October, 1884, by Henry O. Marcy, A.M., M.D.

The Best Methods of Treating Operative Wounds, read before the same Academy, October, 1882. H. O. Marcy, A.M., M.D.

BACTERIA, the smallest of Living Organisms, by Dr. Ferdinand Cohn, Professor in the University of Breslau. Translated by Charles S. Dolly, M.D.

The Philosophy of Protoplasmic Motion. By Th. W. Engelmann, M.D., Professor of Physiology in the University of Utrecht. Translated by Charles S. Dolley, M.D.

On the PRESERVATION of Embryonic Materials and small Organisms, together with hints upon embedding and mounting Sections serially. By John A. Ryder.

The POPULAR SCIENCE MONTHLY is one of those instructive American periodicals that we always receive with much pleasure. Its papers are scientific and at the same time popular and entertaining.

The *Kansas City Review of Science and Industry* is one of the excellent Monthlies sent to us regularly from America. It has sections devoted to all departments of Science, *e.g.*, Engineering, Geology, Biology, Astronomy, Meteorology, Natural History, Botany, Philosophy, Archæology, Biography, etc., etc.

The *Naturalist's World* continues to give its readers a selection of very entertaining articles in all branches of Natural History. The articles are short, readable, and well illustrated.

Mr. William West, of Bradford, has sent us a selection of S. Louis's splendidly prepared material, amongst which we notice a number of well-cut Sections of Echinus spines, a great number of Insect preparations, a variety of Chemicals suitable for polarising objects, together with Echinodermata, Zoophytes, etc. Mons. Louis's objects are too well known to need further notice.

THE LICHEN FLORA OF GREAT BRITAIN.—In the review of this work in our January part, we spoke of the author as *the late* Rev. W. A. Leighton. We are now pleased to be informed that this is a mistake, and that the Rev. Mr. Leighton is alive and in tolerably good health. We hope to have the privilege of reviewing many more of his very valuable works.

Mr. W. P. Collins, 157, Gt. Portland St., offers, in his monthly Catalogue, a good selection of books in all departments of Science.

THE JOURNAL OF MICROSCOPY
AND
NATURAL SCIENCE:
THE JOURNAL OF
THE POSTAL MICROSCOPICAL SOCIETY.

JULY, 1885.

Cystopus, or White Rust.

BY GEORGE NORMAN, M.R.C.S., F.R.M.S., &c.

Plates 15, 16.

CYSTOPUS is a fungus parasitic on living plants, especially Crucifers, and is placed by our English mycologists in association with numerous well-known parasitic fungi, such as *Ustilago*, *Uredo*, *Uromyces*, *Coleosporium*, etc., in the order **Cæomacei,** family CONIOMYCETES. The characteristics of this family, according to Berkeley, are :—" Spores, either solitary or concatenate, produced on the tips of generally short threads, which are either naked or contained in a perithecium, rarely compacted into a gelatinous mass." Berkeley also says that this family is distinguished by the vast predominance of the reproductive bodies over the rest of the plant, if not in size, at least in abundance; and from the ease with which in general they fall from the point of attachment, in consequence of which, as the name implies, they have a dusty appearance. Cooke's definition of the order, *Cæomacei,* is simply " Parasitic on living plants; peridium absent; spores, of one or two orders, simple."

But except for the characteristic of parasitism common to all, *Cystopus* seems to have little connection with the genera it is thus associated with; and it seems preferable, at all events for the present, to accept De Bary's classification, in which resemblance of life history is made the principal feature. By this means *Cystopus* and *Peronospora* become associated together as different genera of the same order, and closely allied to the *Saprolegnieæ.*

Cystopus, or White Rust, is one of the commonest of parasitic fungi, and may be seen in the summer on numerous Cruciferous plants, and unfortunately also in many kitchen-gardens, where it attacks the cauliflowers and cabbages. The general appearance of a plant affected by the fungus is, to use the comparison of many observers, as though it had been splashed with whitewash. But when the plant is closely examined, the splashes are seen to be arranged in a somewhat concentric or spiral manner, those, however, on the leaf-stalks and flower-stems being disposed more irregularly (Pl. XVI., Fig. 21).

Experienced observers can detect the presence of the fungus long before the white splashes or pustules are visible, by the swollen and distorted appearance of the leaves and stems, caused by the presence of the spawn or mycelium, which invades every part of the plant above ground. The mycelium consists of unpartitioned, irregularly-branched tubes, having thick, gelatinous walls, and containing colourless and almost homogeneous protoplasm. It grows exclusively in the intercellular canals of the parenchyma, and is furnished with numerous suckers, which become affixed to the constituent cells of the host. These suckers are a characteristic feature of the mycelium of *Cystopus* (Pl. XV., Fig. 1).

From this mycelium arise bundles of club-shaped tubes, each of which produces from its summit the reproductive cells called conidia (Pl. XV., Figs. 1, 2). The growing conidium, to use the expression of Tulasne, is nothing less than the obtuse summit of the club-shaped tube, which, by a partition, separates itself from the lower part, becomes constricted till it is attached only by a short, narrow neck, and eventually falls off. The process is, however, so frequently repeated that, as a result, each club supports a short chain of conidia attached to one another by joints, and this constitutes another distinguishing feature.

It is these conidia, crowded together and lying under the surface of the epidermis, which produce the white pustules already described. When large numbers of conidia have been thus produced, the epidermis of the host-plant bursts in an irregular manner and the conidia are set free. The detachment of the conidia, one from the other, is effected in the following manner :—The primary septum or constriction separating two conidia becomes divided by a central gelatinous lamella into two plates belonging to the respective conidia, and by the solution of this gelatinous lamella, the conidia are set free.

Each conidium is filled with finely granular protoplasm, and when it becomes matured in damp air or water, a division of the protoplasm into five or eight portions takes place, just as in the case of the potato fungus. These secondary spores—or, rather, in this case zoospores—are presently discharged from their conidium or spore-case, and after remaining immoveable for a short time, two vibratile cilia are developed from beneath, and the zoospore sails away over any moist surface as if endowed with animal life (Pl. XV., Figs. 3—7).

Moisture of some sort, as rain or dew, seems essential for the bursting of the sporangia and the expulsion of the zoospores; in dry air no differentiation of the contents of the conidium ever takes place. Thus, when the conidia are fully developed, the first shower of rain will cause them to burst into activity, till the whole surface of the plant and every drop of water upon it is swarming with zoospores. It is thus obvious that the fungus may pass from leaf to leaf and from plant to plant and from weeds to food-plants by means of these active zoospores, which seem to retain their activity for several hours. The zoospores are also undoubtedly carried about in damp air and in currents of wind; they are also widely distributed by means of insects, birds, and small animals. Fortunately, the mycelium, conidia, and zoospores are not possessed of great vitality, and they easily perish by frost, drought, or even excess of moisture. But the question then arises, "Why is not this fungus exterminated during the winter season?" and the answer is, that this fungus, like the *Peronospora*, possesses another method of reproduction—a sexual one—which results in the formation of the winter or resting-spores.

The mycelium of *Cystopus*, besides producing the chains of spores already described, produces also other bodies, which may be roughly compared to the pistils and anthers of flowering plants. The terminal portion of a tube of mycelium swells out into a large spheroidal cell, with thickened walls and granular protoplasmic contents, which are shut off from the mycelium-tube by a partition. This is the female organ or oogonium, and the granular protoplasmic contents accumulating in the centre form the oosphere. A neighbouring portion of mycelium-tube also becomes partitioned off, assumes an obovate form, and encloses within its thin membrane a mass of fine granular protoplasm. This is the male organ or antheridium, which presently comes in contact with the oogonium, projects a fine beak through its wall, and pierces the oosphere within. This is the act of fertilisation, answering to the discharge of pollen on to the stigma in flowering plants. In the same way as an ovule becomes a seed after fertilisation, so the oosphere becomes an oospore after the contact of the antheridium. A membrane is now formed around the oospore, which is at first very thin, but gradually becomes thickened by deposits from the surrounding fluid, and is at length yellowish-brown in colour, and has its surface studded with large obtuse warts, one of which, larger than the rest, surrounds the fecundating tube (Pl. XV., Figs. 8—12). Zalewski, who has made some detailed observations of these fungi, finds that the oospore is enclosed in a double coat, composed of endospore and exospore. The endospore consists entirely of pure cellulose, and the exospore is usually clearly differentiated into three layers, the innermost of which is thin, homogeneous, and cuticularised; the middle layer suberised, finely granular, and composed of very thin round or angular columns, placed very closely at right angles to the surface; and the outermost composed of cellulose, and dark brown, cuticularised or suberised externally. The mature oospore contains a ball of protoplasm, occupying from one-half to nearly two-thirds its diameter, which itself contains a large amount of oil. The protoplasm between this and the wall of the oospore is dense and granular; in its outer portion are a number of bright, round spots, probably vacuoles. The oospore grows and matures itself whilst still within the supporting leaf or stem for many months, and does not become perfectly ripe till the host-plant has decayed. Although the dead plant may be reduced to tinder by drought and frost, the oospores or resting spores remain alive and uninjured.

The oospores germinate on the ground during wet weather in spring, and according to observations made by numerous microscopists, this is what occurs:—The brown exospore bursts irregularly, and the colourless endospore protrudes in a short, thick tube, which gradually becomes a large vesicle, into which the protoplasmic contents of the endospore enter. Eventually, the endospore entirely quits the exospore, and the little masses of protoplasm accumulate in a globular mass in its centre. Finally, the spores isolate themselves from each other; then for some minutes they swarm within the vesicle, which presently gives way, and the zoospores disperse in the surrounding moisture (Pl. XV., Figs. 13—15). We thus find repeated, after an interval of from six to ten months, the phenomena described as belonging to the chains of conidia. The zoospores produced in both cases are exactly similar, as is also their future career.

The activity of the zoospores lasts from two to three hours; then the cilia disappear, and the now immoveable spore assumes a globular form, covers itself with a membrane of cellulose, and puts forth a germinal tube, the extremity of which swells into a small bladder, and receives by degrees the whole of the protoplasm.

If the spore has not by this time come in contact with the host-plant, it perishes. But if it does find a suitable host, it attaches itself to, but never enters, one of the stomata; the germ-tube is pushed forth, and at once enters the air-cavity, and with it the entire protoplasm of the spore (Pl. XV., Figs. 16—18). The latter remains as a delicate vesicle, containing a little watery fluid, which soon shrinks and escapes further observation. But here a curious point arises, and as the credit of the observation is due to De Bary, it will be well to quote from his remarks on the subject. He had been making an extended series of experiments on the infection of plants with *Cystopus* spores by artificial means, and in giving his results he says:—"If one uses for experiment leaves or stems of plants, which generally bear *Cystopus*, the germs enter the stomata quickly, take the form which has just been indicated, but never show any ulterior phenomena of vegetation. If in a few days, or even weeks after sowing, one examines the epidermis and the tissue beneath, one finds the germs to all appearances fresh, but without having changed the aspect they exhibited on the first day." He asks then, "How are the plants infected?" and answers, "It is only the germs which enter by the stomata of the cotyledons, whose growth produces mycelium."

They enter in the manner already described; soon the terminal swelling lengthens out, branches, and assumes all the qualities of ordinary mycelium. These first tubes are gifted with the faculty of growing, and branching out to an extent only limited by the hospitable plant; and if the plant possesses sufficient vitality to live through the winter they live with it and revive their vegetation in the spring. "I shall not hazard an explanation of these singular facts, because one knows too little about the difference between the composition of the leaves and that of the foliated cotyledons of the Cruciferæ. I confine myself to a detailed account of the experiments which gave me the result indicated. All the experiments have been made with plants of *Lepidium sativum*, growing from seeds of the same crop. They were sown in flower-pots, placed in a room, and watered carefully, so that nothing might be touched by the water except the soil.

"On 29th Oct., fifty-six plants of *Lepidium* had just displayed their cotyledons. I pulled up six, and plunged them into water containing a large number of conidial zoospores, and the little plants fell to the bottom of the vase. On 30th Oct., the epidermis of three of them was examined microscopically, and showed a great number of germs penetrated into the stomata; the three others were planted in the ground, and continued to grow. On Nov. 2nd the cotyledons of one of them were examined; they contained very fine tubes of branched mycelium growing from the germs which had entered by the stomata. On Nov. 17th, the cotyledons of the two remaining plants were drooping, and conidial swellings were visible on both surfaces. On Dec. 21st, each of the plants displayed their first two leaves, which were covered with pustules of *Cystopus*, and at the end of December the plants died. Five of the original fifty-six plants, planted separately, received on their cotyledons drops of water charged with zoospores. Within a month all of them had developed *Cystopus*, and a fortnight later four of them died; the fifth continued to be infected with *Cystopus* during the whole time it was under observation—viz., about six months. The forty-five remaining plants had ordinary culture. They passed the winter without growing, and in the spring they developed normally.

"A fresh batch of seeds of *Lepidium* was sown in March. Sixty of the young plants had ordinary culture in flower-pots, and their growth was normal. A dozen young plants were put in flower-pots and the soil only watered, with the precautions already described, with water charged with oogonial zoospores. The plants developed normally. On March 20th, eleven plants received on their coytledons drops of water charged with oogonial zoospores. On April 2nd, five of them had fine pustules of *Cystopus* on their cotyledons, and the other six produced pustules either on their cotyledons or leaves at various intervals. None of these plants succumbed to the attacks of the parasite, but flowered and fructified normally. It is, however, easy to conceive that degeneration of the invaded plants is produced by the vegetation of the fungus." *

The first development of *Cystopus* seems, therefore, to be somewhat difficult, because it can only take place in the cotyledons; but this is somewhat compensated for by the enormous quantity of reproductive organs that are formed. Thus, a single plant of *Capsella* or *Lepidium* infected with *Cystopus* can easily produce a million conidia, each containing from five to eight zoospores, besides a large number of oospores, each containing about a hundred zoospores. We must also remember that the oospores or winter resting-spores germinate on the ground in the spring, and are thus ready to attack the cotyledons as they make their appearance above ground.

The definition of *Cystopus* given by Cooke is, "Receptacle consisting of thick branched threads; conidia concatenate, at length separating; oospores deeply seated on the mycelium." De Bary says:—"Conidiophores growing in large bunches, the conidia being developed in single rows, in basipetal order." *Cystopus* possesses much fewer species than *Peronospora*. Four only have been described as British, and some four or five more have

* "Ann. d. Sc. Nat. Bot.," Ser. iv., Vol. xx.

been noticed by European observers. The only Continental species that need be noticed are *Cystopus Bliti* and *Cystopus Portulacæ*.

Cystopus Bliti (Pl. XVI., Figs. 25, 26).—In this species the conidia are unequal, the terminal cell sterile, and smaller than the rest; membrane hyaline, somewhat ochraceous, often umbilicated; the other cells obovate or pyriform; oospore globose, epispore brown, surface reticulated. It is found on *Amarantus Blitum*.

Cystopus Portulacæ (Pl. XVI., Figs. 27, 28) also has the conidia unequal; the terminal cell larger than the rest; membrane clear and yellowish, often umbilicated at the base, sterile or fertile. Other fertile conidia yellowish, cylindrical. Oospores large, globose; epispore brown, covered with slightly raised, loose reticulations.

De Bary says this species inhabits both cultivated and wild Purslane, but he had not observed it on any other plant. In the garden where he observed it for several years in great abundance, neither the *Portulaca grandiflora* nor *P. lanceolata* had the slightest trace of the fungus, though they grew quite mixed up with the rusted Purslane. Cooke says this species should be watched for in this country, for though the cultivation of Purslane is exceedingly limited, the plant is remarkably liable to attack from this parasite.

The four British species are—*Cystopus spinulosus*, *C. lepigoni*, *C. cubicus*, and *C. candidus*.

Cystopus spinulosus (Pl. XVI., Fig. 29) has conidia, in time much elongated; sori crumpent on both surfaces of the leaf, white; oospores globose, epispore brown, tubercles minute, solid, very prominent, often acute and spinulose. This species is sometimes called the Thistle white rust, as it is found on thistles; most plentiful in September.

Cystopus lepigoni, Sandwort White Rust.—Conidia unequal; terminal cell sterile, globose; membrane thickened; fertile cells sub-globose or cylindrical; membrane hyaline; oospores globose; epispore brown, tubercles minute, irregular, very convex, often resembling spines. Found on *Spergularia rubra* from June to September.

Cystopus cubicus (Pl. XVI., Figs. 22—24), Goat's-beard White

Rust.—Conidia unequal; terminal cell sterile, larger than the rest; membrane thickened; ochraceous; fertile cells shortly cylindrical; membrane hyaline; oospores globose; epispore brown, verrucose; warts hollow, round, or irregular. This species attacks *Compositæ*, Goat's-Beard, Salsify, *Scorzonera*, etc., and is common in summer and autumn. De Bary states that he has never found oospores on the *Tragopogon*, although he found them very plentifully on the *Scorzonera*.

CYSTOPUS CANDIDUS (Pl. XVI., Figs. 19—21), Crucifer White Rust.—Conidia equal, globose; membrane equal, ochraceous; oospores sub-globose; epispore yellowish brown, with irregular, obtuse warts; warts solid. This species is the best known of all. It is found on Shepherd's-purse, Cabbages, Horse-radish, and other *Cruciferæ;* also on some few species of *Capparideæ*. It is common in the summer.

The following practical remarks by Worthington Smith will well conclude this part of our subject:—"Alternation of crops must tend to diminish white rust. Cabbages, cauliflowers, etc., should not be grown for two years in succession where white rust has prevailed. Weeds should be gathered together and burnt when infected with white rust. No cabbage, cauliflower, turnip, or mangel refuse should be allowed to remain in a decaying state throughout the winter in the fields, for in these positions white rust hibernates." *

Having given a detailed account of this group of fungi, we will now consider its position in the mycological world. The classification of fungi is at present in an unsatisfactory state. It is found that many supposed genera are only the early state or condition of some other known fungi, and a constant process of sifting and re-arranging is continually going on, especially amongst the smaller and microscopic forms. Any clue to a scientific classification deserves consideration, and of late years this has been sought for, and apparently with some success, in the study of the reproductive organs of fungi and the details of their life-history. Classification on this principle may still be called artificial, but it is natural, in so far as it attempts to bring into prominence actual affinities, and not merely differences and resemblances of external

* "Diseases of Field and Garden Crops."—W. G. Smith.

habit. The arrangement of Fungi suggested by Sachs and Cohn is one of the best-known attempts of this nature. They proposed the division of Fungi into four classes, namely—PROTOPHYTA, ZYGOSPOREÆ, OOSPOREÆ, and CARPOSPOREÆ.

The first class, PROTOPHYTA, contains those simple forms, called *Saccharomycetes*, or Yeast Fungi, and *Schizomycetes*, or Bacteria, etc. No sexual organs are found here, and even no non-sexual organs, the multiplication of individuals being effected by the fission or separation of the ordinary vegetative cells.

The second class, ZYGOSPOREÆ, contains all those fungi in which sexual reproduction takes place by means of conjugation, the essential characteristics of the process being that the two cells which take part in it are alike, and produce, by the coalescence of their protoplasmic contents, a cell of peculiar form, the Zygospore, which usually remains for a time dormant, and is then termed a resting spore. Conjugation is the simplest form of sexual reproduction, but the mere fact of sexuality shows an advance in the mode of reproduction. In keeping with this, the ZYGOSPOREÆ manifest, generally, a higher degree of organisation than the PROTOPHYTA. The principal representatives of this class are the *Mucors*, or Moulds, which are, however, also propagated by means of a non-sexual or reproductive cell, or conidium.

To the next class, OOSPOREÆ, belong those fungi which are reproduced sexually by means of Oogonia and Antheridia. In this class is included *Cystopus*, and as the details of the sexual reproduction were fully described when speaking of that fungus, it need not be repeated. It will be remembered that here also there is an alternative, non-sexual reproduction by means of conidia. De Bary gives the following summary of the oosporous Fungi :—*Pythium.*—Most of the protoplasm of the antheridium passes into the oosphere.—*Phytophthora.*—A small quantity of the antheridial protoplasm enters the oosphere.—*Peronospora.*—Probably the same process as in the preceding genius.—*Saprolegnia.*—The antheridial tube does not open into the oosphere, and no passage of substance can be observed.—In *S. torulosa* and *S. asterophera* no antheridial tubes are developed, and in another species no antheridia.

In the last class, CARPOSPOREÆ, are included all the true fungi—viz., the *Ascomycetes*, *Æcidiomycetes*, and *Basidiomycetes*. All the fungi belonging to this class are characterised by the formation of a spore-fruit or sporocarp as the result of the fertilisation of the female reproductive organ, and differ herein from all those which have hitherto been considered. This spore-fruit consists generally of two distinct parts: a fertile part which is directly derived from the female organ, and ultimately produces true spores, and an investing part, which encloses the spores and occasionally attains a considerable size, as in the Truffle. The sporocarp is derived from a female organ called the "Carpogonium." This in the simplest forms is a single cell, closely resembling the oogonium of Class III., and the resemblance is still more complete when, as in the case of *Podosphæra*, the carpogonium is fertilised by a tube growing from the male organ, just as is the case in *Saprolegnieæ*. In the majority of cases, however, the carpogonium is multicellular before fertilisation, and its cells contribute in different ways to its further development; some absorb the fertilising substance, whilst others give rise to that part of the fructification which produces the spores, as in the *Ascomycetes*. The male reproductive organ occurs in various forms, but fertilisation is usually effected by a tubular outgrowth.

Although for the purposes of classification the *Æcidiomycetes* and the *Basidiomycetes* are included in this class, the authors acknowledge that no direct proof has yet been given of the existence of sexual organs in either of them, and even in some of the *Ascomycetes* the sexual organs seem in abeyance.

Seeking, therefore, fresh information on this subject, we find De Bary, in a recent memoir, proposing a classification of Fungi based on the theory of descent. He considers that, passing from the typical *Peronosporæ*—viz., *Pythium*—to the higher *Ascomycetes*—such as *Erysipheæ* on the one hand, and to the *Saprolegnieæ* on the other—the sexual process is gradually eliminated, and the sexual organs become at first functionless and then disappear altogether.

In *Pythium* itself the antheridium pierces the oogonium wall and fertilises the oosphere by pouring protoplasm into it. In *Phytophthora* and *Peronospora* the process is essentially similar, but the quantity of protoplasm passed over from the antheridium is smaller. In the *Saprolegnieæ* the fertilising tubes do not open, and no protoplasm can be observed to pass over from the antheridium to the oospheres. Or in some forms no antheridia are present at all, and the parthenogenetic spores are nevertheless capable of germinating. Now, if the *Podosphæra*, already mentioned, be compared with *Peronospora*, the antheridia will be found to correspond in both cases, and the carpogonium to be homologous with the oogonium of *Peronospora*. It is remarkable that the antheridium only applies itself closely to the carpogonium and does not pierce it, and there is apparently no passage of substance from one to the other—*i.e.*, there is no sexual process, though the sexual organs are present. Numerous investigations lead us to conclude that while the sexual organs are present but functionless in these lower *Ascomycetes*, they disappear entirely in the higher forms.

De Bary concludes that we may regard the *Peronosporæ* as phylogenetically important in two senses:—1.—Their general biology strongly suggests that they are derived from algal ancestors, possibly not very unlike *Vaucheria* and its allies. 2.—That they are the progenitors of a few chief series of true Fungi—on the one hand, the main series of *Ascomycetes* and allies; on the other, the *Saprolegnieæ* and forms derived from and allied to them.

The *Zygomycetes* are regarded as branching off from the *Peronosporeæ*. *Pythium* seems closely allied to the *Chytrideæ* (a group of fungi previously described as being parasitic on the *Saprolegnieæ*), and the *Chytrideæ* seem allied to the lower *Ustilagineæ* by means of the group *Protomyces*. According to this view, the resting spores of *Ustilagineæ* would be the homologues of oogonia which become developed apogamously.

The *Tremellini*, a group of well-known gelatinous fungi, belong to the *Basidiomycetes*, but possess basidiospores, so suggestive of the teleutospores of the *Uredineæ*, that De Bary does not hesitate to place them as derived from those *Uredineæ* which possess no æcidia; whilst those Uredines which form æcidia resemble the *Ascomycetes* in so many points of structure and development that we may regard them as closely allied. The *Tremellini* would then lead us to the *Hymenomycetes* and *Gasteromycetes*, which form the bulk of the *Basidiomycetes*.

The conclusion arrived at by De Bary, and supported by other observers, is to the effect that as we proceed along the main lines from the lower to the higher Fungi, the sexual process and sexual organs gradually become less and less evident, and at length disappear altogether, and the fructification then arises by apogamy.

We are indebted to Marshall Ward for some very ingenious suggestions on this subject. He points out that the absence or presence of sexual organs rises or falls with the nature of the parasitism or saprophytism displayed. In the *Saprolegnieæ*, for instance, the Fungi may probably be looked upon as very highly nourished by the decomposing proteids of animals. Their sexual organs seem to be present in most cases, but functionless.

In the *Zygomycetes*, which are essentially saprophytes on decaying vegetable matter, etc., or parasitic on one another, and may be probably regarded as not so highly nourished, we find the sexual organs functionally perfect, though very simple in character. In the *Ustilagineæ* we meet with parasitism of a peculiarly high order, so to speak. The fungus not only robs its host, but has in most cases curiously adapted its life to the habits of the latter, using it rather as a slave than as a victim to be destroyed forthwith. The same is true for the highly-organised *Uredineæ*, and we here meet with the highest adaptation of all—heterœcism. But in both these groups the search for sexual organs has hitherto proved futile.

Again, if we proceed upwards from the *Erysipheæ*, which are epiphytes, adapting themselves to parasitic habits of that special kind, which leads to life in the interior of temporary organs like leaves, through the *Ascomycetes* we find, speaking generally, more and more tendency towards close and specially-adapted parasitism, ending in the parasitic *Pezizas*, forms like the *Pleosporas*, etc., and especially *Claviceps*. There is thus strong reason for believing that a connection exists between the mode of life of a given Fungus, and the extent to which it is apogamous. We are at least assured that profound differences exist—in degree at any rate—between the saprophytism of a mucor growing in a solution of horse-dung, and of a *Pythium* developing its fructification in the rotting parenchyma of a plant which it has previously killed. There is also an equally striking difference between the parasitism of an Epiphyte like *Erysiphe*, and that of a highly specialised Æcidiomycete like *Puccinia*. There is not only a difference between the mode of attacking or living upon the substratum, but also as to the kinds and quantities of the various matters absorbed. Thus, a Uredine in a leaf obtains different food from a Claviceps in a grain of rye, or *Ustilago* in a hypertrophied stem of *Zea Mays;* and that these differences may be very important is fully demonstrated in cases of heterœcism.

May it not then be possible that the sexuality of the higher Fungi has disappeared because its purpose has been equally well, or better attained otherwise than by means of sexual organs? The two points common to all cases of sexual reproduction are:—

1.—A larger or smaller quantity of protoplasmic matter passes from one portion (the male organ) of the same or another individual, into the protoplasm contained in another portion (the female organ).

2.—The protoplasm contained in the female organ therefore becomes capable of further development; either at once, or more generally after undergoing a period of rest.

We have, in the germination and development of an oospore, simply a renewal of the growth of the organism, and it seems to imply—if the term may be allowed—a condition of weariness on the part of the protoplasm. No doubt the molecular energy of the protoplasm forming the oosphere is less than that of the rest of the plant for the time being; the access of the antherozoid, or male protoplasm, however, reinvigorates the sluggish mass, and renewed life ensues. This may require some time, however, and we may possibly not be far wrong if we imagine that interval to be occupied in molecular rearrangements in the mass. But although we can sum up the foregoing by saying that after a time, protoplasm requires reinvigorating by the addition of fresh protoplasm from another source, it is extremely improbable that the protoplasm of the male and female organs is at all similar.

While we have reasons for believing that the mass of an oosphere consists in the main of protoplasm such as occurs in any cell capable of growth, it would be absurd to suppose that the protoplasm of the male element is of the same nature; on the contrary, there is strong evidence that it differs extremely.

We need not consider here the suggestion of De Bary that profound chemical differences exist and effect the environment, or Sach's recently expressed view as to the analogies between ferment actions and fertilisation. Enough for our purpose that sexual reproduction essentially consists in the reinvigoration of a sluggish mass of protoplasm, by the addition of another and different mass of protoplasm. It must be allowed that no satisfactory theory exists to account for the gradual disappearance, first of sexuality, and then of even the morphologically represented sexual organs in the Fungi; and any attempt to explain the matter seems to involve more than one vicious assumption. It has been suggested by Eidam and others that the apogamous Fungi are not always apogamous. The Mucors, or Moulds, for instance, may be propagated through numerous generations by means of the asexual spores; the sexual organs only arising now and again under favourable conditions. But it is not easy to conceive how fertilisation in a distant past has transmitted its effect through countless generations to the individual plants which now reproduce without any sexual act at all.

Now, reverting to the subject of parasitism, it can scarcely be doubted that the protoplasm of a higher plant, such as a phanerogam, differs from that of a lower cryptogam in being capable of doing more work; and that the great advantage derived by a parasitic Fungus which has its life so adapted that it can tax the cells of a planerogamous host-plant, is, that it obtains its food-materials in a condition more nearly approaching that of its own substance, than would be the case if it had to work these materials up from inorganic matters. Now, it seems not improbable that the protoplasm of a phanerogam may contain so much energy that it can not only supply the vegetative mycelium of a parasitic fungus with all that it requires for its immediate growth, but also suffices to enable that fungus to store up enough energy in its asexual spores to last until the next generation of the fungus gains its hold-fast on another source of life-giving substance. But we may imagine even this to fail after a time, and that at length the fungus derives too little benefit to be able to go on, or that the season during which the host-plant flourishes is drawing to an end.

No doubt, we have in heterœcism the salvation of such a fungus. Not only is it carried through a dangerous period, by seeking relief at the hands of a second host, but (what is far more important) it obtains reinvigoration by the new protoplasm with which it comes in contact.

It is not pretended that the hypothesis embodied in the foregoing, at once explains all the cases possible, or that it is not open to numerous objections; but at any rate it is a suggestion which well deserves consideration.

In writing the above paper, the following works have been consulted :—

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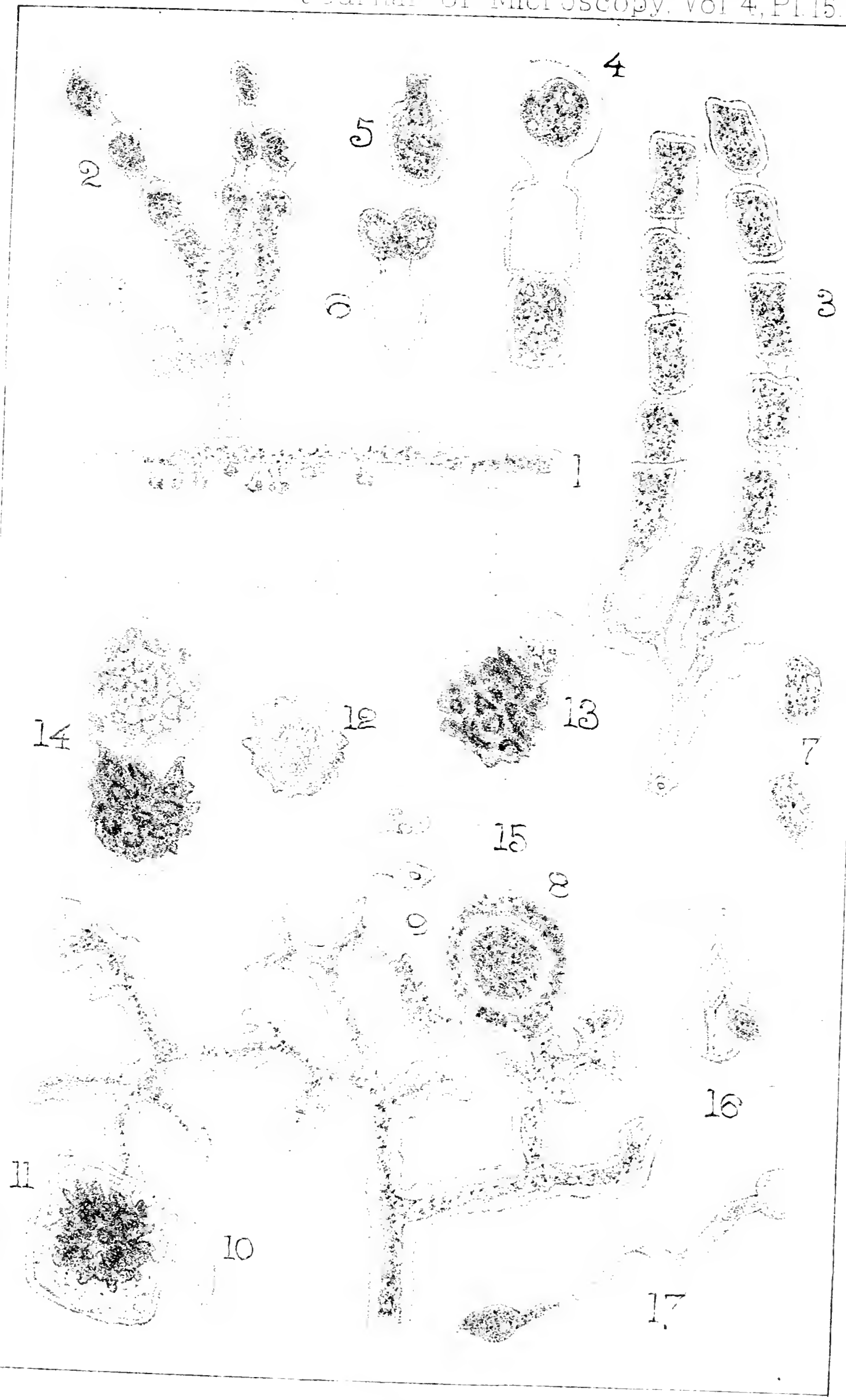
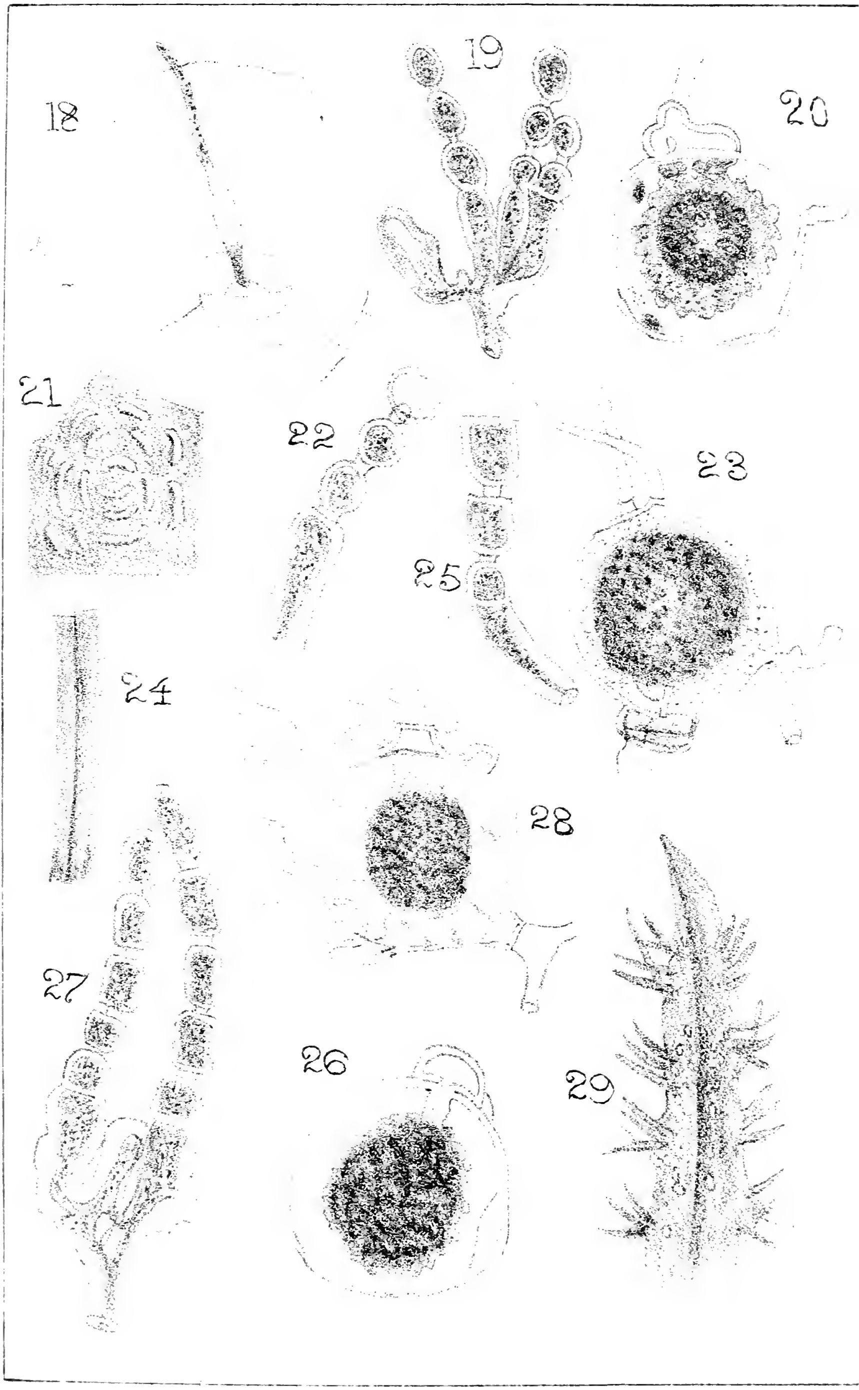
EXPLANATION OF PLATES XV. AND XVI.

Fig. 1.—Mycelium of *Cystopus*, with suckers.
,, 2.—Chains of conidia.
,, 3.—Conidia, fully ripe.
,, 4.—Conidium protruding a membrane full of zoospores.
,, 5 and 6.—Development and expulsion of zoospores.
,, 7.—Free zoospores.
,, 8.—Oogonium with oosphere.
,, 9.—Antheridium.
,, 10.—Remains of antheridium.
,, 11.—Ripe oogonium with oospore.
,, 12.—Ripe oospore.
,, 13.—Ditto, with tube of endospore protruding.
,, 14.—Endospore fully protruded and containing zoospores.
,, 15.—Free zoospores.
,, 16.—Zoospore fixed on stoma.
,, 17.—Zoospore germinating.
,, 18.—Germ within stoma, swollen and elongated.
,, 19, 20, 21.—*C. candidus* :—
19—Conidia. 20—Oospore. 21—Fungus on Cabbage-leaf.
,, 22, 23, 24.—*C. cubicus* :—
22—Conidia. 23—Oospore. 24—Fungus on Goat's-beard leaf.
,, 25, 26.—*C. Bliti* :—
25—Conidia. 26—Oospore.
,, 27, 28.—*C. Portulacæ* :—
27—Conidia. 28.—Oospore.
,, 29.—*C. Spinulosus*, on Leaf of Thistle.



Cystopus.



Cystopus.

On Mounting Beetles and other Insects without Pressure.

By Robert Gillo.

BEING desirous of obtaining as much knowledge as possible of the structure of Beetles, and more especially of their mouth-organs, I thought I could not do better than prepare some of them as transparent objects for the microscope; for although a dissection, in which you may examine each part separately, is undoubtedly best, still it is of considerable advantage to be able to see the various organs *in situ*. I therefore set to work and prepared some by the usual process—viz., mounting in balsam with pressure—but soon found that this method was most unsatisfactory, for although all the organs were visible under the microscope, the relative position of each and the form of the whole was altogether altered by pressure. To attain the end I had in view, I experimented in various ways, and after several failures finally adopted a process by which I have prepared a large number of insects. Some of my friends who have seen these objects have asked me to publish an account of the process. I willingly do so, but with much diffidence, since there is really nothing new about it. I consider that the plan I adopt is a selection and combination of methods and dodges known to all microscopic mounters.

Let us suppose that the object to be mounted is an ordinary Ground-Beetle, perhaps half-an-inch long. The first thing to be done is to steep it in *Liquor Potassæ* (full strength), and for this purpose I use a test-tube. When the solution becomes dark-coloured, it must be poured away and fresh added. After being in this for ten days or a fortnight, the insect must be transferred to water in a tea-saucer (distilled or soft water should be used), and whilst holding it steady with a camel's-hair brush, gently squeeze the body with another, giving the brush at the same time a kind of rolling motion, thus driving the contents of the abdomen towards the anus, from which it will presently be discharged. The beetle should now be removed to clean water, and left for an hour or so, when the squeezing process with the two brushes must be repeated as before, when more of the abdominal contents will be ejected. Again place the insect in clean water, and in this way, by several soakings and squeezings, the whole of the contents of the viscera will be removed without the least injury to any of the internal organs.

Throughout this process, however, the insect will be seen to be as opaque as it was at first. It is, therefore, necessary to bleach it; and to effect this it must be placed until sufficiently transparent, which may take a week or more, in the following solution: A saturated solution of Chlorate of Potash, to which is added 10 or 20 drops, or more, of strong Hydochloric Acid to each ounce of solution. A shallow but large-mouthed corked bottle is best for this purpose. The chlorine, which is slowly liberated, in the solution, attacks the chitine, and thus gradually bleaches it, and renders it transparent.

It is now necessary to wash all this solution out of the insect, which is best accomplished by placing it in a small pomatum-pot filled with *distilled* water, and after an hour or so to change the water, repeating the process four or five times. Nothing will be found so convenient as pomatum-pots for washing insects, and in practice I generally use several of them placed in a row, and pass the insects on from one to the other in succession.

For the next part of the process, a nest of china saucers or palettes—such as are used by water-colour artists (these fit sufficiently accurately one on the other to hold spirit for a day or two without its evaporating)—will be required. In an empty palette place the insect (on its back), and arrange its legs, etc., in the positions they are intended to retain when finished. Now gently pour methylated spirit over it so as completely to cover it, noticing that the legs are not displaced, for if they are right during this part of the process, they will naturally assume the same position in the final stage of the mounting. After several hours, or next day, change the spirit for fresh; and again, after several hours, pass the insect into ether, but as this is such a volatile fluid, it should be used in a test-tube tightly corked. There need be no anxiety about the position of the legs in this stage, as they have been already stiffened by the spirit, and if displaced now will spring back again into their original position. After soaking some hours in ether, pass into turpentine, in which it may be allowed to remain any length of time.

To mount the insect, it will be necessary to form some kind of cell upon the glass slips, and this can be easily accomplished as follows:—First take the insect out on a slip of glass, and notice its extreme length and breadth, so as to know the size of the cell required; also notice the thickness of the insect. Select a piece of glass rather thinner than the thickest part of the object. The insect must now be replaced in the turpentine until all is ready. From the selected piece of glass cut with a diamond two strips, 1—16th of an inch wide; place them together, and cut off two pieces one-eighth of an inch longer than the cell required, then cut two more pieces the width of the cell to form the ends. This plan of cutting two pieces together will be found the best, as it is not only necessary to cut the strips from the same piece of glass, but from the same part of it. The mounting medium to be used is balsam in benzole, which should be rather thick, so that it will just drop comfortably from a glass rod, but not so fluid as would be used for mounting in the ordinary way with pressure. Place the insect on a clean slip, and arrange it carefully; now drop some balsam both on it and around it, and put the slips of glass in a proper position to form the cell. The balsam between the glass will hold them securely whilst the cell is being filled quite full of balsam. Now place on the cover-glass, which must, of course, be a suitable size and quite clean, and affix one or two spring clips if the mount is a large one. It will often happen that the cell will not be quite full, and that a bubble of air will be enclosed. This can easily be got rid of by opening the cell at the corner with the setting needle, and dropping in some more balsam. By a little dodging, all air-bubbles can be disposed of. Use plenty of balsam, and when all seems to be in a proper position, put aside to harden for a week or more. It will often happen, when taking off the clip, that a bubble of air will run in; if so, instantly replace the clip, and the bubble will go out again. Now, at the exact spot where the air enters, place a drop of balsam and remove the clip, when, instead of air, balsam will be drawn in, and the slide should again be put aside for a day or two without any clip.

Owing to the large amount of balsam contained in the cell, the slide, whilst in this state, requires to be handled very carefully, and must be kept in a horizontal position. A good body of some cement is therefore necessary to protect it and to give rigidity to the whole. I have found, after many trials, that the best plan is to give two coats of Ward's brown cement, leaving the slide several hours to dry before applying the second coat. Next put around the cell a good body of the following cement:—Red lead, white lead, and litharge, each in powder, mixed together in boiled linseed oil, with a palette-knife, and put on with a penknife in the same way as putty would be used. This cement will take a week to harden, when it must be pared smooth, and finished off with black varnish. It is important to remember that the process cannot be hurried. It is, however, quite easy to do several specimens at one time, and whilst some are in one part of the process others are passing through other stages, so that it seems far longer and more complicated than it really is. Insects prepared by this method show the whole of the internal organs in their proper position, and when examined with the spot-lens illumination, the whole of the tracheal system will be very plainly visible. They also polarise brilliantly. This is probably owing to the action of the acid in the bleaching solution on the different tissues.

What is a Plant?

By H. W. S. Worsley-Benison, F.L.S.,
Lecturer on Botany at Westminster Hospital, President of the Highbury Microscopical and Scientific Society.

Part II.

VII.—Function of Circulation.

THE presence of circulatory organs formed Cuvier's *second distinction*. Animals, possessing a digestive cavity, taking various foods into it which needed sundry operations to be performed on them, and requiring to be quite independent of the atmosphere and heat, must have some *internal* system, governed by some *intrinsic* force, by which the prepared food could be conveyed to all parts of the body. Thus came about a circulatory apparatus, culminating in the higher forms in an apparatus consisting of heart, arteries, veins, capillaries, and lymphatics. So argued the great naturalist; but he admitted the absence of such a system among some lower forms, thus practically resigning its diagnostic value. Of course, circulation goes on in plants, but relatively to the digestive process, and from a *morphological* point of view, it presents no similarity to animal circulation, although it performs an analogous function.

Circulatory organs, as such, are absent in PROTOZOA, CŒLENTERATA, and PORIFERA. Still, a kind of circulation is kept up in the *animalcules* by the cilia referred to before, and by the contractile vacuoles, which probably also subserve the function of respiration; in the *Sponges*, moreover, we have a system of canals, with "pores" for water to enter by, and "oscula," or little mouths, for its escape. We are justified, however, in saying that these animals are devoid of circulatory organs, and Cuvier's second test thereby becomes invalid.

VIII.—PRESENCE OF NITROGEN. Cuvier held that because animals needed muscles to move with, and nerves to guide movement and receive impressions, therefore the chemical constitution was more complex in animals than in plants. This was effected by the presence of nitrogen, which he set down as his *third distinction.* Chemical research has made rapid strides since 1828, and we know now that nitrogen is always present in plants, and quite as important to them as to animals, seeing that the protoplasm, or "sarcode"—*i.e.*, the living substance of plants and animals, the "physical basis of life," as Huxley rightly calls it—is essentially and absolutely identical in both kinds of living beings, whether high up or low down in the scale, whether in the germ or in the adult. Its presence, therefore, as a means of diagnosis between the two kingdoms, is hopelessly useless, and must vanish.

IX.—GAS-EXCHANGE; FUNCTION OF RESPIRATION. If we fill a wide-mouthed bottle with water, place some green leaves in it, and expose the whole to sunlight, bubbles of *oxygen* gas will soon be evolved from the leaves. That the gas is oxygen could be proved in several ways. If we boiled the water before using it, thus expelling the *carbonic acid*, no bubbles would come away, showing that *the oxygen was gained by decomposition of the acid contained in the water.* Suppose that our experiment had been performed in the dark, no oxygen bubbles would have arisen, showing *light to be necessary for decomposition of carbonic acid.* We used *green* leaves; our inference is that *chlorophyll is the decomposing agent.* It is so; it is the talisman with which the plant works its will with the mineral world. Grow some mustard-seeds in moist flannel in darkness; the first leaves are almost colourless; expose the plants to the sunshine, they become green; this shows *light to be necessary in order to produce chlorophyll*, which shall be competent to decompose the carbonic acid of the atmosphere.

Now, on the other hand, let an animal—say, one of ourselves—breathe into a bottle containing lime-water. Shake the bottle well; a milky fluid is seen, which, analysed, would prove to be calcic-carbonate, obtained from the union of lime-water with the *carbonic acid* from the animal's breath. In other words, the animal evolves, not oxygen, but carbonic acid. We need not dwell on the ascertained fact that animals absorb or take in oxygen, and we have seen that a plant takes in and decomposes carbonic acid. Now, Cuvier founded on such facts as hese this *fourth distinction.* He held that animals gave off carbon and hydrogen in the form of carbonic acid and water, absorbing oxygen from the air; plants, inversely, took in carbonic acid and water, retained the carbon and hydrogen, giving off oxygen to the air. In short, his conclusion was that *evolution of oxygen*, under the agency of light, was the special feature of plant-life—*respiration—i.e., evolution of carbonic acid*, and *absorption of oxygen*, that of animal life.

How does this distinction fail in its turn? We saw just now that our green leaves in darkness evolved no oxygen bubbles. We did not say that no bubbles were evolved. As a matter of fact, our green leaves in darkness would have given rise to bubbles of *carbonic acid*, and had we led this gas into a bottle of lime-water, precisely the same result would have ensued as that produced by the animal breath.

Again. *Either in sunshine or darkness*, take some *germinating* *seeds*—such as peas, or some *budding flowers*—such as chamomile flowers, or, as a third case, some *Fungi*—such as mushrooms (the order possessing no chlorophyll); place them in a tightly-stoppered bottle; after a few hours introduce a lighted taper into the bottle; it will be extinguished at once. Or lead the gas evolved by the bodies named into a solution of lime-water; calcic-carbonate is quickly formed. From all these experiments we gather that green parts of plants in darkness, and parts not green, and Fungi, in either sunshine or darkness, evolve not oxygen, but carbonic acid, precisely as animals do. *They possess, that is, the function of respiration.* Familiar examples may any day be seen in the evolution of this acid in the process of malting, which is really one of corn sprouting by artificial means; also, in carbonic acid coming off from yeast, which is really a case of its evolution from a Fungus. Thus we see that on the ground of respiration we cannot build up any distinctive diagnosis of animal-life as opposed to plant-life. As Huxley says, "The difference vanishes with the sunshine," even with the green parts of plants, while with parts not green and the Fungi, no difference exists at any time. We must, therefore, resign the distinction, or write down the oak as a plant by day, an animal by night, a statement manifestly absurd. Moreover, modern research, especially Bernard's experiments, show that the green parts of plants, even in sunshine, do truly respire, or evolve carbonic acid to some extent, only its effects are hidden by the excess of the more marked process of their evolution of oxygen. Still one further remark. It has been shown with positive proof, by Mr. P. Geddes, that some *animals* possessing chlorophyll, such as *Spongilla*, *Hydra*, and *Convoluta*, (all before-named,) and others on which Algæ are parasitic (in the sense of living in their substance), such as the *Radiolaria*, *Anthea cereus*, *var. smaragdina*, and *Helianthus*, two well-known anemones, do actually evolve oxygen, exactly like chlorophyllian plants! So that, on both the animal and the plant sides, our diagnosis fails us. Therefore, we see that all the four distinctions of Cuvier fail to be absolute and diagnostic in the light and under the test of recent biological discovery.

X.—Function of Sensation. The possession of the power to "feel" was long held to be peculiar to animals, and a distinction was based on this supposition, plants being devoid of any such power. Sensation was, moreover, thought to be invariably accompanied by the presence of a nervous system. What do we find to be the case? We now look on a "nerve" as simply "a linear tract of specially modified protoplasm between two points of an organism—one of which is able to affect the other by means of the communication so established."* One of the chief properties of *protoplasm*, the living substance of plants and animals, is "*contractility*." All contraction ensues as the result of the application of some "*stimulus*," such as light, heat, electricity, mechanical irritation, and the like, or by the exercise of the will. The phenomenon of "*reflex action*" in animals is familiar to all. Stating it simply, in the case of any external stimulus, the "impulse" is sent along a "sensory" tract of nervous matter to the brain, and thence reflected along a "motor" pathway to the muscles, causing movement or contraction in them. Touch one of the tentacles of a snail, and it is instantly retracted. This is due to irritation of the nervous system acting on the muscles, and causing them to contract. In the anemone, although no definite nervous system is present, yet, taking the above definition of a nerve, we can understand the evidence the creature gives of sensation by the immediate withdrawal of its circlet of tentacles. We can easily demonstrate reflex action in ourselves by placing our fingers in boiling water, or by touching a hot cinder. We execute a similar hasty retreat.

Now, protoplasm in animal and plant is absolutely identical. The contractility in that of a plant can in no way be distinguished from the contractility in that of an animal. Furthermore, Dr. Burdon-Sanderson, in 1873, at Darwin's suggestion, undertook some experiments on contractility, as seen in the protoplasm of our old friend, *Dionæa*. He found this to be accompanied by an "*electrical disturbance*," precisely similar to that taking place when a human muscle, such as the "biceps," contracts, as in bending the arm. Among plants, we find numerous cases of protoplasmic contractility ensuing as a result of stimuli of various kinds, analogous to that taking place by the agency of nervous tissue. We

* Huxley, "Science and Culture," p. 158.

can only select a few examples. We will consider them more in detail in a future paper on the "Power of Movement in Plants," when we shall classify these movements according to their respective stimuli.

Light is in many cases the acting stimulus. This is seen notably in *Desmodium*, the "Telegraph-Plant," where the large terminal leaflet descends as the sun falls, the two lateral leaflets meanwhile perpetually moving up and down; in the *Compass-plant* of American prairies, which invariably grows with its leaf-edges N. and S., while their surfaces are placed E. and W., a property made use of by the trappers on a dark night, in order to find out in what direction they are going; in the stem of *Helianthus*, the Sun-flower; in the southern inclination of *ripening ears of corn;* and in many other cases.

Similarly, we have the opening and closing of many flowers at certain hours of the day. *Heat* operates as a stimulus here, as well as light. Bindweed opens at 3 a.m., Chicory at 5 a.m., Pimpernel at 8 a.m., Evening Primrose at 6 p.m., Evening Campion at 7 p.m.; Goatsbeard closes at noon, and so is called "John-go-to-bed-at-noon" by the dwellers on the Wye; Pimpernel at 3 p.m., Daisy at sunset. Thus Linnæus made his "floral clock"! Then, again, the varying periods of the year (these further varying with geographical position) at which flowers open have to do with the stimuli of light and heat.

Moisture is a stimulus to plant-movement. This is seen in many "hygroscopic" plants. Bindweed and Pimpernel close on the approach of rain, the latter thus called the "Poor Man's Weather-Glass." So, too, the "elaters" of *Equisetum* uncoil in damp weather, and help to scatter the spores; a similar cause is at work with the "annulus" surrounding the spore-cases of some Ferns, enabling it to contract, and set free the spores.

Something closely akin to all these is seen in the "sleep" of leaves, such as those of Wood-sorrel, Balsam, Melilot, and notably of *Mimosa*, the Sensitive plant.

Mechanical irritation is the only remaining stimulus we can notice. A footfall will cause the leaves of the Wood-sorrel to close; a touch, the vibration of a passing train, or even of a trotting horse, will similarly affect *Mimosa;* an insect, as it usually knows to its cost, can, by alighting on a leaf of *Drosera* or *Dionæa*, cause it to close on itself; the leaves of *Rhus* can be made literally to dance by throwing them into water. A similar effect—*i.e.*, a sudden movement—is seen in the irritation of some stamens; for example, those of Pellitory, Barberry, Knapweed, Nettle, Periwinkle, and many others, the result being the discharge of the fertilising pollen. Such movements are seen in the caudicles of the pollen-masses of certain Orchids; in the styles of Cactus, Passion-flower, etc.; in both stamens and styles in Fuchsia, Mallow, and others; finally, in the capsules of some plants, as Geranium and Balsam, in which last case the writer has seen the contained seeds scattered to a distance of over six yards! Many other examples might be cited, all showing contraction of plant-protoplasm as akin to that in the animal economy. The theory that plants "feel" when plucked may not be quite so absurd as is supposed; we may wake some morning to discover a "something" comparable to a nervous system in the plant domain, and Wordsworth may have uttered a deeper truth than he imagined when he sang:—

> "'Tis my faith that every flower
> *Enjoys* the air it breathes."

On the animal side, the PROTOZOA, PORIFERA, and some CŒLENTERATA, are devoid of any nervous system; we meet with none until we come to the Jelly-fishes, where the brilliant researches of Mr. Romanes have discovered one to exist. Still, all those devoid of it respond, like plants, to stimuli of sundry kinds. Sensation, therefore, fails as a distinctive mark.

Driven from our ground at every point, so far, let us make one more attempt to find a sure standing-place; with what success, it remains to be seen. We will, as briefly as we can, select for this purpose, as our "forlorn hope"—

XI.—THE NATURE OF THE FOOD. We have seen already the general relation of plants to the mineral world. It is this:—They are able to decompose *simple compounds*, such as water and carbonic acid. From these they get their oxygen, hydrogen, and carbon; their nitrogen they get from ammonia, or its salts, these being usually dissolved in the water taken up by the roots. From these simple bodies they can, by *taking away their oxygen*, *build up* their own compound substances, such as starch, cellulose, and the *nitrogenous body*, *protein*, which forms the chief part of their protoplasm; *i.e.*, they are able, out of these simple substances above named, together with some phosphates and sulphates—the "raw materials"—to build up their own vegetable "stuffs." They are *producers*.

Animals, on the contrary, are, for the most part, unable to do this. They need their protein ready made for them. They live, therefore, on plants, or plant-eating creatures, which contain starch, sugar, protein, etc.; these they *break down* into simpler bodies, and by *adding oxygen* to these (the reverse of the plant process), they reproduce the water, carbonic acid, and ammonia, destined again to be given off, and to become the food of plants. They are *consumers*. So the circle of life is kept up, and to use Huxley's apt terms, animals are the "ideal aristocrats," as opposed to plants, which are the "working classes"! The plant process is one of *deoxidation* and *synthesis;* the animal process is one of *analysis* and *oxidation*, or combustion.

Now, this *manufacturing power* possessed by plants is the only sharp line of demarcation that we can find that shall separate them from animals. Even to this, sharp and clear as it is, there are modifications, to use a milder term than that of exceptions. Let us glance at a few of these.

Many of the higher plants—the *parasites*, before named, as also the *Fungi*, or moulds—having no chlorophyll, are unable to decompose the simple inorganic bodies, and so to use them as food; still, they are manufacturers, for if we supply them with bodies slightly more complex, such as ammonia tartrate (containing carbonic acid), they can build up their protein from these, and are therefore plants. Suppose we sow a single spore of *Penicillium*, the mould found on old boots, or on jam, in a solution containing ammonia tartrate, with a small addition of phosphates and sulphates, keeping it warm, in either darkness or light, we shall shortly find a thick film of mould many million times the weight of our spore in cellulose, protein, etc.

All this has been manufactured. No sunshine, no chlorophyll, and yet work done; proving that manufacture can go on independently of both these agents, so long as the food is other than carbonic acid.

Again. *Torula*, the yeast-organism, the one causing fermentation in sugary solutions, flourishes, if placed in a tartrate liquid; but—and mark this—it flourishes far more abundantly if pepsin, a nitrogenous body, be added. Here it seems to feed on ready-made protein, like an animal, and we see no reason to doubt that *Botrytis* and *Empusina*, the fungi, respectively, of the caterpillar and the house-fly, *Peronospora*, the potato-fungus, *Hemileia*, the coffee-plant fungus, *Puccinium*, parasitic on grasses, and *Æcidium*, living on the celandine, as also the *Fungi* that are parasitic on human skin, do, one and all, feed on the ready-made protein of their hosts. Thus they resemble animals, although undoubtedly plants.

Æthalium, or flowers-of-tan, an organism growing around tan-pits, during part of its life has no cellulose coat, feeds on protein, takes in solid food, and moves about from place to place, even going so far as to climb some little way up the trunks of adjacent trees; yet, at another period, it shows several distinctly plant-features. It is, at present, a biological puzzle. The organisms known as *Monads*—such as the "Heteromita" of Huxley and the "calycine monad" of Dr. Dallinger—are equally puzzling. The latter is an organism only one three-thousandth of an inch in size, possessing two cilia, the hinder one being only one one-hundred-thousandth of an inch in diameter! These bodies resemble plants in many ways, and yet may with almost equal reason be placed among animals. We cannot say which they may be until their method of feeding has been definitely ascertained. Finally, there are the *Insectivorous plants*—*Drosera*, etc.—that feed on the nitrogenous compounds of their victims.

On the plant side, therefore, modifications are by no means few or inconsiderable; but even on the animal side, where the absence of power to manufacture is very nearly universal, Mr. Geddes has found that in *Convoluta** fine granules of starch are formed inside its green chlorophyll granules, looking as if the creature were nourished in virtue of its chlorophyll—*i.e.*, as if it fed on carbonic acid, like a plant; and we are by no means sure

* *Vide* No. IX. in this paper, "Gas-Exchange."

that this may not be also said of *Spongilla* and *Hydra*, though this is not definitely proven.

Mr. Geddes points out that there is a strange parallel between the *Drosera*—which, while imitating a carnivorous animal, tends to lose its normal character by possessing so tiny a root—and the *Convoluta*—which, imitating a green plant, loses all trace of an alimentary canal, and is of exceedingly abstemious habits.

We see, therefore, that even the nature of the food, as a distinctive mark, fails us in some cases on both sides; many plants needing more complex bodies for food, many appearing to subsist on ready-made protein, while some, possibly, could not live without it; some few animals seeming to possess the plant-power of decomposing carbonic acid.

However, we may say that, *physiologically*, the most distinctive feature of plant-life is the power to manufacture protein from less complex bodies; that of animal-life, the absence of such power.

Let us now gather up our evidence, and see what reply, if any, we may give to the query at the head of this paper. Looking carefully through the eleven sections, and marking their details, we find the case to be pretty much this:—In form, in the presence of starch, or of chlorophyll, in power of locomotion, in the presence of circulatory organs, or of the body called nitrogen, in the functions of respiration and sensation, we can by no means find diagnostic characters; *in the presence of a cellulose coat in the plant-cell*, *in digestion followed by absorption*, *and in the power to manufacture protein*, we find fairly constant and well-marked distinctions; the *morphological* feature of plants being this *cellulose coat;* of animals, its absence; the *physiological* peculiarity of plants, this *manufacturing power;* of animals, the want of it.

Finally, seeing that some plants are devoid of the power to manufacture protein out of the simple compounds, requiring those more complex; that some appear to feed on protein, as such; remembering the cases of *Æthalium*, and also of the "Monads," bearing in mind the example of *Convoluta*, and possibly others among animals: we are compelled to admit that in many cases the difference is one of degree rather than of kind, and that to the question, *Is this an animal or a plant?* we must often reply, *We do not know!*

One word of caution. We do not strive to show any origin of animals from plants. Were that so, the lowest animal form would be most nearly related to the highest form among plants, whereas it is among the lowest forms on both sides that we find such perplexing similarity both in form and function. As Dr. Wilson puts it, "The two series form a tree, with two branches, diverging most widely at their highest forms"; they become more parallel as we descend the scale, meeting below in the *root* of the tree; the speck of *protoplasm*, which, differentiated and guided by the Divine Hand which governs all life, is directed along either the animal or the plant branch. Should further research show a close union of these first parallel and afterwards divergent lines of life, and entire inability to primarily separate the one from the other in many instances, this result will not lessen the fascination which the study of life and its wonders possesses for us. Nay, more. We shall not have less of reverence for Him who, behind and above all forces and powers, ever stands as the primary cause of all power and force; the one Law-giver, behind all the laws of His marvellous universe; the Maker of all the "atoms," whose concourse is *not* "fortuitous," let the theorists say what they may. The more we study the intricacy, delicacy, and beauty of the varied creations of a Power, which, although we cannot comprehend, we are, through that very study, constrained to believe in, the more surely shall we be led reverently, silently, and lovingly, to

"Look through Nature up to Nature's God."

London; February, 1885.

Notes.

1.—*Presence of Starch* (p. 78). *Radiolarian yellow-cells.* These are now definitely known to be parasites, in the form of unicellular algæ. Geddes, in 1882, confirmed the views of Cienkowski in 1871, Hertwig in 1879, and Hamann in 1881; he proposes the name *Philozoon* as the generic name of these algæ. He shows that the parasitic Philozoon renders service to the Radiolarian by supplying it with starch by osmosis, by evolving nascent oxygen into the surrounding animal tissue, and by nourishing the host in virtue of being digested by it after death; receiving as its reward the carbonic acid and nitrogenous waste of the Radiolarian, which is its own needed support, and by using which it is enabled to multiply itself.*

2.—*Presence of Chlorophyll* (p. 78).

It is now ascertained that the supposed Chlorophyll in *Idotea* and *Bonellia* is not that body at all, but a green pigment, for which the term "bonellein" is proposed. In *Anthea cereus*, var. *smaragdina*, the substance is termed "Anthea green," differing from chlorophyll in some ways, but apparently capable of causing evolution of oxygen; in the variety *plumosa*, which also evolves oxygen, there is no chlorophyll, but a great number of parasitic algæ are seen in the endodermal cells. The variety *smaragdina* also contains a few parasitic algæ.†

[ERRATUM.—Part First, Section I., p. 77, for "Chalmydamonas,," read "Chalmydomonas."]

Chironomus Prasinus.

BY A. HAMMOND, F.L.S.

Plates 9 and 10.

PART II.

THE Malphigian tubes are four in number; they open into a slightly dilated chamber at the beginning of the small intestine. The term "bile tubes," which I have employed for these organs on former occasions, must, I think, be discarded, the balance of opinion being against it. It is generally stated that the Malphigian tubes belong to the proctodeum, and are consequently of epiblastic origin, and there is no difficulty in accepting this theory in the present case, so far as the structures of the larva may be allowed to bear upon the point, but in an allied genus ‡ which I have investigated, the separation between

* P. Geddes, "Nature," Vol. XXV., p. 303.

† *Ibid.*

‡ *Simulium*, species not determined.

stomach and intestine is very sharply marked both in the character of their epithelial and muscular coats, and the tubes here seem decidedly to enter the lower portion of the stomach. It is difficult to see how this comes about.

Connected with the alimentary canal are two large glandular sacs, which open by ringed ducts, uniting to form a common duct which opens into the œsophagus immediately behind the mouth. I have cursorily glanced at these organs both in *Tanypus* and the Blow-Fly. In Chironomus they are specially worthy of attention. Their high development may be estimated by the activity and importance of their function, as evidenced by the felting of the mud in which the insects live. This development does not lie in the extent of secreting surface as brought about by the methods usually adopted in the compound glands of vertebrates. Like other glandular structures of insects, they are simple though somewhat irregular in shape, and the reason of their extraordinary efficiency as secreting organs must be sought rather in the character of their secerning elements than in their multitude, and these present under microscopical examination two special characters, that may both, I think, contribute to this result, viz., first the character of the nucleus, and second the shape of the cell and the position of the nucleus therein. Figure 4 represents a portion of the gland in a condition, as I take it, of comparative functional inactivity, a state, at all events, in which I sometimes find it. The cells are of considerable size, as may be seen by the scale attached, and are nucleated and slightly granular in aspect, but there is nothing unusual in their appearance. On other occasions, however, the nuclei present a very peculiar aspect, which I have never seen except in structures of these and allied larvæ. As these features of the nuclei have formed the subject of a paper by Prof. Balliani, I prefer to give succinctly the result of his observations thereon.*

He commences by showing that structures similar to this had been previously observed by him in other insects, etc., where the nuclei presented granulations arranged linearly. To bring them out he uses acetic or chromic acid for just sufficient time only to produce the result; further action being injurious. By such

* Carus Zool. Anzeiger, 1881, pp. 637 and 662.

means he succeeded in showing that the germinal vesicle of the ovarian ova of a rabbit enclosed a network formed of uniserial rows of globules, and not homogeneous filaments. In many cases these nuclear grains, instead of being globular, are disc-like, resembling rouleaux of blood-globules, and this is especially the case in *Chironomus*, where the nuclei of the salivary glands, in which the phenomena are most strikingly shown, enclose, firstly, two large nucleoli, sometimes separate, sometimes more or less united (see Fig. 16) ; and secondly, a coiled, cylindrical cord of slightly varying diameter ; sometimes continuous, sometimes interrupted, and occasionally doubled ; the extremities of which pierce the nucleoli (see Fig. 16). At a small distance from each extremity there is an abrupt discoid swelling, which may be described as a ring which the cord traverses a little before the extremity pierces the nucleolus. This ring is difficult to see in living cells, but is brought out by re-agents, colouring matter, etc. The structure of the cord presents alternate dark and light bands, the former of which appear to be formed by a solid substance, the latter by a liquid. These bands are the expression of thin discs, which are quite independent of each other, as may be seen when separated by pressure. It will scarcely be questioned, Balbiani says, that the cord is the homologue of the intra-nuculear network of other nuclei, which are generally described as consisting of homogeneous threads continuous with the wall of the nucleus, and branching and anastomosing therein. Are these, however, he asks, the characters of the fresh and living nuclei ? It has been stated that the prolonged use of re-agents beyond the time required for fairly bringing out the phenomenon in question, destroys the utility of their application ; nay, more, knots up the cord and fuses the discs with one another ; and this is what he thinks has happened with many observers who thus have only described homogeneous, intra-nuclear networks, where otherwise they might have described structures similar, more or less, to those so beautifully seen in this insect. He observes, finally, that the nuclei of *Chironomus* are truly organisms—*i.e.*, they are provided with special parts fulfilling special functions, and perhaps this inference may extend to both animal and vegetable kingdoms. There is no doubt that there is exhibited in these nuclei a high degree of differentiation. Now, differentiation, we know, is always associated with perfection of function. We are justified, therefore, I think, in connecting the extraordinary secreting activity of the glands, in the first place, with the complex structure of the nuclei of the cells concerned in the process.

But, again, there is another point, as I have mentioned, which bears upon this subject. Under some conditions I have found that the cells, instead of being simple in shape, as in Fig. 4, assume the very remarkable forms exhibited in Fig. 8, where the nucleus, with a certain amount of the protoplasm of the cell, becomes almost separated from the remainder, and projects into the cavity of the gland as upon a pedicel, the remainder of the cell assuming a flat, polygonal form. Now, here we find that the nucleus, the centre of the vital activity of the cell (which vital activity is here chiefly manifested in the act of secretion) is removed into what I think we may regard as a speciallised portion of the cell, both on account of its marked separation from the remainder, and on account of its projection into the cavity of the gland—*i.e.*, into a position obviously the most favourable for a copious outpouring of the secretion from its walls. The remaining flat portion, or base of the cell, I regard as nutritive—*i.e.*, it takes from the blood, to which it offers a large surface, the material requisite for the growth of the whole; and the more so, as I have occasionally noticed secondary nuclei in this part, evidences of imperfect cell-division, showing that here the processes of growth go on, but giving as yet no traces of the complex structure just described. I think it possible that the pedicellated portion of the cell, with its nucleus, becomes completely separated, and falls off when its vital activity is exhausted and its mission accomplished, its place being taken by the new cells into which the basal portion has by this time divided. We have, I think, in these cells a differentiation of the nucleus, evident as a matter of ocular demonstration, and another differentiation, equally real, of the protoplasm, which can for the present only be a matter of inference, but both contributing to the higher organisation of the gland.

The Vascular System and Cœlom.—It will be well, perhaps, shortly to compare these parts of the organism as they are found in the Vermes and Arthropoda respectively, observing that a reference to my paper on *Tubifex rivulorum* * will help to illustrate many of the points mentioned. The cœlom of the Vermes is marked off into sections almost separated by the inter-segmental septa, whilst that of the Arthropoda is continuous. The vascular system of the former is closed and quite cut off from the cœlom; that of the latter (*i.e.*, the dorsal vessel) is in communication with it. The vascular fluid of the former differs in colour, etc., from that occupying the cœlom; that of the latter is identical with it. The dorsal vessel of the former is in close connection with the intestine; that of the latter is separate therefrom. The cœlom of the former is circumscribed by an endothelial lining, the peritoneal membrane of Dr. Williams; that of the latter is not so circumscribed, but extends between the muscles and other organs. These differences show that it must not be concluded, as might happen from a superficial view, that the cœlomic cavity of the Arthropoda is homologous with that of the worms, and Gegenbaur states that the cœlom of the former is part of the vascular system.†

The dorsal vessel, therefore, of our larva may be regarded as part and parcel of the vascular body-cavity in which it lies. It consists of a chambered tube commencing in the twelfth, or penultimate segment of the larva, and extends forwards towards the head; its anterior termination I have not been able to trace. It is curious that while in many allied larvæ this tube appears to be contractile throughout its length, the contractility in this case is, I think, confined to the first chamber (reckoning these in a backward direction) in the twelfth segment, where it is very marked, and is evidently due to the presence of a coating of transverse muscles which produces the systole. How the diastole is brought about is not equally obvious, but I think it is by the elasticity of a number of almost invisible connective tissue cords that connect the dorsal wall of the chamber with the integument.

* See this Journal, Vol. I., p. 14.

† Gegenbaur's Elements of Comparative Anatomy, p. 278, English translation.

I have not seen the least trace in this larva of the triangular muscles known as the wings of the heart,* although I have distinctly recognised them in the larva of a closely allied insect, the Crane-Fly, where they extend nearly the whole length of the vessel. The blood is admitted by two slits or orifices at the posterior end of the chamber, and is prevented from returning by two valves at its anterior end. This first chamber is much the largest of the series, and seems pre-eminently to claim the title of heart; the rest of the tube may be more justly entitled the aorta. I can detect no other orifices for the admission of blood except the two mentioned.

The fatty rete of this larva generally presents a number of oil-globules of very various sizes scattered through a homogeneous ground-substance. In young larvæ I have found nuclei instead of oil-globules. The latter, therefore, I think, must be looked upon as the secretion of cells of which the whole substance was originally composed, but the divisions between them have disappeared, the structure having become what is termed a syncitium. It assumes two forms, the first of which is a laminated trabecular one, consisting sometimes of irregular sheets of rounded contour, one or more of which may intervene between the hypoderm and the muscular tunic of the larva, and connected with each other by anastomosing processes; or the trabecular character being more pronounced, it may, as in the thoracic segments, consist of a number of intercrossing and anastomosing shreds. Sometimes portions are found between the muscles. The second form is found surrounding the intestine, and consists of sausage-shaped or irregularly tubular masses of the same tissue. As I think there is always a distinction, more or less, between the portions of the rete, I would propose to designate them respectively by the terms: somatic rete and splanchnic rete. At other times I have found the somatic rete largely composed of granular cells of very varying sizes, up to 1–800 of an inch, with no oil-globules. This seems to be a special condition, and the larvæ in which it is found are so swollen out by the great accumulation of it in each segment as to assume a knotted appearance. In this condition, too, it

* Since writing this, I have been able to recognise the existence of the triangular muscles.

reflects light strongly, so that the larvæ appear opaque and white, as well as knotted. This is only seen in mature larvæ.

Perhaps the most usual condition of the blood of this larva is that of a clear red fluid, in which little or nothing can be discerned. Frequently, however, filamentous elements (Fig. 18) can be seen carried along with the circulation, and in situations such as the respiratory appendages, where the movement of translation is occasionally from some cause impeded; careful watching will, I think, result in the conviction that these filaments have a proper movement of their own, somewhat resembling that of the filaments of *Oscillatoriæ*, and knotted portions present slow, amœba-like changes of shape. On some occasions I have found the blood filled with a vast number of large, clear cells, as much as the 1–600 of an inch in length, having an oval outline and vacuolated appearance. Whether these could be regarded as blood-cells I am somewhat uncertain.

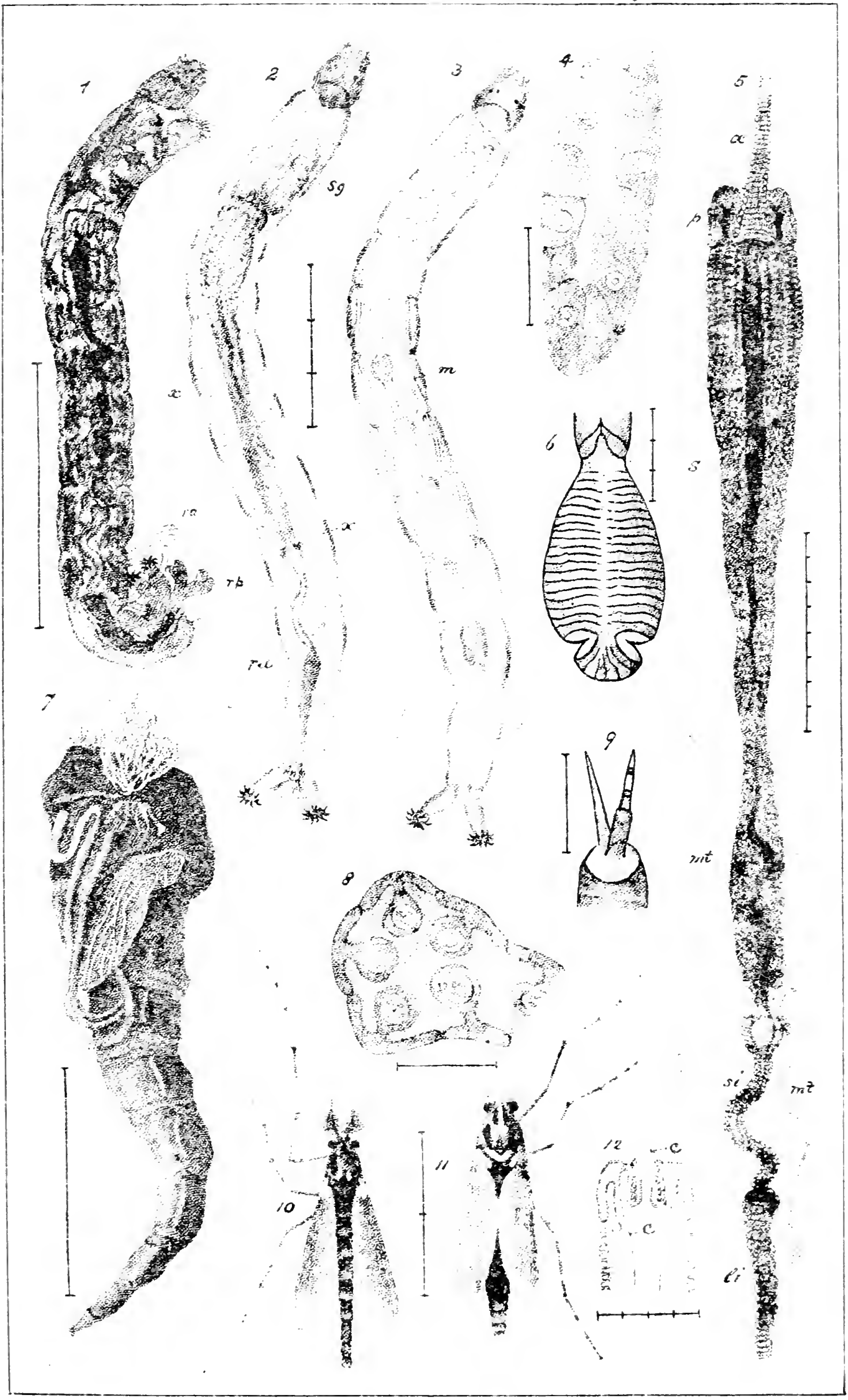
The nervous system consists, as in *Tanypus*, of a supra-œsophageal ganglion, or brain, united by a pair of crura (embracing the œsophagus) with a double ganglionated cord (see Fig. 3), consisting of 12 ganglia, the five anterior of which are approximated, and the last two, closely contiguous. It may be remarked that Dufour * states that the nervous cord of the Diptera is invariably single and not double. It is evident that he either had not examined the larval state of the insects, or that his statement was meant to apply exclusively to the imago, in which sense it is probably correct. The nervous cord of the Crane-Fly is single in both conditions, but at the posterior end of each pair of commissures, and immediately in front of the succeeding ganglion, there is a small split in the substance of the cord, sufficiently indicating that its original condition was double, as we find it in *Tanypus* and *Chironomus*.† Four black pigment spots, two on

* Recherches Anatomiques sur les Dipteres. Memoires Presentés a l'Institut de France. Tome II., 1851, page 176.

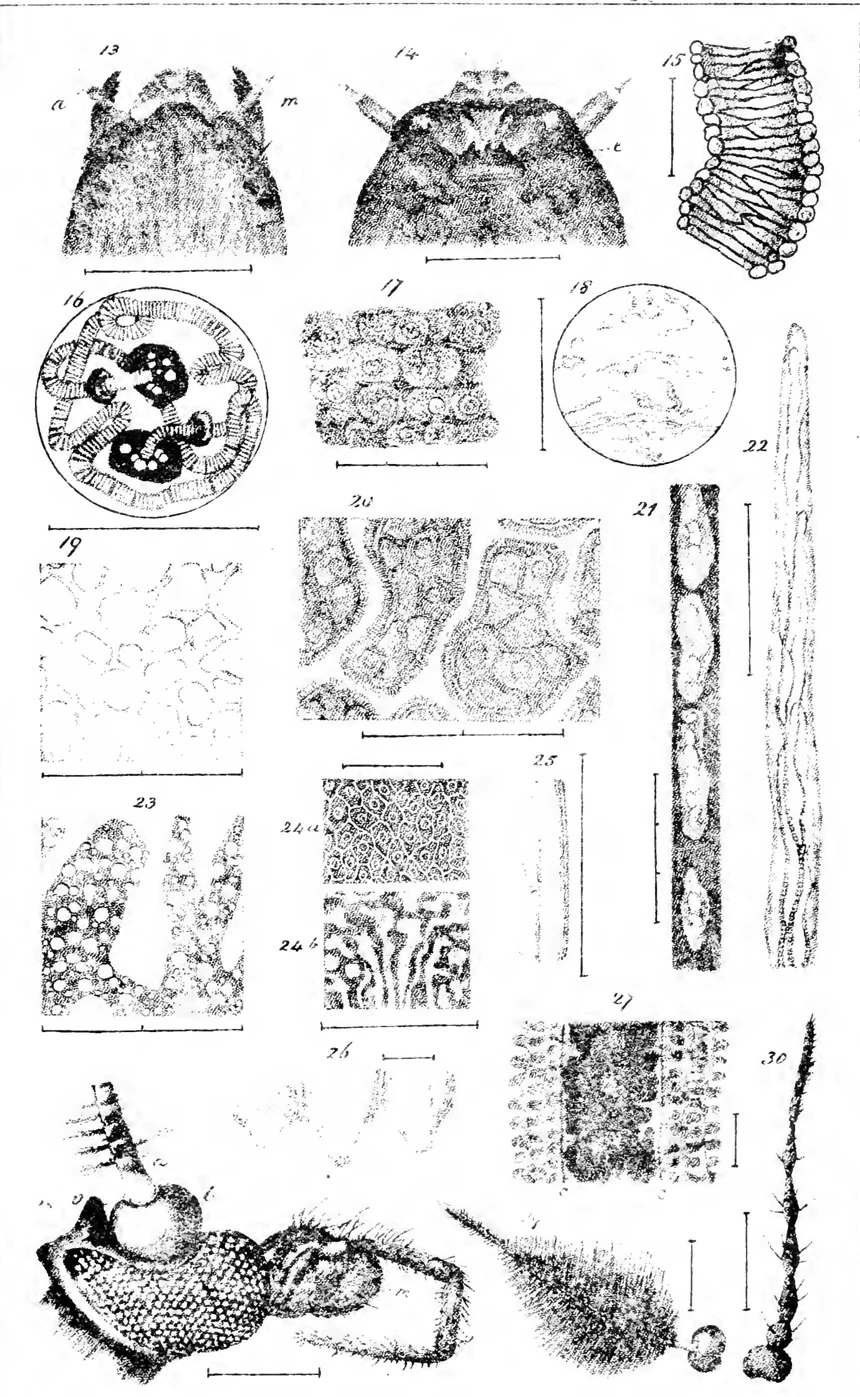
† The coalescence of the nervous cords in the perfect condition of Dipterous insects must be taken, I think, as an indication amongst others of the high grade of development of this order of Insects. It is paralleled by an equally noticeable tendency of the integumental parts to coalesce in the ventral mesial line. Compare the widely separated legs, for instance, of most, if not all, Orthopterous insects with the close approximation of these organs in the Diptera. Notice also the great preponderance of the dorsal abdominal plates in the latter over those of the ventral.

each side of the head, serve the purpose, it may be presumed, of eyes; each of the inner pair is furnished with what looks like a couple of crystalline lenses. The antennæ are bifid, as shown in Figs. 9, 13, and 14.

MUSCULAR SYSTEM.—I have little to say at present on this subject beyond what I have mentioned in connection with the alimentary canal. There is the usual muscular intestine lying under the integument (see Fig. 3), and consisting principally of longitudinal fibres, connecting segment with segment. They are broad, band-like, striated fibres of somewhat equal diameter throughout, attached by either extremity to the integument, and invested with sarcolemma. By their means the various movements of the body are produced, and special fibres are found in the head connected with the organs of the mouth. Transverse muscles also occur in the abdominal segments, which in the living larva frequently stand out from the surrounding tissues with an opalescent brilliancy. This happens whenever the axis of the fibre corresponds with the line of vision as is frequently the case during the movements of the animal. They are thus represented in optical section in Fig. 21, and their position is indicated in Fig. 2. One observation I should like to make with reference to the phenomenon of contractility evinced by them. If a living larva be crushed under the cover-glass while under observation, so as to press out the viscera, etc., and yet not disintegrate the muscular coats, the muscles will be seen for some time to exhibit irregular contractions, as follows:—One end of the muscle suddenly assumes a great increase in breadth, and the transverse striæ become approximated. This swollen portion passes like a wave, with more or less activity, to the other end, so that the whole of the muscle does not become contracted at once, but every portion of it swells and contracts successively; another wave following the first after an interval. This is an example under exceptional conditions of the normal mode in which muscular fibres contract, and affords a very instructive lesson.



Chironomus prasinus.



Chironomus plumosus.

EXPLANATION OF PLATES IX. AND X.

Plate IX.

Fig. 1.—Larva of *Chironomus prasinus*, side view: *ra*, respiratory appendages; *rp*, rectal papillæ.

,, 2.—Larva, showing, *sg*, salivary glands, the alimentary canal, and transverse muscles, *x*.

,, 3.—Ditto, showing double ganglionated nerve-cord and subcutaneous muscles, *m*.

,, 4.—Portion of salivary gland, showing simple condition of cells.

,, 5.—Alimentary canal: *œ*, œsophagus; *p*, proventriculus; *s*, stomach; *mt*, malphigian tubes; *si* and *li*, small and large intestine.

,, 6.—Heart of Larva, front view.

,, 7.—Pupa

,, 8.—Portion of salivary gland, showing petiolated cells.

,, 9.—Antenna of Larva (bifid extremity only).

,, 10.—Perfect insect, male.

,, 11.—Ditto, ditto, female.

,, 12.—Section of proventriculus, showing the extremity of the œsophagus hanging in the cavity, and reflexion of the cuticular lining, *c*, around it.

Plate X.

,, 13.—Head of Larva, dorsal view: *a*, antenna; *m*, mandible.

,, 14.—Ditto, ventral view: *l*, labium.

,, 15.—Portion of small intestine, showing muscular covering.

,, 16.—Nuclear cord and nucleoli from cell of salivary gland, after Balbiani.

,, 17.—Portion of large intestine, showing epithelium.

,, 18.—Filamentous elements in blood.

,, 19.—Thickened epithelial cells from stomach.

,, 20.—Ditto in groups, with radiating pores.

,, 21.—Transverse section of the transverse muscles in abdominal segments.

,, 22.—Extremity of a respiratory filament of the pupa.

,, 23.—Portion of somatic rete, with oil-globules.

,, 24.—Hypodermic cells: *a*, ordinary condition; *b*, amœbiform.

,, 25.—Section of integument, cuticle, and hypoderm.

,, 26.—Short cœcal projections of stomach.

,, 27.—Anterior portion of stomach, showing cœcal projections; *cc*, cuticular lining, enclosing food mass.

Fig. 28.—Head of male fly: *a*, root of antenna; *b*, bulb of same; *m*, lobate mouth; *p*, palp; *o*, ocellar prominence.
,, 29.—Antenna, male.
,, 30.—Ditto, female.

A scale consisting of one or more divisions is placed near each figure. Each division represents 10th, 100th, or 400th of an inch, as per table below:—

10th of an inch,	Figs. 1, 7, 10, and 11.
100th ,,	Figs. 2, 3, 4, 5, 8, 12, 13, 14, 15, 22, 26, 27, 28, 29, and 30.
400th ,,	Figs. 6, 9, 16, 17, 18, 19, 20, 21, 23, 24, and 25.

Animal Metamorphosis.

By J. B. Jeaffreson, M.R.C.S., Etc.

Part 2.

Plate XVII.

THE majority of the Mollusca undergo a very definite series of changes. Most of them commence life as a small, ciliated, worm-like body, having at its head an expanded lobe, richly clothed with cilia, resembling the trochal disc of a rotifer, by means of which it swims about actively. This process is lost in the adult, and the animal is only able to move about with a slow, creeping mode of progression. The larvæ of all bivalves possess eyes, but they are generally lost in the process of development, and when such organs appear in the adult they are of secondary formation. In their embryonic stages all molluscs possess a shell, within which the young can entirely retract itself, but in the adult forms of the Nudibranchiata, or Sea-slugs, it is entirely lost or only quite rudimentary. Young oysters, or mussels, are hatched in the gill-chambers of the mother, and swim about freely by means of a ciliated disc at the anterior end of the body. The embryo oyster (Fig. 15) is enclosed in a transparent, but rather thick, shell, composed of two convex valves united by a straight hinge. These valves are symmetrical in size and shape, so that the shell resembles that of a cockle more than an adult oyster. Sooner or later the young oysters lose their ciliated disc, settle down in life, fix themselves to some solid body, the upper shell remains convex while the lower becomes flat, and the animal acquires the asymmetrical characteristics of the adult.

The young Anodon, or Fresh-water Mussel (Fig. 14), is enclosed in a pair of three-sided valves, which are furnished with curious barbed or serrated hooks, by means of which it attaches itself to the fins and gills of small fish ; and so different are the young in appearance from the adult mussels that they were looked upon as distinct animals and described under the name of *Glochidia.*

In the Cephalopoda (including the Octopi and Cuttle-fish) development is direct, no metamorphosis taking place after they leave the egg.

The next sub-kingdom—the ARTHROPODA—contains the Crustacea and the Insecta, the young of most of which pass through a metamorphosis.

The Crustacea include the lobsters, crabs, shrimps, entomostraca, barnacles, and acorn-shells. The young lobster only differs from the adult in the possession of small outer appendages on the walking-limbs and in the smaller size of the tail; but the crab emerges from the egg in a form totally unlike the adult, as a little swimming creature, about a quarter of a line in length, with a dorsal shield armed with a strong median spine, and followed by a jointed post-abdomen, which bears no appended limbs. It is now known as a Zoæa (Fig. 16). In seven or eight days, having cast off his coat several times, he loses his spine, his back becomes broader and more depressed ; the eyes, from being sessile, are elevated on moveable stalks; the claws undergo an entire revolution, the first pair becoming stouter than the others and armed with strong nippers, and he becomes a tailed crab (Fig. 17), although the tail is greatly diminished in size. Still, he goes on swimming, and after moulting a few times more his tail is folded under, and he sinks to the bottom a true walking-crab.

Many of the Crustaceans make their appearance from the egg as a minute, rounded, oval, or pear-shaped larva, with three pairs of legs—the anterior simple, the others bifid. It is called a Nauplius (Figs. 18, 22, 24, 25). In front, above the mouth, lies a single, simple eye. It swims freely about, and by various moultings and changings gradually assumes the adult form. The Epizoa, Cirripedia, and Entomostraca, all commence life in the Nauplius form, and the primitive form of one of the shrimps (Peneus) has also been shown, by Fritz Muller, to be a Nauplius (Fig. 18), which at first has only three pairs of limbs, but soon acquires additional pairs and a jointed body (Figs. 19 and 20), and gradually approximates more and more to the adult form from which it originated.

Here, and with the Entomostraca, a gradual development takes place to a more complex structure, but in other Crustaceans which take on a parasitic condition we find that the Nauplius, instead of proceeding to a higher form, takes on a kind of retrogressive metamorphosis. Thus, in the case of the *Sacculina* (Fig. 21), a parasite which infests crabs, and is a mere sac filled with eggs and absorbing nourishment from the juices of its host by root-like processes, and in the *Lernæocera* (Fig. 23), which, in its adult condition, is an elongated, worm-like creature found attached to the gills of fishes, the early, active Nauplius forms (Figs. 22, 24) lose their locomotive and sense-organs, and degenerate into comparatively simple bodies, leading an almost vegetative life, and becoming mere re-productive machines.

In the Cirripedia—the Acorn-shells and Barnacles—a similar retrogression takes place. The Acorn-shells (or Balani) are the limpet-like shells which encrust the rocks along our seashore, occurring in myriads upon every solid object between the tide-marks; while the Barnacles (Fig. 26) are commonly found attached by an elongated stalk to floating logs of wood or ships' bottoms. They commence life in the active Nauplius form, which every autumn can be found swimming in large numbers along our coasts. It has the usual three pairs of legs, the first of which is uncloven, the two subsequent pairs forked; the back is covered with an ample shield, often terminating anteriorly in two extended horns, while in the Nauplius of the barnacle (Fig. 25) the posterior part is prolonged into two elongated spines. It is also furnished with organs of vision. After going through a series of moultings, it comes to present a form which reminds us strongly of a Daphnia (Fig. 27); it is now quite translucent, the body being enclosed in a shield composed of two valves, which are united by a hinge along the upper part of the back, while they are free along their lower margin, where they separate for the protrusion of a large and strong anterior pair of prehensile limbs, provided with an adhesive sucker and hooks, and of six posterior legs adapted for swimming. The bivalve shell is subsequently thrown off, and, forming a broad disc of attachment, the Balanus fastens itself to a rock, and assumes a perfectly fixed and immobile state of existence. The eyes and antennæ vanish; the body is enclosed in a limpet-shaped shell, composed of several pieces, having an aperture in the summit which is closed by a moveable lid, and from which the animal can protrude its delicate legs, or "cirri," which look like a glass hand, and are constantly employed in sweeping the water in search of food, so that it has been compared by an eminent naturalist to a man standing on his head and kicking his food into his mouth. The barnacles (Fig. 26) attach themselves to a floating piece of timber, a ship's bottom, the skin of a whale, or, in some species, to the abdomen of a crab, the anterior portion becoming extremely elongated into the peduncle of attachment.

The true spiders pass through no metamorphosis, the young being hatched in the form of the parent, but moulting repeatedly before they attain the size of the adult. Their cousins, the mites, however, live a double life. Commencing with only six legs, and then hiding themselves in some crack in the ground, they lie motionless for many days, and ultimately come out with eight legs like minute spiders, but distinguished from them by the fact that their body is always one undivided piece, and not pedunculated; that is, jointed to the abdomen by a narrow point of attachment.

It is among the Insects that we find the best-known and most complete series of changes known under the name of metamorphosis. Born in one shape, the insect dies in another; organism, functions, and habits, all change, the adult insect differing so widely from the young that we cannot in the least recognise the one from the other. What can be more unlike than a caterpillar, a crysalis, and a perfect butterfly, the mud-brown aquatic larva of the dragon-fly, and its brilliantly-coloured imago, the rat-tailed maggot, and its adult representative, the hoverer fly, or the pretty little lady-bird, and its ugly, grub-like larva, which has been compared to a tiny, six-legged crocodile?

The changes differ in degree, but in their most complete form consist of the following series of transformations:—When hatched from the egg, the young insect is always wingless, presenting itself generally under the form of a small, worm-like creature, usually furnished with a certain number of powerful hooked feet, adapted for clinging closely to the surface of the leaves on which it feeds with its powerful masticating jaws. It is technically called a "larva"—popularly, a grub or caterpillar. Its sole object in life now is to eat and grow, which it does rapidly, repeated changes of the skin being necessitated by its continual enlargement. After attaining its full size, it passes into its second stage; it shrivels up, casts off its skin, takes on a new form, and becomes motionless. It is then called a "nymph," or "pupa." This is a mere transitory stage, and in this kind of temporary sepulchre transformation into the perfect insect takes place, and when this is effected, splitting its crysalis-case, it creeps out into the world, drying its body and wings in the sun; it soars off to sip the flowers, and fulfil the purpose of this third stage of its existence, namely—the reproduction of its species.

How different is the perfect insect from its earlier stages! The caterpillar-head and powerful horny mandibles have now become useless, and a long, delicate proboscis, with which to suck honey from the flowers, replaces them; the vigorous feet of the larva are exchanged for long, slender legs, which scarcely rest upon the petals; the minute eyes, if they still remain on the forehead, are supplemented by two large compound eyes, which stand out one on each side of the head; the tiny, stunted antennæ have become long and delicate; while from the shoulders spring two pairs of many-tinted wings, which carry it from flower to flower, and help it to escape from the many enemies to which it is exposed.

All insects, however, do not show such complete transformations as those we have been considering. In some the young maintain a constantly active condition in every stage. In others, as the Orthoptera (which includes locusts, crickets, grasshoppers, and earwigs) and the Hemiptera (bugs and plant-lice), the larval state is passed while in the egg, and the young is hatched in the exact likeness and with the habits of the parent, with perfectly-developed eyes, antennæ, jointed legs, and maxillary organs; the only difference, except size, being that the wings and their cases do not burst through the thoracic rings until after a second moult.

The larval stage is frequently aquatic. Thus, the beautiful dragon-fly passes its early life as an ignoble water-grub, living in a stagnant pond, soiled with mud and filth, gliding stealthily along the bottom, and greedily seizing worms, water-slugs, and even small fishes, for its prey. The May-flies, caddis-worms, and gnats also spend the earlier part of their existence in the water.

Many larvæ, again, pass their early stage buried in the soil, while others, as stag-beetles, goat-moths, etc., burrow in the wood of trees, or in the bodies of other caterpillars or beetles, as the young of the ichneumon flies, which live as parasites during their sluggish infancy, feeding on the fatty portion of the caterpillar, in which the eggs have been deposited by their careful parent; while the gad-fly begins its life inside a horse, the judicious mother having placed her eggs on some part of the horse's body which he is sure to lick, and so carry the young grub to its natural warm home; and the larva of the *Rhipidius* lives in the abdomen of the cockroach.

So great is the resistance of the pupal stage to vicissitudes of temperature, that in it insects have been known to be frozen into a solid mass of ice, and still retain their vitality; and in addition, many, before passing into the crysalis state, envelope themselves in a mantle of silk, which still further protects them from the assaults of wind and rain, while some, as the caddis-worms, protect their larval state by building round themselves a dwelling formed of pieces of grass or rushes, or multitudes of minute shells, or grains of sand agglutinated together by a silken thread; making use, in fact, of any materials that may be supplied to them: fragments of broken glass of various colours, or small pieces of coral being utilised by them, when confined in an aquarium, thus forming habitations most beautiful in appearance.

The time taken by these transformations varies much in different insects. Most butterflies pass through their larval stage in about three weeks, and, assuming the crysalis form in autumn, pass the winter in this safe retreat, emerging from it in the first warm days of the following spring; but the tiger-moth lays its eggs in autumn, the caterpillars are hatched the same month, but after a time retire to winter quarters, re-appearing the following spring, and then going through their subsequent stages of development. Others, as the Ephemeræ, live for nearly two years at the bottom of the pond in which they are hatched, till at last they acquire wings and exist only for a few hours.

The female Cockchafer, about the end of April, digs a hole in a well-cultivated field, in which she lays her eggs (about thirty in number). In a month, the small whitish larvæ, which feed on the rootlets of plants, are hatched; as the cold comes on, they dig deeper, and pass the winter in clusters; when spring arrives, they are larger and more ravenous, and are most destructive to plants and even trees. This subterranean life goes on for three years, at the end of which time each larva makes a sort of chamber of clay, and is transformed into a nymph or pupa, remaining torpid till the end of February, when it emerges from its case; at first, it is soft and uncoloured, and remains underground till about the end of April, when its skin has become hard and strong, and for the two short remaining months of its life it flies from tree to tree, feeding on the leaves of the oaks, beeches, and maples.

The Ant-lion—which, in its perfect stage of existence, is a four-winged insect, resembling the dragon-fly—passes the first two years of its life in the larval state, burying itself in a conical pit, which it excavates in fine, loose sand; from the bottom protrude only its formidable jaws, ready to seize any insects, especially ants, which approach too near to the margin of its pitfall and slide down its slippery walls, the sand giving way beneath their feet. When about to change into a pupa, it constructs a coccoon of sand, which it lines with a beautiful tapestry of silk. Having remained in this coccoon about three weeks, it gnaws through the envelope, and though on emerging the creature is not more than half-an-inch in length, it almost instantaneously stretches out to an inch and a quarter, while its wings, which did not exceed the sixth of an inch, expand to nearly three inches.

The Goat-moth lives three years in the larval form; while the larva of the Stag-beetle for several years burrows in the wood of the oak before assuming its perfect form, and flying about among the trees during the summer evenings; and the larvæ of the Tetramera (one of the sections of the Coleoptera) pass a long time in the pupal stage, having been known to eat their way out of wood even after it has been made into furniture.

Some species of the Ephemeræ, after emerging from the pupa, and making use of their wings even for some considerable distance, have yet to undergo another change. Fixing themselves by their claws in a vertical position on some object, they withdraw every part of the body, even the legs and wings, from a thin pellicle, which has enclosed them as a glove does the fingers.

Having passed in review through the various classes of the Invertebrata, we now come to the second grand division of the animal kingdom—the Vertebrata. It was formerly supposed that, of all the Vertebrata, the Amphibians were the only class that underwent a metamorphosis; but of late years it has been discovered that the young of some of the most lowly organised fishes are so unlike the adult that they were described as belonging to distinct genera. This is the case with the Lamprey, the young of which, until the discoveries of Auguste Müller in 1856, were described as distinct animals under the name of *Ammocætes*, and as other forms have never been observed with roe or milt, it is probable that they are the larvæ of some larger kinds of fish.

The young of the Amphibians invariably undergo metamorphosis after exclusion from the egg, though in some cases the eggs are retained so long in the parent that there is little or no obvious change. In the metamorphosis of the Batrachians we seem to have the process carried on before our eyes to its fullest extent. Not only is one specific form changed to another of the same genus, but we have a transition from one class to another. The fish becomes a frog, the aquatic animal changes to a terrestrial one, the water-breather becomes an air-breather. On its escape from the egg, the young frog presents itself as a little fish-like tadpole, with a broad head and flattened tail. From the side of the head shoot out a few filamentous tufts, which float loosely in the water, and imbibe from it the oxygen which it contains. These branchial tufts rapidly develop till they attain their maximum; they are now two on either side, each consisting of about five leaves, and in them the circulation of the blood, as seen through the microscope, is a most beautiful object. About the seventh or eighth day, these external gills fade away, and more complex branchiæ are developed in chambers situated on either side of the neck. After a few weeks, the hind limbs make their appearance; the fore-legs succeed these. In the meantime the lungs have been developed, and the gills begin to be obliterated, the circulation being gradually adapted to the altered condition of the respiration. The tail now shrinks by a process of absorption, and ultimately disappears, and the frog is complete.

A similar transformation takes place in the Newts, the only differences being that the branchial tufts are retained longer than in frogs, while the tail is not absorbed, and the fore-legs are the first to be developed.

Among the other Amphibians are some which commence life as water-breathing larvæ, but in the adult condition also possess air-breathing lungs, while with others the gills are transitory, wasting and disappearing on the development of the lungs. The curious Mexican Axolotl usually possesses only branchiæ, and passes all its life in water, but under certain circumstances there is no doubt that it may lose its gills and become less aquatic in its habits without thereby suffering any apparent change. Not long ago, at the Paris Zoological Gardens, some of these creatures crept out of their tank on to dry land, and when discovered were found to have become gill-less Salamanders, breathing only through their lungs; thus rendering it probable, as suggested by Cuvier, that these species are merely larval Salamanders, whose development is arrested in their progress to the adult form.

With the Amphibians the process of extra-uterine metamorphosis in the animal kingdom ends, and it now only remains, in conclusion, to see what is the object of the various changes we have been considering, and what deductions may be drawn from the study of them. In a general way, it may be stated that metamorphosis gives its possessor an advantage in "the struggle for existence," or assists it in carrying out the fiat of the Creator, "to be fruitful and multiply." In some cases it seems to be a provision for the distribution of species. Thus, many of the lower animals which in adult life are rooted to one spot—as the Hydra, Sponges, and Corals—or whose powers of movement are very limited—as the Echinodermata, Mollusca, etc.—by means of their free-swimming embryos, are enabled, either by their own locomotive powers or by the action of waves and currents, to be carried to a distance from their birthplace, and so to be disseminated over the surface of the globe, and to prevent the spots inhabited by their respective species from being overcrowded by the accumulation of their progeny. In others, as the Anoda or Fresh-water Mussels, the same object is attained by the larval forms being provided with prehensile organs, by which they can attach themselves, as parasites, to the gills and fins of fishes, and in like manner be carried away from the abode of their parents; these organs being lost on their attaining adult life.

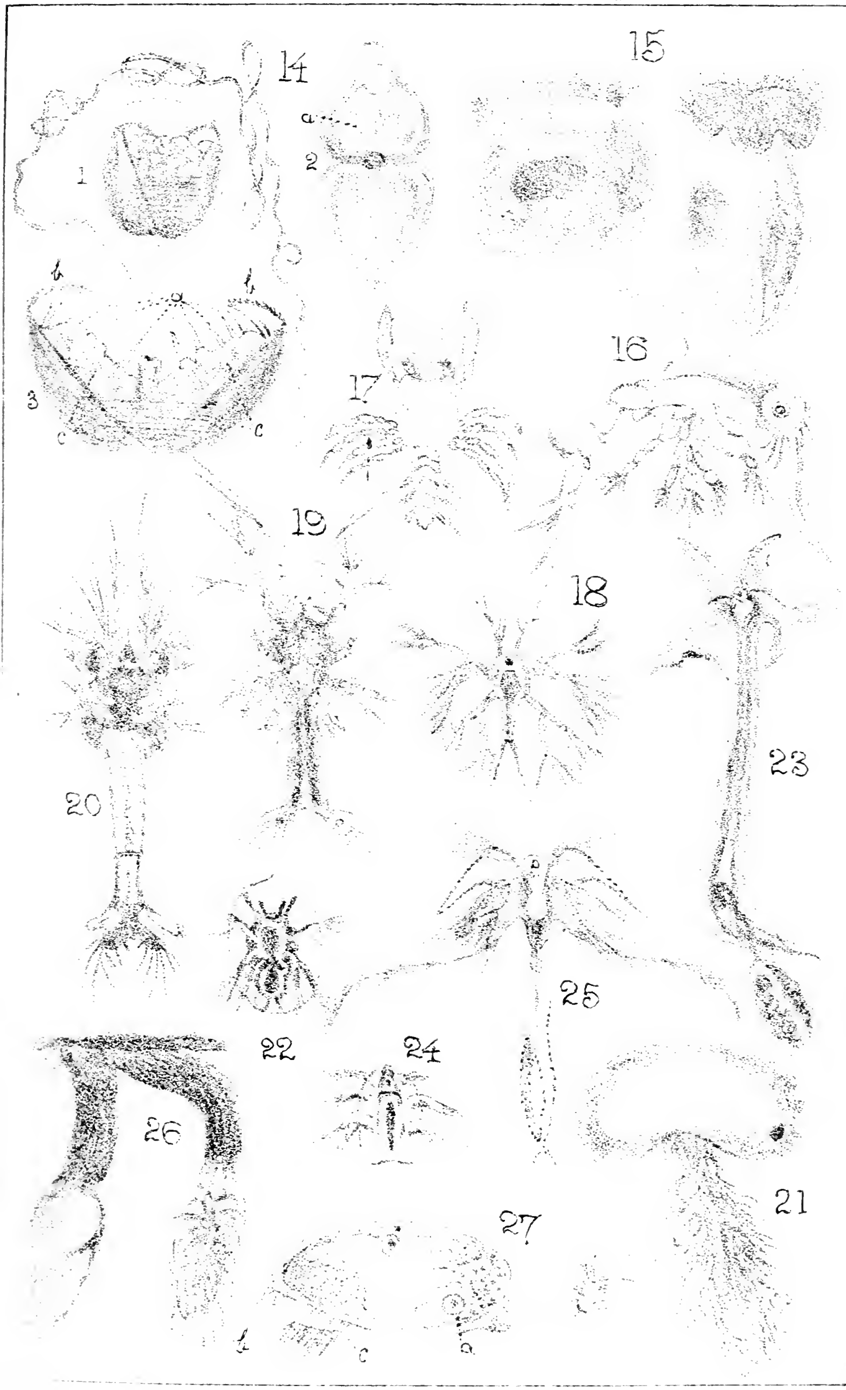
Protection from various dangers to which the young are exposed is another reason for metamorphosis, the form, shape, and colour of the defenceless larvæ being often adapted to the food on which they subsist, so as to be better able to escape the observation of their various enemies; while the pupal stage enables those which are unable to stand sudden changes of weather and temperature to pass some part of their existence in a condition of almost suppressed vitality, in which they are capable of resisting a degree of cold or wet which would be fatal to the adult form, and would speedily prevent the continuance of their life upon the earth; the hard and horny case of others prevents their being a tempting morsel to the birds, which would otherwise prey upon them. How small would be the chance of the survival of butterflies, moths, frogs, etc., if they emerged from their minute eggs simply as tiny representatives of their parents! How little would they be able to resist a sudden storm of biting east wind, or even the downfall of a passing thunder-shower!

Coupled with the study of embryology, the facts of metamorphosis have thrown great light on the theory of evolution; helping to make the study of natural history, which was formerly little more than a dry catalogue of facts, "at once a speaking history of the past and a prophetic index of the future." Haeckel, Spencer, Darwin, and others, have shown us that every animal has been moulded through a wonderful series of metamorphoses into its present shape by surrounding conditions, and that each bears in its parts, or form, the traces, where we can read them, of its development or evolution. The study of embryology is difficult, needing large opportunities and great skill in microscopical manipulation, but by the study of metamorphosis many of these changes are visible to the unaided eye of the ordinary observer.

Where a definite larval form—as the Nauplius of the Crustacea, or the caterpillar of the Insecta—is common to many members of a sub-kingdom, it seems highly probable that it is the re-capitulative representative of an ancestral form common to all this set of animals, which, if not exactly like a Nauplius or a caterpillar, was not very different from it.

The permanent condition of the lower members of any division of the animal kingdom is often represented by the transitory stages of the higher members of the same division. The development of the frog is a good illustration of this general zoological law. The early condition of the young tadpole when the branchiæ are external is represented permanently by the adult Proteus or Siren, and the second stage when the gills have disappeared and the limbs have been developed, but the tail has not been wholly absorbed, finds its representative in the newt. Hence we are justified in concluding that the tadpole is a re-capitulative phase of development, and represents more or less closely an ancestor of the frog, which was provided with gills and tail in the adult state, and possessed neither legs nor lungs. In other words, we may infer that, as the adult frog develops from the *gilled* tadpole through the intermediate *tailed* stage, so, as a class, the frog-like, tail-less batrachia developed at a later period out of the *tailed* batrachia, as the latter had developed out of the *gilled* batrachia, which originally existed alone.

Again. Metamorphosis has shown that evolution has not always proceeded towards a gradual development to a greater complexity of form and structure, but that in some instances it



Animal

has proceeded in a retrograde direction, tending rather to a process of degeneration than to one of advance. This has been ably brought to notice by Dr. Dohrn, of Naples, and by Prof. Ray Lankester. We have thus been enabled to determine the affinities of several creatures which we should not otherwise have dreamt of if we had only studied the adult animals. Nothing at first sight could be more unlike than a shrimp and a barnacle, or a lively, free-swimming Entomostracon and a parasitic Lernæocera or Sacculina ; but the fact that all, in their early stages, pass through the active Nauplius form shows that they are all equally Crustaceans, some of which have proceeded to a more advanced development, while others (especially those which have taken on a parasitic condition) have lost their organs of sense and motion, and retrograded in the scale of existence.

Finally, metamorphosis has been the means of introducing us to a far-away series of our ancestors in the remote past, going back far beyond primæval man and the anthropoid apes. The discovery of Kalewsky, that the tadpole-like larva of the Ascidians, or sea-squirts, possesses in its caudal appendage a cartilaginous axial rod which is homologous with the primitive backbone or notochord, has led certain observers to conclude that the Ascidian mollusc is not only the original ancestor of all the Vertebrata, but even of man himself. Haekel goes still further back, and concludes that "in the gastrula is now found the common ancestral group from which all tribes of animals can, without difficulty, be derived. It is one of the most ancient and important ancestors of the human race."

EXPLANATION OF PLATE XVII.

Fig. 14.—Development of Mussel :—
1. *Glochidium*, Larva still within the Egg.
2. Shell of *Glochidium*, widely opened.
3. *Glochidium*, viewed from the side, showing hooks *b. b.*

,, 15.—Very young Oysters.

,, 16.—Zoæa of Crab, more magnified than Fig. 17.

,, 17.—Early stage of Crab, with tail.

Fig. 18.—Nauplius, larval-form of *Peneus*.
,, 19, 20.—More advanced forms of same.
,, 21.—Adult *Sacculina* (Female).
,, 22.—Nauplius *Sacculina*.
,, 23.—Adult Female *Lernæocera*.
,, 24.—Nauplius of *Lernæocera*.
,, 25.—Nauplius of *Lepas*, or Barnacle.
,, 26.—Adult Barnacle (natural size).
,, 27.—Locomotive "pupa" of *Balanus*: *a.*, Eye; *b.*, Caudal bristles; *c.*, Setegerous limbs.

[Erratum.—p. 88, line 16, for "primula" read "planula."]

The Microscope and how to use it.

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Part III.—On Mounting Microscopic Objects—*continued.*

Staining Wood Sections.

After the sections have been bleached and thoroughly washed by the methods just described, we may proceed to stain them. This may be done by the use of carmine or logwood; after which, the sections may be mounted in balsam by the ordinary process. Better effects are, however, produced if we employ the *double* staining method, for the carrying out of which various kinds and combinations of dyes have been used and recommended. It is needless to enumerate the whole of these here. The agents used are carmine and aniline green, and to carry out the method, solutions of these will be required. The solution of carmine (Beale's) is made by rubbing up in a mortar: carmine (the finest), 15 grains (or about 1 gramme), with a few drops of distilled water; then adding ½ drachm of strong *liquor* *ammoniæ* and sufficient distilled water to make 8 drachms of solution. The fluid must now be exposed to the air for two days to get rid of superfluous ammonia, when 7 drachms of distilled water are to be added to it. Many recommend the carmine solution to be made with borax instead of ammonia. It is not in our opinion nearly so good as that mentioned above, as it not unfrequently spots the stained sections with an apparently crystalline deposit, which utterly ruins them. This never occurs when ammonia carmine is employed; that is, if the solution used be fresh. To prepare the green dye, take 3 grains of aniline green, and by means of heat dissolve it in 2 drachms of distilled water; then filter this solution into 6 drachms of absolute alcohol. If wood sections, without any previous preparation, were to be stained with these agents, we should find that when, in order to mount them in balsam, the sections being passed through alcohol in the usual manner, a great part, or the whole of the colour due to the action of the aniline green would be discharged by the alcohol. In order, therefore, to render the staining permanent, it is advisable to use some kind of mordant to fix the aniline stain, and for this purpose we have found tannic acid extremely useful. It is employed in the form of solution made by dissolving 1 drachm of the acid in 2 ounces of methylated spirit, and then filtering the product.

The sections to be stained, having been bleached and washed in the manner already described, must, after a short preliminary soaking in alcohol, be placed in the tannic fluid for about one minute, and thence transferred to the green dye for three minutes, upon the expiration of which time they are to be rapidly washed in distilled water, and immediately passed into the carmine fluid, there to remain for from three to four minutes, then rinsed in dilute acetic acid (5 drops of glacial acetic acid to 1 ounce of distilled water), again rapidly washed in distilled water, and finally transferred to clean methylated spirit. Let them remain in this for five minutes, pour off the alcohol, and replace by fresh spirit; allow the sections to remain in this another five minutes, and afterwards transfer to oil of cajuput. In ten minutes pour off the oil of cajuput, and replace by turpentine, in which they should be allowed to soak for five minutes, when the sections are ready for mounting in balsam. It must be noted that the times given above are only approximations, and will not hold good for all cases, since the time required for the action of the stain is materially modified by the thickness of the section, and by its physical structure, and very possibly also by its chemical constitution. It will be found in practice, that, for the general run of wood sections, very little variation from the times indicated will be required. When an alteration in this direction is necessary, it will be within very narrow limits, and to carry it out successfully will not tax either the ingenuity or the patience of the experimenter very severely. Wood sections stained by this method make beautiful preparations. Not only are certain portions of the section dyed green and crimson respectively, but other portions acquire various intermediate tints, so that certain sections of much diversity and complexity of structure, when stained by this method, rival in splendour some of the diatoms. We will give a few examples of pretty botanical sections :—

Coffee Berry.—The *unroasted* berry should be soaked for some hours in cold water until sufficiently soft (seeds should not be allowed to remain too long in water, especially in warm weather, otherwise they will begin to germinate, in which case their internal structure becomes entirely changed), then imbedded in paraffin and cut in the microtome, the section being made in the direction of the *long* axis of the berry. Only a few perfect sections can be obtained from each berry, for at the *hilum* the seed-covering turns in and penetrates the substance of the berry to such a depth, that before many sections have been made, the reflected covering will be cut down upon ; when this has been reached, a circular ribbon representing the covering will—unless in exceptional cases—fall from the centre of the section and mar its beauty. Sections of the berry may be mounted in glycerine, or if stained rather strongly with carmine, mounted in Canada balsam and benzole ; the same method of treatment applies to all other hard berries or seeds.

Chicory.—After the student has got his slide of coffee he will do well to prepare a longitudinal section of unroasted chicory-root for comparison. He will observe the striking difference between the two substances, and see how easy it is to distinguish one from the other. Thus, whilst in *coffee* the cells are small and more or less angular, *chicory-cells* present a round or oval outline; the presence of *dotted ducts* will also be detected, which are entirely absent from coffee. To make the comparison complete, a coffee berry should be soaked in water until the skin, or seed coat, becomes loosened. A portion of this is then, with the point of a knife, to be removed to a slide and examined in glycerine, when it will be found to consist of a hyaline membrane in which are imbedded small, rod-like bodies of elliptical shape, and having their long axes running in the same direction. These rods cannot be mistaken for any of the ducts met with in chicory.

Orange Peel, common object though it be, is not to be despised by the microscopist. Transverse sections must be prepared by the gum method. These sections are not to be subjected to the action of alcohol; but after drying between glass slips, soak them in turpentine and mount in balsam. We shall then have a good view of the large globular glands whose office it is to secrete the essential oil, upon which the odour of the orange depends. Sections may also be bleached, and stained with carmine and aniline green as before mentioned.

Potato.—From the large amount of water which it contains thin sections cannot be cut from the potato in its natural state. It must, therefore, be partially desiccated, either by immersion in methylated spirit for a few days, or by exposure to the air. Sections may be readily obtained by imbedding and cutting in paraffin. Such sections, mounted in balsam, are very beautiful, the starch being seen *in situ*, whilst if polarised light be employed, each granule gives its characteristic black cross.

Rush is to be prepared and cut as orange peel. Transverse sections of this plant furnish slides of most exquisite beauty.

Sponge may readily be cut after being tightly compressed between two pieces of cork, or its interstices may previously be filled up by immersion in melted paraffin or mucilage, and sections cut in the usual manner.

Vegetable Ivory, after prolonged soaking in cold water, may readily be cut in the microtome. The sections should be mounted unstained in balsam, and though not usually regarded as polariscopic objects, nevertheless, when examined with the selenite, yield very fine colours.

Wood.—Shavings of extreme thinness may be cut from large pieces or blocks of timber by means of a very sharp plane. In this way excellent sections may be procured of most of the common woods, as oak, mahogany, pine, etc. Where, however, the material to be operated upon takes the form of stems, roots, etc., of no great thickness, they should, after having been reduced to suitable consistence, be imbedded in paraffin and cut in the microtome. Before imbedding, it must not be forgotten to immerse the wood to be cut in weak gum-water, this precaution being of great importance, especially in the case of stems, etc., of which the bark is at all rough and sinuous. If the sections are to be mounted unstained, they are usually put up in weak spirit (mixture of spirits of wine 1 part, distilled water 3 parts). For mounting, proceed as follows :—A ring of gold-size must, by means of the turn-table, be drawn in the centre of the slide, and put away in a warm place for several days (the longer the better), in order that the ring may become perfectly dry and hard. The section, with a drop or two of the mixture, is to be put in the centre of the ring, and a cover-glass of requisite size having been cleaned, this must have a thin ring of gold-size applied round its margin. The cover is now placed in position, and gently pressed down, the pressure apparatus being employed, if necessary, to prevent it from moving. In about twenty-four hours another layer of the varnish should be applied, and the slide afterwards finished in the manner already described. A very general method also of dealing with this class of objects is to mount them dry. This plan cannot, however, be recommended, as the sections always present a disagreeable black or blurred appearance. To avoid this, we may have recourse to Canada balsam, but the ordinary method of employing it must be slightly modified, a drop of chloroform being substituted for the clove oil, otherwise this latter agent would cause the section to become so transparent as to render minute details of structure difficult to recognise.

A good **blue** stain (tending to purple) is also given by the substance termed indigo carmine; it is particularly good for sections of brain and spinal cord that have been hardened in chromic acid. A saturated solution of the powder in distilled water having been prepared, this may either be used with the addition of about 4 per cent. of oxalic acid, or if an alcoholic fluid be preferred, methylated spirit may be added to the aqueous solution; the mixture being filtered to remove any colouring matter that may have been precipitated. If sections thus stained have an excess of colour, it may be removed by the action of a saturated solution of oxalic acid in alcohol.

A beautiful **green** hue is given by treating with a saturated solution of picric acid in water, sections previously stained with aniline blue; or the two agents may be used together, four or five parts of a saturated solution of the latter being added to a saturated aqueous solution of the former. This picro-aniline, it is believed, may be relied on for permanence; and it acts well in double staining with picro-carmine.

Double Staining.—A good example is seen in double staining the frond of a fern with logwood and aniline blue; the *sori* taking the latter, and standing out brilliantly on the general surface tinged by the former. If a section of stem be stained throughout by a solution of eosin (2 grains to the ounce), and be then placed, after washing in strong alcohol, in a ½ grain solution of Nicholson's blue made neutral, the blue will, in a short time, entirely drive out the red; but by carefully watching the process, it will be seen that the different tissues will change colour at different times, softer cells giving up their red and taking in the blue more quickly than the harder; so that, by stopping the process at the right point (which must be determined by taking out a section and dipping it in alcohol, and examining it under the microscope), the two kinds of cells are beautifully differentiated by their colouring. The best effects are usually produced by carmine and indigo-carmine, logwood and picro-carmine, carmine or logwood and aniline blue or green.

Osmic Acid.—Various degrees of dilution of a 1 per cent. solution. This agent is very serviceable in the preparation of delicate vegetable structures. The acid seems to be taken up by each granule of the protoplasm, and there to be decomposed, giving to the granule the characteristic grey colour, thus at the same time both hardening and staining. (Parker—*Journal, R.M.S., Vol. 7, p. 381.*) We use the following mixture :—9 parts of a ¼ per cent. solution of chromic acid, with 1 part of a 1 per cent. solution of osmic acid, which answers for many purposes better than osmic acid alone, the brittleness produced by osmic acid being completely avoided. After being subjected to this agent, the specimens should be treated with 30 per cent. alcohol, gradually increased in strength to absolute.

Molybdate of Ammonia is recommended as affording a cool blue-grey or neutral tint general stain, which affords a pleasant ground colour to parts strongly coloured by bright *selective stains.*

Chemical Testing.—The following short list will be found useful :—

(*a*) Solution of iodine in water. Take iodine, 1 grain ; iodide of potassium, 3 grains ; distilled water, 1 ounce. This solution turns starch blue, cellulose brown ; also gives an intense brown colour to albuminous substances.

(*b*) Dilute sulphuric acid (1 part of acid to 2 or 3 parts of water) gives cellulose that has been already dyed with iodine a blue or purple hue ; also when mixed with sugar, it gives to nitrogenous substances a rose-red hue, more or less deep.—(Pettenkofer's test).

(*c*) Schultze's test is a solution of choride of zinc, iodine, and iodide of potassium ; it detects cellulose.

(*d*) Concentrated nitric acid gives albuminous substances an intense brown.

(*e*) Acid nitrate of Mercury (Millow's test) colours albuminous substances red.

(*f*) Acetic acid, both concentrated and diluted with from 3 to 5 parts of water, is useful to the animal histologist.

(*g*) Solution of *caustic potash or soda* (the latter generally preferable) has a remarkable solvent effect upon many organic substances, both animal and vegetable.

Aqueous Media.—Fresh specimens of minute protophytes can often be very well preserved in—

(*a*) Distilled water saturated with camphor. When the preservation of colour is not a special object, about a 1–10th part of alcohol may be added.

(*b*) Salycylic acid. Small proportion that will dissolve in cold water is very successful. For coarser structures a stronger solution is preferable; and this may be made by combining with the acid a small quantity either of borax dissolved in glycerine or of acetate of potash.

(*c*) A mixture of 1 part of glycerine and 2 parts of camphor-water may be used for the preservation of many vegetable structures.

(*d*) For preserving soft and delicate marine animals which would be shrivelled up or curled by stronger agents, a mixture of 1 part of glycerine and 1 of spirit, with 8 or 10 parts of sea-water, is the most suitable preservative.

(*e*) For preserving minute vegetable preparations, the method devised by Hantsch is said to be peculiarly efficient.*

To Clean Glass Slides and Covers.—First wash well in a solution of soda or potash; if this does not suffice, use the following:—Bichromate of potash, 2 ounces; sulphuric acid, 3 fluid ounces; water, 25 ounces; and afterwards thoroughly rinse in warm and cold water.

Dammar Cement.—Dissolve gum dammar in benzole, and add one-third of gold-size; it dries very quickly, and is preferably used as a first coat for affixing the cover-glass when glycerine is used for mounting.

Gum, for attaching labels, covering papers, and objects mounted dry (as parts of insects, foraminifera, etc.). Dissolve 2 ounces of gum arabic in 2 ounces of water, and add 2 drachms of soaked gelatine (for the solution of which the action of heat is required), 30 drops of glycerine, and a lump of camphor.

Fluid for the Cultivation of Microscopic Fungi, sufficiently hygrometric to keep the spores moist, adapted to fungoid growth—Dextrine, 2 grains; phosphate of soda and ammonia, 2 grains;

* This formula was given on p. 30.

saturate solution of acetate of potash, 12 drops; grape sugar, 16 grains; freshly distilled water, 1 ounce (Dr. Maddox). The whole is to be boiled in a large test-tube or beaker for fifteen minutes, and covered, whilst boiling and cooling; when settled, it should be poured into perfectly clean 2-drachm stoppered bottles and kept for use. In using Maddox's growing slide, the fungi or spores are placed, with a droplet of the fluid required, on a glass cover large enough to cover the tinfoil cell. This, after examination to see that no extraneous matter is introduced, is placed over the tinfoil, and the edges fastened with wax softened in oil, leaving free spaces for entrance of air. *Cohn's fluid* is also good for protophytic fungi (Schizomycetes, consisting of Bacteria, Vibriones, etc.). The solution is composed of 1 part of potassium phosphate, 1 part of magnesium sulphate, 2 parts of ammonium tartrate, and 0·1 part of calcium chloride; dissolved in 200 parts of distilled water.

Carmine Fluid (Beale). See page 186. Staining vegetable tissues and germinal matter:—carmine, 10 grains; strong liquor ammoniæ, $\frac{1}{2}$ drachm; Price's glycerine, 2 ounces; distilled water, 2 ounces; alcohol, 4 drachms. Put the carmine in small fragments in a test-tube and add the ammonia. By agitation, and the heat of a spirit-lamp, the carmine is soon dissolved. The ammoniacal solution is to be boiled for a fewseconds, then allowed to cool. After the lapse of an hour, much of the excess of ammonia will have escaped. The glycerine, water, and alcohol may then be added, the whole passed through a filter or allowed to stand for some time, and the perfectly clear supernatant fluid poured off and kept for use. This solution will keep for months, but sometimes a little carmine is deposited, owing to the escape of ammonia, in which case one or two drops of liquor ammoniæ may be added to the four ounces of carmine solution.

Solution of Osmic Acid.—Osmic acid, 1 part; distilled water, 100 parts; is the strength generally used for staining, although, of course, circumstances will alter this. Fat-cells and oil-globules are coloured by it.

Schultze's Test.—Wash the substance which is to be examined in water, pour off the water, and then moisten it with a drop of syrup; add 1 drop of sulphuric acid. The reaction produces a purplish-red colour, if the substance contains either muscular tissue, corpuscles of blood, pus and mucus, epidermic and epithelial scales, hairs, feathers, horn, whalebone, cellular parts of algæ, etc. The reaction is *not* produced in areolar, elastic tissue, gelatine and chondrine, chitine, silk, cellulose, gum, starch, or vegetable mucus. This is used as a test for cellulose, which it colours blue. Dissolve zinc in hydrochloric acid, evaporate the solution with excess of zinc until it acquires the consistence of syrup, and dissolve in this enough iodide of potassium to saturate it; iodine is then added, and the solution diluted with water if necessary. This reagent has the consistence of strong sulphuric acid, and is of a pale yellowish brown. It must, of course, be kept in a stoppered bottle.

Carbolic Acid Preservative, for animal and vegetable tissues. Carbolic acid, 1 drachm; alcohol, 2 drachms; distilled water, 12 ounces; dissolve the carbolic acid with the alcohol, then add it to the water and boil for ten minutes, and bottle for use.

Acetate of Aluminium.—To 1 part of acetate of aluminium, add 4 parts of distilled water. This is very good for preserving vegetable colours, as in the case of desmids and other algæ.

Glycerine and Acetic Acid is useful for mounting many minute insects and other objects; it is composed of glycerine, 1 ounce; acetic acid, ½ ounce.

Siliceous Cement, for protecting corks from the fumes of acid, etc. Mix together equal parts of colloid silica and thick gum-water, with sufficient gilder's whiting to make it of the consistency of treacle.

Ralph's Liquid.—Bay salt, 1 grain; alum, 1 grain; distilled water, 1 ounce; dissolve and mix. This makes a good preservative for many algæ, etc.

Spirit of Nitrous Ether (Sweet spirits of nitre) is much used for delicate dissections of insects, and is made by a mixture of sweet spirits of nitre and glycerine, in equal parts.

For Labelling Slides.—A good plan is to punch some squares or circles out of very thin talc; cover the end of the glass slip with a thin layer of gilder's whiting and gum-water; when dry, write on this with common ink, let it dry, put a very small drop of Canada balsam upon it; cover with a circle of thin talc, and allow all to dry; then clean the edges with benzole and water mixed. It will not peel off or get dirty like printed labels.

On Diatoms in the Stomachs of Shell-Fish and Crustacea.

By E. S. Courroux.

THE text-books on the mounting of objects frequently observe that diatoms are to be found in the stomachs of fish, particularly shell-fish, but seldom contain any statements as to the practical results of such findings. A few remarks, therefore, on the subject, by one who has made an attempt at investigation in this direction, may not be out of place.

The only fish to which I have had recourse at present are shrimps, mussels, and cockles. From shrimps I have obtained most plenteous gatherings, as also at times from mussels. Cockles have given a moderate supply. The quantity yielded is, however, a matter of chance, and sometimes scarcely any diatoms will be found; but more often than not, the result will fully repay the operator for his trouble.

In the case of mussels and cockles, and shell-fish of that description, the stomach should be cut out and steeped, or even boiled, in nitric acid until it is dissolved, and the resultant deposit washed and cleaned after one of the methods recommended in the text-books. A little special care, however, in the treatment of shrimps' stomachs will not be thrown away. On removing the shelly skin at the back of the head, the stomach will be seen as a small, dark-coloured body, the size of a small pea. Its position may generally be detected in the perfect shrimp from the dark appearance at the back of the head. The stomachs may be detached with the point of a knife, and when some 12 or 20 or more (as the deposit obtained from them is small) have been collected, they should (taking care that the skin of each stomach is cut or broken) be boiled for a few seconds in a weak solution of washing-soda or ammonia, and then immediately be thrown into a beaker of cold water. By these means we get rid of grease, etc., and render the subsequent treatment by acids more easy. The empty skins of the stomachs will float and may be picked out of the solution.

The residue which collects after the solution has stood for some time should first be washed free from alkali, and then treated with acids in the usual manner. It is unnecessary to enter into the details of the cleansing of the deposits, as a reference to Mr. Griffin's articles in this Journal,* or some of the many books on the subject, will supply all requisite information.

With regard to the specimens to be met with in these operations, I may remark that in a gathering from the stomachs of shrimps caught off Flushing, in March, 1884, I have obtained large specimens of *Eupodiscus argus*, *Coscinodiscus*, *Actinoptychus undulatus*, *Actinocyclus Ralfsii* and others, *Triceratium*, *Biddulphia rhombus*, and in larger numbers than any of these a beautiful circular form, with several rays, of which I have been unable to find the name; possibly, it is a species of *Actinoptychus*. Amongst the small forms, I have found the beautiful *Doryphora amphiceros* in great profusion. This last form I have met with more frequently in the stomachs of shrimps than elsewhere.

The method of separating deposits into different densities is very useful here as with many other gatherings of diatoms, inasmuch as the large forms are then more easily isolated. The often-advised whirling in a large evaporating dish in order to separate the diatoms from sand and *débris* may be frequently practised with success. In the washings of all diatoms I have found it of the utmost advantage to perform the later rinsings in distilled water. The diatoms are thus more effectually cleaned from salt, etc., and present less attraction to moisture in the case of dry mounts.

* See this Journal, Vol. III. p. 229.

The operator may be reminded that the material, even from a considerable number of stomachs, is of course very small in quantity, and must be handled carefully; and as the most beautiful forms are often the lightest, it is of the utmost importance to let the deposit settle thoroughly in the washings of the lighter portions of the gatherings. The water holding the diatoms in suspension should be allowed to stand at least half-an-hour for every inch of its depth, and hence time will be saved by using watch-glasses and shallow dishes for the purpose.

A great deal more might be said on the subject of cleaning the diatoms, but it would be a mere repetition of what is found in the authorities on mounting, and it is only experience gained by long practice which will enable the operator successfully to clean mixed gatherings. But, finally, I would advise all enthusiasts on the subject, whether with much or little experience, if they have not tried the sources above mentioned (particularly the stomachs of shrimps), to do so without fail.

Structure of Diatoms.

From the "Journal of the Royal Microscopical Society," Vol. V., p. 286.

DR. G. C. Wallich, writing to the *English Mechanic*, Vol. xl., p. 496, refers to Flögel's view,* that in such genera as *Triceratium* and *Coscinodiscus*, the little hexagonal or cylindrical cavities, though completely closed by a siliceous film on the internal surface of the valve, are not closed by any such membrane on the outer surface of the valve; and to Cox's, who insists† that the cellules are closed by a siliceous film externally as well as internally.

Dr. Wallich considers the objections to the latter view insuper-

* Journal of R.M.S., Vol. IV., p. 665.

† Ibid, p. 941.

able. If the cellules are closed at both their extremities during the life of the organism, each cellule must be full either of protoplasm or of some other more or less fluid substance, unless, indeed, each contains a gas, or constitutes a perfect vacuum, which is scarcely within the bounds of possibility. If each contains protoplasm, it is obvious that the remains of this, during the mounting of the specimen, would be recognisable amongst the larger species, either by optical or chemical tests. During the boiling in acid, or burning on mica, the fluid contents would burst the films, and in many cases leave behind the evidence of their former condition. In his experience, such evidence has never been forthcoming, and judging from what is known of cellular structure in organic life generally, there are no examples of truly vacuous cavities, inasmuch as all organic tissues are pervious to dialytic or osmotic action.

It is no doubt true that the organic silica of the diatom, perfectly hyaline as it looks, is in reality a "colloid," and hence, as it contains an infinitesimal percentage of water, just as flint itself does, dialytic action may take place through the film under notice. But even then the perviousness to moisture of the diatom, if it really keeps the chamberlets full of fluid during the vitality of the organism, would not suffice to settle the question; for, if any fluid whatever remained in the cellules, should the specimens have been but recently taken from their element, it would burst the film on the application of heat, and inevitably burst the walls, whilst traces of the disruption would occasionally be visible under the microscope. Again, if the chamberlets contained gas of any kind, and in spite of the effects of the boiling in acids, this gas were too minute in quantity to burst the walls, we should certainly be able to detect gas-bubbles in some of the chamberlets. But, as is well known, the bubbles so common in mounted specimens are not due to the cellules having originally contained gaseous material, but to the accidental admission of air during mounting.

The only remaining alternative is that the cellules cannot be considered closed cavities, and hence that the alleged presence of an external investing and closing film is illusory.

Reviews.

Scientific Papers and Addresses. By George Rolleston, M.D., F.R.S., arranged and edited by William Turner, M.B., Hon. LL.D., F.R.S., with a Memorial Sketch by Edward B. Tylor, Hon. D.C.L., F.R.S., with portrait and plates; 2 Vols., pp. LXXVI.—944. (Oxford: The Clarendon Press, 1884.)

These two valuable volumes contain a selection of the most important Essays contributed by the late Professor Rolleston to the Transactions of various learned Societies and to Scientific Journals. Along with them are also reprinted several Addresses delivered before the British Association for the Advancement of Science, and other learned bodies.

These reprints have been arranged in the following sections:—I.—Anatomy and Physiology, in which are included many important Anthropological memoirs. II.—Zoology, including his Memoirs on Archæo-zoology. III.—Archæology. IV.—Addresses and Miscellaneous Papers.

In an Appendix to the Second Volume is a digest of many of the unpublished MSS. left by Dr. Rolleston; these will be found of much interest to the Archæologist. As a frontispiece we have a fine Portrait of the Author, and the work is further illustrated with many excellent lithographic plates and wood engravings.

Original Researches in Mineralogy and Chemistry. By J. Lawrence Smith. Printed for presentation only. Edited by J. B. Marvin, B.S., M.D.; pp. XL.—630. (Louisville, Ky., U.S.A., 1884.)

Our best thanks are due to Mrs. J. Lawrence Smith for the volume before us, which contains all the more important contributions to Science of the late Professor. The articles are arranged chronologically, except in a few cases; where two or more have been written on the same or kindred subject, they are then grouped together. The volume represents strictly original investigations, and treats of a very large number of subjects, amongst which we find the description of an Inverted Microscope, invented by the author in 1850. The papers on Meteorology are voluminous, in connection with which we have a catalogue of 292 meteoric stones and irons which were in the possession of the author until a few days of his death, when they were purchased by the Havard University.

Plant Analysis: Qualitative and Quantitative. By G. Dragendorff, Ph.D. Translated from the German by Henry G. Greenish, F.I.C.; pp. XVI.—280. (London: Baillière, Tindall, and Cox, 1884.)

The Author and Translator may both be congratulated on the production of this standard work on Plant Analysis in English. Although undoubtedly more exact, and perhaps in some cases less complicated methods of Analysis *may* be discovered in time, this work stands at present unrivalled, as giving the best analytical methods for the detection and estimation of the proximate constituents of plants. Copious foot-notes are given, referring the reader to original articles on various processes which have appeared in different scientific journals, thereby much enhancing the value of the work. A few illustrations of special apparatus are interspersed throughout the text.

THE MEDICAL ANNUAL and Practitioner's Index. A Yearly Record of useful information on subjects relating to the medical profession; pp. 16a—371. (London: Henry Kimpton, 1885.)

We find the second year's issue of this useful little annual much enlarged and otherwise improved. The volume commences with a paper by Dr. J. E. Taylor, Editor of "Science Gossip," entitled, "A Review of Popular and General Science." We believe the chapters on Health Resorts have been in a great measure re-written; several new features are added to the book.

WORLD-LIFE, OR COMPARATIVE GEOLOGY. By Alexander Winchell, LL.D.; pp. XXIV., 642. (Chicago, U.S.A.: S. C. Griggs and Co., 1883.)

The learned Professor in this exceedingly interesting book gives us a thoughtful view of the processes of world-formation, world-growth, and world-decadence. He has gathered together many of the important facts observed in the constitution and course of nature, and has endeavoured to weave them into a system by the connecting threads of scientific inference.

SPARKS FROM A GEOLOGIST'S HAMMER. By Alexander Winchell, LL.D. Second Edition; pp. 400. (Chicago: S. G. Griggs & Co.)

This perhaps is a more popular work by the same author; it consists of descriptions, essays, and discussions of subjects suited to occupy the attention of the Geologist. The subjects range from the descriptive and literary, to scientific, historic, and philosophic. Thus we have the Æsthetic, where the reader is conducted on an interesting excursion to Mont Blanc; the Chronological, in which is discussed the age of Continents, Obliterated Continents, and a grasp of Geologic Time; the Climatic, the Historic, and the Philosophic. Readers will be charmed with this book.

GEOGONY: Creation of the Continents by the Ocean Currents, an advanced system of Physical Geology and Geography. By J. Stanley Grimes; pp. 116. (Philadelphia, U.S.A.: J. B. Lippencott and Co., 1885.)

The Author argues that "All the elevations of the earth's crust have resulted from the sinking of the ocean basins, or of smaller local basins, beneath the weight of the sediment. And that when the ocean covered the globe there were three pairs of elliptical currents, which collected sediment on the ocean's floor, the weight of which produced three pairs of sinking basins, viz.—the North and South Atlantic, the Pacific, and the Indian Ocean basins.

PARADISE FOUND. The Cradle of the Human Race at the North Pole; a Study of the Pre-Historic World. By William F. Warren, S.T.D., LL.D., President of the Boston (U.S.A.) University; pp. XXIV.—505, with original illustrations. (Boston: Houghton, Mifflen, and Co., 1885.)

To many of our readers it will appear a startling assertion that the Cradle of the Human Race was situated at the North Pole. Dr. Warren assures us, however, that such is the fact, and in the book before us he gives us the arguments by which his theory of Polar origin is very carefully worked out. The work is divided into six parts. In the first we have a survey of the present state of the question, giving the results of explorers, both historic and legendary, followed in Part II. by his own hypothesis. In Part III. this is scientifically tested in its bearings on Geogony, Geography, Geology, Climatology, Palæontology, Botany, Zoology, Anthropology, &c.; in Parts IV. and V. a confirmation of the hypothesis by ethnic tradition; and, finally, in Part VI., we have the significance of these results.

The book is a serious and sincere attempt to present what to the Author's mind is the true and final solution of one of the greatest and most fascinating of all the problems connected with the history of mankind, and as such deserves careful reading; and whilst exhibiting much deep research, it is written in a pleasant and readable style.

Dissertations on the Philosophy of the Creation, and the first Ten Chapters of Genesis Allegorised in Mythology. Containing Expositions of the Ancient Cosmogonies and Theogonies, the Invention of Hieroglyphics, and of the Ancient Hebrew Language and Alphabet. By William Galloway, M.A., Ph.D., M.D.; pp. XVI.—663. (Edinburgh: James Gemmell; London: Hamilton, Adams, and Co., 1885.)

The Author of this interesting work gives us the result of a profound study of Mythology, considered in the first place from an enquiry into the origin of writing, Alphabetic and Hieroglyphic; and next its place is assigned in the Phœnician, Romo-Pelasgian, and Greek Theogonies. An instructive comparison of the Celtic, Semetic, and Runic alphabets are given in two plates.

Scientific Theology. Essays toward the development of Religious Truth on the basis of Modern Science. By Thomas Walter Barber; pp. X.—190. (London: Elliot Stock, 1884.)

The writer of the book before us is evidently well acquainted with modern scientific discoveries and theories; he quite rejects the idea that Science can serve us instead of religion, but believes that Science must to all intents and purposes become conjoined with religion, and work hand in hand with it; an event which we believe all earnest men devoutly hope for.

The Elements of Natural Philosophy. By Sidney A. Norton, A.M. Three hundred and fifty illustrations; pp. 468. (Cincinnati, U.S.A.: Van Antwerp, Bragg, and Co.)

An elementary text-book of Natural Philosophy, in which the facts are clearly expressed, and the illustrations good. A well-selected series of questions will be found at the end of the book.

Energy and Motion, a text-book of Elementary Mechanics. By William Paice, M.A.; pp. VI.—114. (London: Cassell and Co., 1884.)

This little work contains elementary problems on those portions of Kinematics, Statics, and Dynamics, usually included in various preliminary examinations. The exercises appended to each chapter are well chosen, and the answers, so far as we have tested them, are correct.

Practical Physics. By R. T. Glazebrook, M.A., F.R.S., Fellow of Trinity College, and W. N. Shaw, M.A., Fellow of Emmanuel College; pp. XXII.—487. (London: Longmans, Green, and Co., 1885.)

The Authors have performed a real service to the student of Physical

Science by the publication of this text-book. It contains the methods adopted in the Cavendish Laboratory for the practical determination of problems relating to the principal Physical Sciences, together with a description of the more important instruments used. It embraces practical work in Linear and Map Measurement, Mechanics, Acoustics, Heat, Light, and Electricity; the information imparted being quite distinct from that found in ordinary text-books.

Aids to the Analysis of Food and Drugs. By H. Aubrey Husband, M.B., C.M., B.Sc., M.R.C.S., F.R.C.S. Edin.; pp. 77. (London: Baillière, Tindall, and Cox.)

We are told by the Author of this little pamphlet that it is especially intended for the assistance of candidates for sanitary degrees. We must confess that we doubt the utility of a small volume of this kind. If it be intended to teach analytical chemistry, we fear it will fail in its object, as in consequence of the condensed nature of the instructions given, the minute details essential to a correct result being insured are necessarily omitted.

The Microscope in Botany. A guide for the Microscopical Investigation of Vegetable Substances. From the German of Dr. Julius Wilhelm Behrens. Translated and Edited by Rev. A. B. Harvey, A.M., assisted by R. H. Ward, M.D., F.R.M.S. Illustrated with thirteen plates and fifty-three woodcuts; pp. XV.—466. (Boston, U.S.A.: S. E. Cassino and Co., 1885.)

The very valuable work before us has engaged the constant attention of the Author since 1880. Chapters I. and II. treat of the Microscope and its Accessories, and chapter III. of the Preparation of Microscopic Objects; chapter IV. of Reagents; chapter V. of Microscopical Investigation of Vegetable Substances. In the compilation of this work the author has attempted the utmost completeness. It deals with the anatomical constitution of the cell and of plant tissue, and yet its enquiries relate far more to physiological and biological processes and results, rather than to matters purely anatomical and histological.

The treatise occupies a field almost entirely to itself in the botanical literature both of Germany and of the English-speaking world, and we trust that its publication will stimulate investigations into the deeper problems of plant-life. The American Editors have introduced some very valuable additions into the text; these are enclosed in brackets, and marked with the initials of the respective editor. We consider this the most valuable work of the kind that has come under our notice. It is beautifully printed on very superior paper.

The Preparation and Mounting of Microscopic Objects. By Thomas Davies, Edited by John Matthews, M.D., F.R.M.S.; pp. VIII.—214. (London: W. H. Allen and Co.)

This useful little book, now in its fourteenth thousand, is too well known to need any description from us.

Physiological Botany. Part I. Outlines of the Histology of Phænogamous Plants. By George Lincoln Goodale, A.M., M.D., Professor of Botany in Havard University; pp. VII.—194. (New York: Ivison, Blakeman, Taylor, and Co., 1885.)

This book, the first part only of Vol. II. of Prof. Asa Gray's series of Botanical Text-Books, is a valuable and interesting one to the advanced student of Botany. Professor Goodale strongly insists upon the use of the Microscope in botanical research, and gives many simple and clear directions for its use, and for the preparation of the different tissues of plants for examination. The minute structure and development of every part of the plant is clearly explained, and well illustrated by no fewer than 141 capital engravings.

The second part of this volume will deal with Vegetable Physiology, and will be published very shortly; it will then form a volume that no earnest botanical student should be without.

THE MICROTOMISTS VADE-MECUM. A Handbook of the Methods of Microscopic Anatomy. By Arthur Bolles Lee; pp. XIV.—424. (London: J. and A. Churchill, 1885.)

The aim of the Author of this useful work is to put into the hands of the anatomist a concise, but complete account of all the methods of preparation that have been recommended to the Microscopic Anatomist. We have first an Introductory Chapter, with general instructions for preparing objects for examination; followed by chapters on Fixing Agents, Theory of Staining, Hardening Agents, Theory of Embedding, with a word on Microtomes, etc. etc. Both the Amateur and the Advanced Anotomist will find much valuable information in this book.

HISTOLOGICAL NOTES for the use of Medical Students. By W. Horscraft Walters, M.A., Demonstrator and Assistant Lecturer in Physiology at the Owen's College, Manchester; pp. VI.—65. (Manchester: J. E. Cornish; London: Smith, Elder, and Co., 1884.)

A well written and unpretentious little volume. The instructions given are an enlargement, although still in a very condensed form, of the Author's "sheets" given to the students of the Practical Histology Class at the College. They are very plainly and concisely written, and will doubtless be found of great assistance to the Histological student.

A MANUAL OF PHOTOGRAPHY, intended as a Text-Book for Beginners, and a book of reference for Advanced Photographers. By M. Carey Lea. Second edition, revised and enlarged; pp. 439, 8.4. (Philadelphia, U.S.A.: Printed for the Author.)

The work before us is one of the best Photographic Manuals which we have seen, and one that every practical Photographer would do well to study. It is divided into four portions; the first gives a short and clear course of instruction for beginners. In the subsequent parts the various subjects are treated of in detail, *e.g.*: Part II. treats of Photographic Optics and the Theory of Perspective; Part III.—Photographic Manipulations; Part IV.—Certain Theoretical Considerations as to the Action of Light on Chemical Compounds, and the Action of various portions of the Spectrum; Part V. is devoted to Photography in its Relation to Health, and also to Chemical Manipulation.

LA PHOTOGRAPHIE APPLIQUÉE A L'HISTOIRE NATURELLE. Par M. Trutat; pp. XIII.—223. (Paris: Gauthier-Villars, 1884.)

We have here very full and carefully written instructions for the production of Photographs in every department of Natural History, Zoology, Botany, and Geology. There are 58 well executed engravings, besides 5 fine photographic plates. We think that Pl. IV., a piece of red Marine Algæ *(Plocamium rubrum)*, printed in natural colours, by one single operation, is the most perfect example we have met with.

WILD FLOWERS AND WHERE THEY GROW. By Amanda B. Harris, with 60 illustrations by Miss L. B. Humphrey; pp. 160. (Boston: D. Lothrop and Co.)

This book is written in a bright, popular style, with vivid recollections of a child's delight in the beauty and abundance of wild flowers. It is, however, a matter for regret that only the popular names of the flowers are given, for as these appear to differ very considerably in "New" and "Old" England, it is difficult to identify them. The work is handsomely bound, printed, and got up, and the plates are charming.

PLANT-LIFE ON THE FARM. By Maxwell T. Masters, M.B., F.R.S.; pp. 132. (New York: Orange, Judd, and Co., 1885.)

In the little book before us the Author gives an outline of the physiology or life-history of plants, of the way in which they are affected by circumstances under which they exist, and of the manner in which they in their turn react upon other living beings, and upon natural forces. The most practical part of the book treats of the comparative values of different manures, and their effect on the various grasses and cereals, illustrated by experiments made at Rothamstead.

THE BOTANICAL ATLAS. A Guide to the Practical Study of Plants, containing representatives of the leading forms of Plant Life. By D. McAlpine, F.C.S. Two Vols.: Vol. I., Phanerogams; Vol. II., Cryptogams. (Edinburgh: W. and A. K. Johnson, 1883.)

The object of the Author in preparing these two truly magnificent volumes, is to provide a guide to the practical study of Plants; the examples selected are always of the commonest kind, selected from every readily available source. In the volume devoted to Planerogams, the flower and its various parts passing into fruit and seed are mainly considered, coloured dissections being given. In the Cryptogams a similar course is adopted, and, as the figures of every plant, or section of a plant, are represented in their proper colours, the student cannot fail to find these books most helpful in his botanical pursuits.

Each volume (Atlas folio) consists of 26 coloured plates, and contains an immense number of figures, with a page of letterpress descriptions opposite.

We feel that we cannot recommend these volumes too strongly to our Botanical friends.

YOUR PLANTS. Plain and practical directions for the treatment of Tender and Hardy Plants, in the House and in the Garden. By James Sheehan; pp. 79. (New York: Orange, Judd, and Co., 1885.)

A useful little book, written professedly for Amateurs, giving clear and easy directions for the culture, planting, grafting, pruning, etc., of greenhouse, garden, and window plants; the making of Wardian cases, etc. Mr. Sheehan exposes the popular fallacy of supposing it to be unhealthy to keep plants in a room; he says the amount of carbonic acid discharged at night from two dozen large plants, will not equal that exhaled by one infant sleeper.

A YEAR'S WORK IN GARDEN AND GREENHOUSE. By George Glenny; pp. XVI.—237. (London: Chatto and Windus.)

The Author of this work has endeavoured to show how an amateur, without much experience, may dispense with the skilled labour which is often difficult, and sometimes impossible, to obtain. The work is really a calendar of gardening operations for each month of the year. Thus we have twelve months' work appointed for the Flower Garden, the Fruit Garden, and the Frame Garden. Then follows a list of various tools required, with full instructions for using them, also instructions in Budding, Grafting, etc. etc.

TREE GOSSIP. By Francis George Heath; pp. VIII.—176. (London: Field and Tuer, 1885.)

We find here much pleasing information, not only about trees individually, but about matters relating to them generally; as, for instance, the book begins with a chapter on the Ages of Trees, others on Autumnal Tinting, Destruction of American Forests, etc. In short, the book is mainly devoted to the bye-ways of tree life. For convenience of reference the chapters are all arranged in alphabetical order. Mr. Heath is the author of several works on Trees, Ferns, etc., and we venture to think that this is not the least interesting of them all.

A MANUAL OF BOTANIC TERMS. By M. C. Cooke, M.A.; pp. IV.—118. (London: W. H. Allen.)

A useful Dictionary of Botanic terms, with their derivations. It is illustrated with a number of plates, containing in all 307 figures.

BOTANY. By Professor Bentley; pp. 128. (London: Society for Promoting Christian Knowledge, 1879.)

This is one of those useful Shilling Manuals of Elementary Sciences published by the above Society. It was prepared with a view of supplying young people with a simple introduction to the study of plants. Each chapter is followed by a series of questions; the book is further illustrated with 134 figures.

A PLAIN AND EASY ACCOUNT OF BRITISH FUNGI, with especial reference to the Esculent and Economic species. By M. C. Cooke, M.A., LL.D. Fifth edition, revised, with coloured plates of 34 species, and numerous wood engravings; pp. VIII.—166. (London: W. H. Allen, 1884.)

The little book before us commences with a general description of British Fungi, which is followed by the Anatomy of the Fungi. Then the various genera are more particularly described; followed by a valuable chapter on the "Discrimination and Preservation of Fungi;" and, lastly, a tabular arrangement of the Orders and Genera.

ORCHIDS: A Review of their Structure and History. Illustrated. By Lewis Castle (formerly of the Royal Gardens, Kew; Author of "Cactaceous Plants"); pp. 60. (London: "Journal of Horticulture" Office.)

In this little shilling review of the Orchid family the Author tells us "it is not intended to describe the culture, but to endeavour to convey some idea of the peculiarities and recommendations possessed by these remarkable plants," The various chapters are devoted to descriptions of Orchid Life; Orchid Flowers, in which the Labellum and Pollen Masses receive special attention; Orchid Mysteries; Mimicry; Fertilisation; the History of their Structure; Uses; Homes; History; Value; and, finally, Hybrids. Lovers of this very remarkable flower will find much to interest them.

THE COLLECTOR'S MANUAL OF BRITISH LAND AND FRESH-WATER SHELLS. By Lionel Ernest Adams, B.A. Illustrated by Gerald W. Adams and the Author; pp. 125. (London: George Bell and Sons, 1884.)

A most useful book for the collector, giving a clear description of one hundred and thirty British species of British shells, with figures of every species, also indicating the localities where each may be found. Simple directions are given to the collector, by following which the youngest tyro in that most fascinating employment can hardly fail to make a well-arranged and correctly-named collection. There are 8 very good plates.

THE BOOK OF ALGOONAH. Being a concise account of the History of the Early People of the continent of America, known as Mound Builders. (St. Louis, Mo.: Cyrus F. Newcomb and Co., 1884.)

This book gives the history of a people known as Mound Builders, who inhabited that part of America where St. Louis now stands, and are said to have lived at a time contemporaneous with the builders of the pyramids. We are not told from whence the Author (who is nameless) procured his information; he, however, promises "to further elucidate the matter at no very distant date."

HEGEL'S ÆSTHETICS: a critical exposition. By John Steinfort Kedney, S.T.D., Professor of Divinity in the Seabury Divinity School, Minnesota; pp. XVIII.—302. (Chicago, U.S.A.: S. C. Griggs and Co., 1885.)

This is one of Greggs' Philosophical Classics, the object of the work being to reproduce the essential thought of that voluminous treatise known as "The Æsthetics of Hegel." The original work is divided into three parts; we have here a faithful reproduction of the first. A translation of the second part having been already published, the Author of the present work has substituted an original disquisition in language approaching nearer to the vernacular, and giving the substance of Hegel's thought. Of the third part all the important definitions and fundamental ideas are given.

THE ECLECTIC PHYSIOLOGY, for use in Schools. By Eli F. Brown, M.D.; pp. 189. (Cincinnati, U.S.A.: Van Antwerp, Bragg, and Co., 1884.)

Physiology being taught in many of the schools, the information here given is presented in a plain didactic style, common words being used instead of technical terms, and the details of anatomy are subordinated to the more important consideration of Physiology and Hygiene. Much attention is given to the care of proper sanitary conditions in the home, and to habits of healthfulness in ordinary life.

Technological Dictionary of the Physical, Mechanical, and Chemical Sciences. Part I.—English-German; Part II.—German-English. By F. J. Wershoven, D.Sc.; pp. 222—267. (London: Symons and Co., 1885.)

These two small volumes are the first of a series which will include the English, French, German, Italian, and Spanish languages, and will contain terms employed in Physics, Meteorology, Mechanics, Chemistry, Metallurgy, Chemical Technology, and Electrotechnics; and will, owing to the great advances of science, and the necessary coining of new words, be found most useful to the Science student.

Guides for Science Teaching:—

I.—About Pebbles. By Prof. Alpheus Hyatt; pp. 26.

II.—Concerning a few Common Plants. By George L. Goodale (second edition); pp. 61.

III.—Commercial and other Sponges. By Prof. Alpheus Hyatt; illus., pp. 43.

IV.—A First Lesson in Natural History. By Mrs. Agassiz (new edition); illus., pp. 64.

V.—Common Hydroids, Corals, and Echinoderms. By Prof. Alpheus Hyatt; illus., pp. 32.

VI.—The Oyster, Clam, and other Common Molluscs. By Prof. Alpheus Hyatt; illus., pp. 65.

VII.—Worms and Crustacea. By Prof. Alpheus Hyatt; illus., pp. 68.

XII.—Common Minerals and Rocks. By William O. Crosby; pp. 131.

XIII.—First Lessons on Minerals. By Ellen H. Richards; pp. 50. (Boston, U.S.A.: Ginn, Heath, and Co.)

We have before us nine little books, designed to supplement Lectures given to Teachers of the Public Schools of Boston, by the Boston Society of Natural History. They are intended for the use of Teachers who desire to practically instruct classes in Natural History. Beside simple illustrations and instructions as to the modes of presentation and study, there are, in each pamphlet, hints which will be found useful in preserving, preparing, collecting, and purchasing specimens. The missing numbers are in course of publication.

The Telephone. An Account of the Phenomena of Electricity, Magnetism, and Sound, as involved in its action, with directions for making a Speaking Telephone. By Prof. A. E. Dolbear; pp. 128.

Handbook of Wood Engraving, with practical instructions in the art, for persons wishing to learn without an instructor. By William A. Emerson; pp. 95.

Hints and Helps for those who Write, Print, or Read. By Benjamin Drew; pp. 131.

Universal Phonography: or, Shorthand by the "Allen Method." A Self-Instructor, whereby more speed than longhand writing is gained at the first, and additional speed at each subsequent lesson. By G. A. Allen; pp. 142.

Handbook of English Synonyms, with an Appendix showing the correct uses of Prepositions, also a Collection of Foreign Phrases. By L. J. Campbell; pp. 160.

Pronouncing Handbook of Words often Mispronounced, and of words to which a choice of pronunciation is allowed. By Richard Soule and Loomes J. Campbell; pp. 99.

Handbook for Water-Drinkers. By G. L. Austin, M.D.; pp. 48.

The Stars and the Earth; or Thoughts on Space, Time, and Eternity; pp. 88.

Handbook of the Earth. Natural Methods in Geography. By Louisa Parsons Hopkins; pp. 78. (Boston, U.S.A.: Lee and Shepard, 1884, etc.)

The above nine little books form an exceedingly useful set of handbooks on a variety of subjects. The subject matter of each is condensed into a very small compass, so that it is by no means unlikely that the unprofessional reader may obtain as much information from them as from a more elaborate technical treatise on the same subject. Our readers will remember that we reviewed four others of the same series in our January part. The size of the pages is 6 by 4 inches.

Spon's Mechanic's Own Book: a Manual for Handicraftsmen and Amateurs; pp. XII.—702. (London: E. and F. N. Spon, 1885.)

The aim of the Authors of this large and closely printed volume has been to discuss, from an everyday, practical view, the various mechanical trades that deal with the conversion of wood, metals, and stone, into useful articles.

The method of treatment of each branch is scientific, yet simple. First, the character, variations, and suitability of the raw material is considered; then the tools used, and the methods to be adopted for keeping them in proper order. The book forms a complete guide to all ordinary mechanical operations, and will be found useful both to the professional workman and the amateur. It is well illustrated with no less than 1419 engravings; there is also a good index.

Country Cousins: Short Studies in the Natural History of the United States. By Ernest Ingersoll; pp. 252. (New York; Harper and Bros., 1884.)

We are introduced in the work before us to a great number and variety of Birds and Animals. There is also a good paper on Winter Work for Naturalists; How a Naturalists' Club should be organised, etc. We have also an account of Professor Agassiz's sea-side laboratory, followed by descriptions of many sea creatures, including the life, trials, and vicissitudes of an Oyster; Star-fishes, and the mischief they accomplish. The book throughout is most interestingly written, well illustrated, and handsomely bound.

Jelly-fish, Star-fish, and Sea Urchins. Being a research on Primitive Nervous Systems. By G. J. Romanes, M.A., L.L.D., F.R.S., pp. VIII.—323. (London: Kegan Paul, Trench, and Co., 1885.)

This deeply interesting volume (The International Scientific Series, vol. 50) commences with a fine description of the Jelly-fish. The author, who is Zoological Secretary of the Linnæan Society, gives us the result of many years spent in the study of the Medusæ, etc. The work closes with an account of the Star-Fish and Sea-Urchins. It is an important addition to physiological science, throwing much light upon many hitherto very little considered points of structure, and will well repay the careful perusal of the Naturalist.

PHYSICAL ARITHMETIC. By A. Macfarlane, M.A., D.Sc., F.R.S.E., Examiner in Mathematics in the Universities of Edinburgh; pp. IX.—357. (London: Macmillan and Co., 1885.)

This is a treatise on applied arithmetic, the applications being chiefly in physical sciences. The Author tells us that "Knowledge of the elements of pure arithmetic is assumed, but that the more advanced methods are explained when their application happens to occur."

The examples have been partly selected from recent examination papers of the several universities, and partly prepared by the Author. The work is divided into the following sections:—Financial, Geometrical, Kinematical, Dynamical, Thermal, Electrical, Acoustical, Optical, and Chemical.

Looking at the examples from a student's point of view, we should have liked to have seen the sign ∴ (therefore) oftener used in the examples.

YOUNG FOLKS' IDEAS. A Story: by Uncle Laurence, Author of Young Folks' Whys and Wherefores, etc., pp. 243. (Philadelphia: Lippincott and Co., 1885.)

We have here the merest outline of a story into which a good deal of Scientific and Technical Knowledge is interwoven. The subjects varying from Bread-making, Gold and Silver, Gas, and Printing, to Wine, and even Will-making. The young folks to whom we are introduced are certainly the most precocious it has ever been our fortune to meet. The "get-up" of book is everything that can be desired.

GEOLOGY AND THE DELUGE. By the Duke of Argyle; pp. 47. (Glasgow: Wilson and McCormick, 1885.)

This is a lecture delivered by the Duke of Argyle at Glasgow. His Grace very conclusively proves the occurrence of a Deluge of comparatively recent date, but whether this was the same that drowned the world in the days of Noah is we think not so satisfactorily proved; four thousand years of Geologic time being but a very insignificant portion. We feel sure our friends will be glad to read this very clever address.

COMPARATIVE PHYSIOLOGY AND PSYCHOLOGY. A discussion of the Evolution and Relations of the mind and body of man and animals. By S. V. Clevenger, M.D., pp. VI.—257. (Chicago: Jansen, McClurg, and Co., 1885.)

A cleverly written book, the object of the author being to elaborate as far as possible, a practical mental science which will reconcile the observations of Anatomists, Psychologists, and Pathologists, with direct reference to the more intelligent treatment of insanity. The work is divided into fifteen chapters, and exhibits a vast amount of thought and research on the part of the Author.

BRITISH BUTTERFLIES, MOTHS, AND BEETLES. By W. F. Kirby; pp. 96. (London: W. Swan Sonnenschein and Co., 1885.)

A capital little shilling book for the Young Collector. It is divided into three portions, the first of which treats of the order of Insects generally, with their division into orders, etc.; the next is devoted to British Beetles, and on the part played by them in the Economy of Nature; the third to British Butterflies and Moths. The book is illustrated with several plates and a number of wood engravings.

THE ORBS OF HEAVEN, or Planetary and Stellar Worlds. By O. M. Mitchell, A.M.; pp. VIII.—304. (London: George Routledge and Sons.)

Gives us a popular exposition of the Great Discoveries and Theories of Modern Astronomers; it is pleasantly written and well illustrated.

EDUCATION A SCIENCE. By Alexander Bain, L.L.D., Professor of Logic in the Universities of Aberdeen; Fifth edition, pp. XXVII.—453. (London: Kegan Paul, Trench, and Co., 1885.)

The Author of the book before us, another of the "International Scientific Series," views the art of teaching as far as possible from a scientific point of view; thus, in the opening chapters the opinions of many of our great scientists are considered. We then have the subject of Education viewed in connection with Physiology and of Psychology. That five editions of this work have been called for in a comparatively short time, proves the esteem in which it is held.

SCIENCE IN SONG, or Nature in Numbers. By William Richards, A.M., Ph.D., pp. XII.—131. (Boston: Lee and Shepard, 1885.)

In the little book before us the Author attempts to give us the various facts and principles of Science in Verse. Some of the subjects so treated being Steam, Electricity, the Spectroscope, Magnetism, the Telescope, &c.

SCHOOL-KEEPING, and How to do it. By Hiram Orcutt, LL.D.; pp. 244. (Boston: N. E. Publishing Company, 1885.)

The Author's design in publishing this book is first, to aid and encourage those who need and would profit by the experience of others; and secondly, to awaken an interest in the subject. It is divided into seven chapters, viz.—Theory and Practice, How to Begin, How to Govern, How to Teach, Physical Culture, Morals and Manners, and Temperance in Schools.

LESSONS ON ELEMENTARY PRACTICAL PHYSICS. By Balfour Stewart, M.A., LL.D., F.R.S., and W. W. Haldane Gee. Vol. 1, General Physical Processes, pp. XVI.—291. (London: Macmillan and Co., 1885.)

The volume before us is the first of a series, to be shortly followed, it is hoped, by one on Electricity and Magnetism, and the third on Heat, Light, and Sound. The present work is divided into a series of lessons, each one of which being as a rule descriptive of something to be done in a definite manner with definite apparatus. The Authors have endeavoured to render their descriptions as clear as possible, making but a limited use of technical words.

A POPULAR EXPOSITION OF ELECTRICITY, with Sketches of some of its discoveries. By Rev. Martin S. Brennan, A.M., pp. 191. (New York: D. Appleton and Co., 1885.)

A very interesting little book, the aim of the Author being simplicity; he has devoted his care almost entirely to the explanation of principles to the exclusion of Mechanics. Short sketches are given of the men who have added most to the science by their great discoveries.

Vocal and Action-Language, Culture and Expression. By E. N. Kirby, pp. 163. (Boston, U.S.A.: Lee and Shepard, 1885.)

Mr. Kirby is teacher of Elocution in the Lynn (U.S.A.) High School; his handbook originated with the lessons given by him in the class-room, and is intended to benefit public speakers and others. His aim has been to give to the reader a practical handbook on elocution, the authorities quoted being specialists in their various departments. He gives descriptions of the respiratory and vocal organs, based upon Dr. Martin's work "The Human Body," with illustrations taken from that book. The work is divided into three parts: 1. Vocal Culture and Expression; 2. Action-Language, Culture, and Expression; 3. Expression; and closes with general instructions in the art of public speaking.

John Oldcastle's Guide for Literary Beginners; pp. 124. (London: Field and Tuer, 1884.)

This quaint little book is one of "ye Leadenhalle Presse oblong shilling series;" it is got up, except as regards orthography, quite in the old style, on very old-fashioned blue paper. The instructions to literary beginners are thoroughly practical and good; specimens of the Caligraphy of many of our famous Authors add much to the interest of the work.

The Author's Paper-Pad (by the same Publishers), containing fifty sheets of good smooth writing-paper, is a good sixpennyworth.

Health upon Wheels, or, Cycling as a means of maintaining Health, and conducing to Longevity. By W. Gordon Stables, C.M., M.D., R.N., pp. VII.—125. (London: Iliffe and Son, 1885.)

The Author of this little book is a well-known writer on Health and Hygiene in several of our popular periodicals. He is, *par excellence*, a Tricyclist, and combined with instructions for using this very agreeable vehicle, gives no end of good advice on Health generally, including the "Morning Tub," "Sleep," "Pure Air," etc. etc.

Lehrbuch der Geophysik und Physikalischen Geographie. von Dr. Siegmund Günther, Professor am Gymnasium zu Ansbach. Zwei Bände; pp. 418—671. (Stuttgart: Verlag von Ferdinand Enke, 1884—5.)

These admirable volumes on the Physics of the Earth came to hand at the moment of going to press; we have therefore only space to acknowledge their receipt, and hope to notice them at greater length in our October reviews. Vol. I. is illustrated with 77, and Vol. II. with 118 engravings in the text.

The June Part of the Journal of Quekett Microscopical Club is a good one, and contains papers on A New Hydroid Polyp; Newly-Observed Phenomena in the Conjugation of *Rhabdonema arcuatum*; and one by Dr. M. C. Cook on Some Remarkable Moulds. Each paper is illustrated with one or more litho. plates.

Correspondence.

To the Editor of the Journal of Microscopy and Natural Science.

SIR,—

Referring to the letters of Mr. H. W. Lett in your April issue, I would say that *Sambucus ebulus* is not so rare as his words may lead readers to think. It is rare in the sense of being *local*, but it is found in 70 out of the 112 botanical "counties" into which Britain is divided according to the "London Catalogue"—*i.e.*, it has the same "census number" as *Typha latifolia, Sium Augustifolium, Dipsacus sylvestris*, and many others, while *Sambucus nigra*, the Common Elder, has only 90 for its census number.

The Danewort is often passed over by even experienced botanists, partly because the popular idea of its rarity lessens their watchfulness in looking out for it.

Mr. Letts' second note I agree with, in so far as his praise of your Journal goes, but I do think it would be a pity to make it monthly at the expense of such full and thorough papers as we now get. It fills a place that no other journal fills in supplying us with papers that give a grasp of their respective subjects almost impossible to obtain in shorter papers, which a monthly issue would almost necessitate. These papers are popular and readable, and, at the same time, scientific and accurate. The Journal is issued at a most reasonable price, and as a "Quarterly" would be greatly missed by many. We have many science "monthlies," but no "quarterly" that I know of other than expensive ones, and those technical and uninteresting to general readers.

I would rather say increase its present quarterly bulk, and make it 2/- instead of 1/6. Put in plenty of Reviews, as in the current issue, and, as Mr. Lett suggests, start a Query and Correspondence Column. I share his desire to have the Journal coming in *oftener*, but I should be sorry to see it lessen in the *thoroughness* and fulness of its pages, if the monthly issue involved that change. I should like to hear further opinions on this subject.

I am, yours truly,

H. W. S. WORSLEY-BENISON.

Current Notes and Memoranda.

Owing to pressure of valuable matter which we were anxious to give to our readers, we have been obliged to extend the current part of the Journal to 80 pages, and are still unable to find room for our usual "Half-Hour with Mr. Tuffen West," and the "Selected Notes;" these are, however, in type, and the plates printed, and will appear, without fail, in our next.

We insert a letter from Mr. Worsley-Benison, who takes a somewhat different view of the question of monthly issue to that propounded by the Rev. H. W. Lett. We shall be glad to know how a monthly SUPPLEMENT will meet the case, if published at a low price, say fourpence; and embracing the following subjects:—I.—Questions on every branch of Science. II.—Replies to same by Subscribers. III.—Letters to the Editor on any matters of interest. IV.—Cuttings from Scientific Journals. V.—An Exchange and Sale Column. VI.—Answers to Correspondents. Perhaps those of our subscribers desiring it will write us on the subject.

STUDIES IN MICROSCOPICAL SCIENCE. Since our last issue we have received Nos. 3, 4, and 5 of each of the four sections into which these "Studies" are now divided. The slides and plates illustrating Section I. are *Batrachospermum*, showing Cystocarps; v.s. of *Solorina crocea*; and organs of sexual reproduction of Chara. Those of Section II. are t.s. of organ of Bojanus, from the Anodon; Liver of Lobster; and s. of Skin of Frog. Of Section III. we have the third stage of Alveolar Pneumonia and Bronchio-Pneumonia. And in Section IV. the Jaws of Epeira diadema ♀; t.s. Medical Leech; and t.s. Hair of Peccary.

ENTOMOLOGICA AMERICANA is a monthly journal devoted to Entomology in general, and published at Brooklyn, N.Y. This Journal, the third part of which is just to hand, contains much that will be found particularly interesting to the Entomologist. It is, we believe, published by the Brooklyn Entomological Society, and is edited by the Hon. Secretary.

Mr. A. C. PEALE, of the United States Geological Survey, has sent us reprints of three interesting papers, viz.—The Laramic Group of Western Wyoming and adjacent regions; Jura-Trias Section of South-Eastern Idaho and Western Wyoming; and the World's Geysier-Regions.

The following list of Chemicals is recommended in the seventh volume of the Proceedings of the American Society of Microscopists, as giving slides of very interesting Crystals for the Microscope:—Salicine, santonine, helicine, asparagine, aspartic acid, bichromate of potash, arsenious acid, cinchonoidine, hippuric acid, oxalate of ammonia, quinidine, sulphate of cadmium, sulphate of copper, chloride of copper, platino-cyanide of magnesium, pyrogallic acid.

THE JOURNAL OF MICROSCOPY
AND
NATURAL SCIENCE:
THE JOURNAL OF
THE POSTAL MICROSCOPICAL SOCIETY.

OCTOBER, 1885.

How Plants Grow.

By H. W. S. Worsley-Benison, F.L.S.,
Lecturer on Botany at Westminster Hospital, President of the Highbury Microscopical and Scientific Society.

AMONG the characters which separate Living beings—animals and plants—from Inanimate bodies, their manner of growth occupies a foremost position. Inanimate bodies increase by *accretion—i.e.*, a mechanical adding of similar particles to the exterior, such as takes place in the making of a snowball, for instance.

Living beings universally "grow" by a process known as *intussusception—i.e.*, a deposition of food-particles between the molecules of the organism; here we have a positive in-taking, with resultant assimilation, nutrition, and all the processes summarised in the word *life*. It is to this latter method of increase only that the term "growth" can be properly applied.

In my paper, entitled "What is a Plant?"* I stated that the most clearly-marked morphological feature of plant-life was the presence of a cell-wall made up of cellulose, and that the most

* See this Journal, pp. 74 and 154.

distinctive physiological character was the power to manufacture "protein" from less complex materials.

In our present study, we must keep two main facts prominently and clearly before us :—First, that all plant-growth goes on by intussusception, not by accretion; second, that we are dealing with organisms whose elemental parts—*i.e.*, their cells—possess walls made of cellulose, and who are able to exercise this manufacturing power, in virtue of which they *make* their cellulose, and all the other important chemical substances intimately connected with their "growth."

These points being clear, I purpose to sketch in this paper the methods by which plants increase, and, as a type, to trace the growth of an ordinary flowering-plant from the very first cell of the *embryo*—*i.e.*, the initial result of the process of fertilization up to the adult plant, with its various organs.

It is difficult to show how this first embryonic cell comes about without trending in the direction of reproduction. It is equally difficult to trace the after-steps of development without going too deeply into the question of the food of plants, its uses, and the manner in which it is taken in—in a word, the processes of assimilation and nutrition. Therefore, I shall only say so much concerning reproduction as will suffice to define the *position* of the primary embryo cell, and only so much about food and assimilation as may be needful to show the necessity that exists for the food to be used by the plant, and to demonstrate the function of certain organs, which must be named. How plants feed, move, climb, and reproduce, are subjects worthy of separate papers, which may at a future time appear in this Journal.

I.—The Vegetable Cell.

We shall, first of all, discuss the *simple plant-cell:* its composition, contents, form, varieties, and so forth. Having seen it in its initial stage, as the starting-point of the embryo, and discussed the method by which it managed to assert its right to exist at all, we shall trace its development into *tissues* and *organs*, making up the adult plant.

Take as the primary and all-important axiom of plant-life this: *All known plants consist wholly of either one cell, modified in various ways in different cases, or of a number of cells, greater or smaller, modified in almost endless variety.*

Take what plant, or what part of any plant, you choose, it is wholly made up of cells, and nothing but cells. These may be modified so as to produce "vessels"; they are still only cells.

If only the simple cells be present, we call the plant *cellular;* as, for example, Seaweeds, Lichens, Moulds, Liverworts, and Mosses. If, in addition to these simple cells, we find modified kinds, or vessels, we call it *vascular*, including the Club-mosses, Horse-tails, Ferns, and all Flowering plants.

Remembering this axiom, which, unlike the Euclidian axioms, is capable of being demonstrated under the microscope, and is not, on the face of it, always "self-evident" without this process, let us, to start with, reply to the query, "What is a cell?"

(*a*) THE CELL AS AN INDIVIDUAL.

Until quite recently, a cell was supposed to consist *essentially* of a cell-wall enclosing certain contents, such as protoplasm, cell-sap, nucleus, etc. The cell-wall was held by some to be the essential feature; indeed, many observers used the term "cell" to denote cases where only the cell-wall existed, the former contents having vanished, as, for instance, pith-cells and very aged cells, where only air is contained by the wall. Now, however, many cells are known to exist, for part of their life at all events, *without any wall differing chemically* from their other substance. There do also exist some cells devoid of a nucleus, so far as we can ascertain. Hence, some modification of the scope of the term "cell" was needed, and now, universally, *the only essential constituent* of a plant-cell is held to be the *protoplasm*, a viscid, semi-fluid substance. A cell, therefore, pure and simple, is simply *a mass of protoplasm*. This protoplasm is always, sooner or later, closed in by a solid, more or less firm, transparent membrane, *secreted by itself*, and moreover possesses, in most cases, a nucleus. Still, the one great essential feature is protoplasm. Only cells which have it are "alive"; only such cells can grow, change, secrete other substances, or reproduce themselves. Destitute of it, they are "dead," and can only subserve the uses of support, extension of fabric or framework, attraction of fluid, or protection.

Let us now study a typical cell, having not only the living, acting protoplasm, but the usual concomitants of cell-wall, nucleus, and other parts.

Construction and Contents.—The typical cell consists, then, of the following parts:—

1.—A membranous boundary, the *Cell-wall*, consisting of Cellulose ($C_6H_{10}O_5$), coloured blue by iodine and sulphuric acid.

2.—The *Protoplasm*, a semi-fluid, hyaline substance, consisting of various organic materials, among which the albuminous (nitrogenous) are never absent. The chief constituent is *Protein*, made up of carbon, hydrogen, oxygen, and nitrogen, with a little phosphorus and sulphur, and a varying proportion of water. Protoplasm easily coagulates, has a very high absorbing power for water, resists the passage of colouring matters, or salts, dissolved in water, is coloured yellow-brown by iodine, and pink by sugar and sulphuric acid, possesses power of contractility, and is the origin of all new development. A number of very small "granules" are imbedded in the protoplasm.

3.—The *Primordial Utricle*. This is a definite boundary of the protoplasm, similar in composition, but clearer, owing to the absence of "granules." It lines the cell-wall where there is one, and more or less bounds the granular protoplasm when there is no wall. It is not sharply defined on the inside, but passes insensibly into the protoplasm.

4.—The *Nucleus*. A darker, more or less rounded part of the protoplasm, in the centre at first, but afterwards often seen nearer the wall. This is because in the young state the protoplasm usually fills the cavity, but later on becomes merely a delicate parietal layer, carrying the nucleus with it. The nucleus will often creep about in a long cell like an Amœba, and in so doing causes the shifting bands, or "threads," of protoplasm, which it drags after it. This may be seen very well in the cells of the hairs of *Tradescantia* (spider-wort). One or more "nucleoli," or smaller nuclei, may often be seen within the nucleus, and the latter may be usually detected, with careful focussing, by its being clearer than the surrounding fluid.

To detect the utricle as apart from the cell-wall, add a little alcohol. This coagulates the protoplasm, and separates it, *with its utricle*, from the wall. This can be made still more visible by adding carmine, which colours the separated mass, leaving the wall uncoloured.

The protoplasm, utricle, and nucleus are the three contents which play the important part in the origin and growth of all new cells.

5.—The *Vacuoles.* When the protoplasm has reached its limit of absorbing power for water, it exudes this water in the form of drops of varying size in its interior. These form the vacuoles, which are cavities in the protoplasm, and contain—

6.—The *Watery Cell-Sap.* This may be in many small vacuoles, or in one large one, filling the cavity bounded by protoplasm, and formed from it by exudation. The sap—the "crude" sap, as it is called—is the fluid needed for the life of the plant; it is absorbed by the roots, and carried up by the stem. In it are suspended all the other contents—those taken in with it by the roots, and those formed inside the cells themselves. Therefore, it is never found unmixed. When it has reached the leaves, it is, under given conditions, transformed into "elaborated" or unmixed sap, containing the materials of growth ready for use.

We thus see that a typical plant-cell is fitly described as consisting of—

1.—*The Cell-Wall*, lined by
2.—*The Primordial Utricle*, which is the outer layer of
3.—*The Protoplasm*, at the centre of which is
4.—*The Nucleus*, with usually a nucleolus;
5.—*The Vacuoles*, cavities in the protoplasm, and containing
6.—*The Watery Cell-Sap*, a nutritive fluid.

The Cell-Wall is simply the framework of the minute workshops in which the marvellous operations of plant-life are carried on.

Size.—Cells vary in size from 1–6,000th of an inch in diameter (as seen in Fungi spores) to 1–30th of an inch, as seen in some gourds and aquatic plants. Elder pith shows them 1–100th of an inch, and ordinary cellular tissue 1–400th of an inch. In length, they range from 1–50th of an inch long, as in wood-cells, to 1–12th or even 2–3rds of an inch, as in the liber-cells of flax. Some unicellular water-weeds, being many-branched, may measure some inches in length, while their diameter may be expressed in hundredths of an inch. Taking 1–1200th of an inch as a small diameter for ordinary tissue; one cubic inch of such tissue would contain 1728,000,000 cells.

Form.—The normal form is spherical, or nearly so; this is rarely preserved except in the cases of unicellular plants, pollen-grains, and the cells of loose pulp, such as Peach or Strawberry. By mutual pressure, cells usually become polygonal, as in elder pith.

The two conditions affecting cell-form are:—1st, *Mutual pressure;* 2nd, *Variation in vigour of growth—i.e., nutrition.* If these be equal on all sides and at all points, the original form is preserved; with varying pressure, and more vigorous nutrition at the ends than at the sides, are formed the ellipsoidal, oval, and hour-glass shapes. This end-growth, carried yet further, gives us the elongated, prismatic, and fusiform cells. Let nutrition ensue more vigorously at the sides—*i.e.*, favour breadth rather than length, and we find the tabular and disc-shaped varieties. If nutrition proceeds equally on *all sides*, but not at *all points*, the beautiful stellate cell is produced, seen in all the *Juncaceæ*, or rush order, and in *Euastrum*, one of our water-weeds.

Markings.—Varying nutrition is the great factor in producing markings seen on cell-walls. The primary cell-wall is a thin, transparent membrane. Increase in thickness is due to deposition, early in life, of several layers inside the primary one, called secondary layers; the thickness is fairly uniform everywhere, and the transparency is retained; at the same time fresh matter is absorbed interstitially by intussusception. These layers may so increase as to wholly fill the cavity.

Now, uniform thickening obtains only in the early stages; afterwards, want of uniformity is seen, especially at corners and edges, giving the cavity an appearance of being rounded off. This may be on one side only, as in Mistletoe epidermis. It is usually seen at certain spots, forming *pitted cells—i.e.*, cells with pits—which, if the pit extend from wall to centre, become canals (or *pore-canals*, as they are called), simple, as in Clematis pith, or branched, as in the shell of Walnut. If the canals in two adjacent cells meet, the membrane between them frequently vanishes and the cells become perforated, the canals becoming widened at their base, or point of junction, into *bordered pits*, the marking so characteristic of the wood of the pine order.

According to the development of these pits, or of the secondary layers, we get the markings which give their names to the cells, or vessels, in which they occur. As notable instances, we have the *pitted* cells, seen in Pine wood; *reticulated* cells, seen in Balsam; *spiral* cells, as in Cactus and others; *annular* cells, as in Hyacinth, *Sphagnum*, etc., or *scalariform* cells, seen in ferns.

Then, sometimes, *deposition of crystals* is seen in outgrowths of the wall, as in the calcic-oxalate crystals, found in Citron leaf-cells. Another variety of marking is produced by *Infiltration* or *Incrustation*, where particles of foreign matter are deposited among the particles of cellulose. Beautiful examples of this are seen in the cell-wall of the *Diatomaceæ*, where it is transformed into an almost perfect coat of silica, marked with exquisite tracings; as, for instance, *Pleurosigma angulatum*, so well-known to microscopists.

We have spoken of "vessels" more than once. A vessel is formed by several cells placed end to end, their cross partitions being wholly or partially absorbed, so that they come to form a tube, with free communication, more or less, from end to end. If the partitions be only partially absorbed—*i.e.*, at certain points—we get the perforated ones seen in what are called *sieve-tubes*—*i.e.*, tubes with sieve-like partitions, such as are found in Lime, Gourds, etc. If entire absorption takes place, true *vessels* are formed, and these, of course, are marked in a spiral, annular, or other fashion, according to the markings on the cells by whose coalescence they were formed. A vessel, then, is simply a modification of several cells, but its formation is a most important feature in cell-life.

We omit here all mention of other very prominent cell-contents, such as starch, chlorophyll, oils, and many besides, as being foreign to the scope of this paper. So far, we have looked at the cell as an individual only. Now we must regard it as the member of a group—*i.e.*—

(*b*) THE CELL IN COMBINATION.

There are two chief kinds of combinations:—1.—*Cell-Fusions.* Here the separate cells unite to form a vessel (just described), whose elements are usually indistinguishable as such. They simply form *a uniform whole* of a higher type.

2.—*Tissues.* Here the separate elements can be easily recognised, and retain a certain individuality, uniting only by juxtaposition, not by actual fusion, and not necessarily suffering any absorption of partitions.

We cannot now particularise the numerous tissues. That would mean a minute study of the anatomy of root, stem, and leaf, It is enough to say that the whole plant is made up of cell-fusions and tissues in varying proportion, both these being composed of cells, in one case fused, in the other not so. In both cases, cells, and cells only, form the groups; the two groups make up the plant. We thus find our starting axiom to be true.

We must next ascertain how from any one cell, other cells are formed. We have seen how they are fused to produce vessels, but how are they able to produce the tissues spoken of—groups of similar and distinguishable elements? In other words, What is Cell-formation? Here again we must be content with a few broad facts, and let theories alone.

(*c*) CELL-FORMATION AND GROWTH.

By this is meant the origin and multiplication of cells, two processes which are identical, if we shut out spontaneous generation, and the "fortuitous concourse of atoms," and base our study on the axiom, not as yet invalidated, "Omnis cellula ē cellulā."

There are three types of Cell-formation:—

1.—*Renewal, or Rejuvenescence.* This is the forming of a new cell from the entire contents of an already existing one. It is seen among the *Algæ*, where a "swarm-spore" is formed out of the entire protoplasm of a vegetative cell, swims for a time by means of its cilia, secretes a cellulose coat, and finally settles down, to presently form in its turn a new swarm-spore.

2.—*Conjugation.* Two cells approach each other, an aperture is formed at their junction, complete union of the two masses of protoplasm ensues, and "spores" are produced which in turn become independent organisms. This is seen in many *Algæ* and *Fungi*:—in *Spirogyra*, for example, and the *Conjugatæ* as an order, and in *Mucor*, the ordinary green mould.

3.—*Cell-Multiplication.* This is the formation of two or more protoplasm masses out of one original mass; each of the three modes named begins by the protoplasm losing its motile power, and shrinking into a somewhat spherical form. If the "mother-cell" contains a nucleus, this contraction is *preceded* by the formation of fresh nuclei, destined for the "daughter-cells," or new ones. This formation may come about either by simple *division* of the original nucleus, or by *absorption* of it, and re-formation of as many fresh nuclei as there are daughter-cells to be produced. After this point is reached, there occur two different conditions in the process of cell-multiplication, known as "Free Cell-formation" and "Cell-division."

Free Cell-formation. In this, the protoplasm masses of the mother-cell gather round the *previously-formed* nuclei, and so form new cells *enclosed within* the mother-cell, which still for some time retains life, so that only *part* of its protoplasm goes to make the daughter-cells. The cell-wall is in most cases formed while the new cells are still inside the mother-cell, as in the "embryo-sac" (of which presently), and in pollen-grains. In some fewer cases, it is formed after the escape of the new cells, as in the swarm-spores of some fungi and lichens.

Cell-division. This is by far the commonest method of multiplication. *Only* this obtains in all processes of ordinary growth, such as tissue-forming, etc. Here the protoplasm of the mother-cell divides into many portions by repeated bi-partition, following a similar process affecting the nucleus. These fill up the entire space inside the mother-cell, leaving room only for the cell-walls to form, so that in this case *all* the maternal protoplasm goes to make the daughter-cells. Sometimes the formation of cell-walls goes on *pari passu* with division of the protoplasm, as in filamentous *Algæ* and the pollen-grains of many dicotyledons. In others it is sudden, as in the pollen-grains of most monocotyledons.

In tissue-formation this division is repeated again and again, the resulting cells increasing to the size of the parent ones, and again dividing. Meantime, there also ensues an increase in thickness, although, for the most part, this does not go on until the cell has attained its full size, when the secondary layers, already described, come about.

Not only is the *number* of cells thus increased by cell-division, but seeing that they retain connection one with the other, we get the various cellular structures, finding their completest development in the adult plant.

We cannot now say more about the cell and its growth. The question, "How do plants grow?" is easily replied to in cases of one-celled plants, even though these may be of considerable size, as in some *Algæ*, or branched in a complicated manner, as in *Mucor*. In the simplest, many-celled plants—such as *Penicillium*—we find only a row of cells, one above the other; next come those consisting of a plate of cells, with many rows side by side, as in some *Algæ*. In them, renewal, conjugation, or multiplication, may be the method used. In the higher flowerless plants, and in all the flowering plants, the last only is used.

It now remains for us to see in what way and by what means the mother-cell of the embryo comes about, and to trace its progress into the adult-plant. This brings us to the second part of our subject:—

II.—From Cell to Plant.

Here, in broad terms, I shall describe the processes carried on by the reproductive organs of the plant, in order to show the origin of the primary cell.

(*a*) FERTILIZATION.

The organs of a plant are set in two groups—1st, Those of nutrition, including root, stem, and leaf; 2nd, Those of reproduction, found in the flower.

A *Flower* consists normally of four sets or circles of organs:—1. The *Calyx*, usually green, made up of sepals; 2. The *Corolla*, inside the calyx, and made up of petals, usually coloured (these two circles are the auxilliary organs of reproduction, subserving only the purposes of protection and attraction); 3. The *Andrœcium*, or set of stamens, varying in number and position; 4. The *Gynœcium*, or *Pistil*, made up of one or more carpels, separate or united (these two circles are the essential reproductive organs, at which we must look for a time, and ascertain their functions.

A *Stamen* consists of a stalk—the *filament*, and a club-shaped end—the *anther*. The latter contains in its two lobes certain cells, which in turn contain minute grains of powder, often yellow in colour, and called *pollen-grains*. This pollen is *the essential fertilizing agent*, without whose aid no embryo can possibly exist.

A *Carpel* consists of a lower part, or body, called the *ovary*, which is hollow. It ends above in a viscid, cellular tip, devoid of epidermis, called the *stigma*, whose cells secrete a sticky fluid; the stigma may be immediately above the ovary, or raised some distance above it, on a stalk termed the *style;* this may be absent, the stigma never. Sometimes there may be more than one carpel. This may be quite apparent, as in Buttercup, or they may be so united that the ovaries form only one cavity—*apparently*, therefore, only one carpel, as in Primrose, whereas there are really five. With this we have nothing to do now. The fact to remember is this: that the ovary contains one (or there may be very many) minute body attached to its inner wall, termed an *ovule.* This, when "ripe," becomes the *seed.* This ovule is *the essential element that is to be fertilized.*

We must look yet more closely at both pollen-grain and ovule to understand what work is assigned to each.

A *pollen-grain* consists of *a cell with two coats*, and possessing protoplasmic contents. The inner coat is entire; the outer is perforated by minute apertures, and often very exquisitely ornamented by spines and the like, as all my readers probably know. Through these apertures in the outer coat, the inner one is able, under certain conditions, to penetrate and send out a process called a *pollen-tube*, which grows in length according to need. To enable the inner coat to penetrate the outer, moisture is needed. This is found in the moist cellular stigma, to which the pollen-grains are carried from the anther-cells by the action of gravity, by the wind, or by insect agency. *This transference of the pollen to the stigma is absolutely essential.* When once there, the pollen-tube (or tubes) increases in length, nourished by the stigmatic fluid, and penetrating the conducting-tissue of the style, finds its way down this style into the ovary, and finally into the ovule.

An *Ovule* is at first, roughly speaking, a minute nodule of cellular tissue, growing on the wall of the ovary, at a spot called the *placenta.* (This term is used to express the point of attachment of an ovule, or of a set or row of ovules, to the ovary-wall; on opening a pea-pod, each seed, or ripened ovule, is seen attached to its own placenta.) A *Funiculus*, or "little cord," attaches the ovule to its placenta. Presently, a double coat grows up around the developing ovule, covering it entirely except at its apex, where a tiny hole is left, called the *Micropyle* (meaning in Greek a little gate or door). The original cellular mass inside the coats is the *Nucleus.*

While the above changes are going on in the pollen-grain, a change is also seen in the ovule. One of the many cells in the nucleus enlarges at the expense of all the rest, and is called the *Embryo-sac*, inside which, at its apex, appear two nuclei, round which its protoplasm aggregates. These are "naked" cells—*i.e.*, destitute of cell-wall—and are called the *Germinal Vesicles*. In these, we shall see, is *the starting-point of the embryo*, and therefore of the whole plant.

All is now ready for the fertilization to begin. The time occupied by all these changes in pollen-grain and nucleus varies, from a few hours in Crocus to four or five days in Arum, and some months in Orchids. In Crocus, the length of the "tube" is 9,000 times the diameter of the pollen-grain, and yet the former performs its journey in about twelve hours! The pollen-tube, having reached the ovule, enters it *by the micropyle*, or hole left by the double coat just mentioned; it then applies itself to *the apex of the embryo-sac*, close to where the germinal vesicles are situate. The tube contains a fluid protoplasm, holding sulphur and fat-globules in suspension; directly the tube is applied to the embryo-sac, it is supposed that the *Fovillæ*, or contents of the tube, pass through its coat by osmosis into the germinal vesicles. Be this as it may, as soon as the tube touches the vesicles, they are in some way "fertilized," and as the primary result each of them developes a cell-wall, of course, of cellulose. It matters nothing apparently whether one or both vesicles be fertilized; one almost always perishes, possibly from deficient nourishment; still, the tube has, so to speak, "two strings to its bow." The remaining vesicle is our *primary cell of the embryo*, whose position and construction we have now ascertained.

(*b*) EMBRYONIC GROWTH.

We have now to trace the primary cell up to the fully-formed embryo, and see the relation of the parts of the embryo to the parts of the adult plant. We have seen that the vesicles were formed inside the embryo-sac by the process described as free cell-formation. We now see the second kind of multiplication coming into play—*i.e.*, Cell-division.

The fertilized vesicle divides into two—an upper and lower cell. The upper one is developed by ordinary "division" into a chain of cells gradually elongating, and forming the *Suspensor*, or *Pro-embryo;* the lower one developes by similar division and growth into the *Embryo* itself. This increases by repeated division, and soon begins to assume a more definite shape, to be seen presently. One fact in passing. While the embryo is growing, there are developed at the *lower end* of the embryo-sac by free cell-formation a number of cells, filled with nourishing matter, called *Endosperm*, or *Albumen*. On this the growing embryo feeds by absorption. In some cases, similar cells are seen *outside* the sac—*i.e.*, in the nucleus of the ovule; the nourishing matter is then called *Perisperm*, from its situation.

We must here glance at the "regions" of the growing embryo, and see their relation to the parts of the plant as we know them in its adult state.

The Embryo now consists of three primary layers of cells, as follows:—1. An outer layer, called *Dermatogen*, or Epidermal tissue, which is formed first. 2. A layer below this, called *Periblem*, or Primary Cortical tissue. 3. Enclosed by these two is a third, called *Plerome*, or Intermediate tissue; this breaks up into two layers almost directly: an outer one, called the *Procambium*, and a central part, the *Fundamental tissue*. Thus we get three primary tissues, the innermost of which divides into two more, making four in all.

From these four are developed all the tissues of the adult plant, which lie very much in a similar relation to one another from circumference to centre, as do the embryonic tissues.

From the *Dermatogen* comes the *Epidermis*, with its appendages—hairs, stings, scales, prickles, bristles, glands, and the like; from the *Periblem* comes the *Primary Cortex*, known as the bark, with its bast-fibres, milk-vessels, and glandular cells; from the *Procambium* come the *Fibro-vascular bundles*, as they are called, which can be traced into the branches and leaves, and which form the wood of our trees, and the harder, firmer parts of the stem and leaves, including the wood-fibres, vascular cells, true vessels, sieve-tubes, and bast-fibres; finally, from the *Fundamental tissue* are formed the *Pith* and the *Medullary Rays*, which radiate from the pith outwards between the fibro-vascular bundles, and form the "silver grain" of wood. All these changes are carried on by cell-division, again and again repeated, the vessels being formed from the cells in the manner already described.

During this differentiation of the embryo into "regions," it begins to assume a definite shape—*i.e.*, it takes on the appearance of a miniature plant, with root, stem, and leaves. The lower end —*i.e.*, the end next the micropyle—is first developed on the suspensor, and is called the *Radicle*, which is invariably, in the mature embryo, close to the micropyle; this is the future *Root*. At the other end of this central axis is the *Plumule*, a tiny bud, destined to form the growing *Stem;* on the centre of the axis are seen two small protuberances, gradually assuming a bud-like and then a leaf-like form. These are the *Cotyledons*, or nursing-leaves, or seed-leaves—the *first leaves* of the plant. If there be two (as in Bean or Buttercup) the future plant comes under the class of Dicotyledons; if only one (as in Lily or Wheat), it will belong to the Monocotyledons.

We spoke just now of the Endosperm or Albumen that fed the growing Embryo. This brings us to our final step in the passage of the cell up to the plant:—

(*c*) GERMINATION.

If all the endosperm be absorbed by the embryo as it grows, then the *ripe* embryo—*i.e.*, *the embryo inside the seed*—is *exalbuminous*—without albumen, and the embryo *entirely* fills the seed, as in Bean; if part only be consumed, the ripe embryo will still possess some, and is *albuminous*, as in Buttercup and Wheat. These two terms are usually applied to the seed rather than to the embryo.

This Albumen is the mealy part in the wheat-grain, the oily part in castor-oil seed, the hard white part in cocoa-nut, and the hard brown part in coffee-seed, which we grind down to the well-known and much-approved domestic powder.

The difference between the albuminous seed of Buttercup and the exalbuminous seed of Bean is mainly this:—In the former, the embryo *feeds on the albumen*, which enables it during germination to develop its root and stem, and after germination, its plumule; in the latter, the embryo *feeds on part of itself*, the Cotyledons (which are masses of nutritive cells) enabling it to develop both radicle and plumule during germination. Except this difference, germination is similar in both seeds. Both are Dicotyledons; indeed, the presence of one or two seed-leaves affects only the morphological, not the physiological aspect of seed-life.

We see, therefore, that the function of the Cotyledons is one of nourishment. They may perform this in either of two ways. They may simply nourish, and then shrivel up and decay underground, as in Pea, Oak, Chestnut, Orange, and in most Monocotyledons, when they are termed *Hypogæous*; or they may be carried up above the ground, acquire chlorophyll under the action of light, becoming green; then, they feed the plumule, or growing stem, by assimilation, like ordinary leaves. This is seen in Maple, Sycamore, Birch, Beech, Lime, Mustard, and many others; the host of little two-leaved plantlets, seen covering the ground under a beech-tree in early spring, are these two cotyledons doing their work; in this case, they are called *Epigæous*—*i.e.*, above ground.

The conditions absolutely essential for germination are only three: heat (above zero), air, and moisture. Given these three, a seed will germinate. Of course, as a usual thing, it is, in addition, placed in the soil, where its roots can absorb due nutritive materials. Having germinated, how is it to get on until the embryo, now freed from its covering, or *Testa*, can set up for itself as an independent organism, and make its way in the world?

1st.—The nutrient matter in the albumen, or cotyledons, must be dissolved, that it may nourish at all. It is mostly insoluble, in the form of starch. To remedy this, oxygen is absorbed, carbonic dioxide being evolved (causing the loss of weight so well known in growing-seeds); the starch is changed into dextrine, thence into sugar, some of it being converted into carbonic dioxide. During this stage, heat is being freely given off.

2nd.—The nutrient matter must be conveyed to the embryo plant. This is accomplished by the water taken in by the plant dissolving out the dextrine and sugar from their cell-stores, and carrying them to the embryo, which they enter usually at the point where the cotyledons join the axis, travelling therefrom, at first, mostly down to the radicle; afterwards, both thither and up towards the plumule.

3rd.—These materials must be changed into the substance out of which the plant is to be built up. This is a process the very reverse of the first, because it is one rendering soluble matters insoluble—*i.e.*, making cellulose, or the plant-fabric. How this is done we do not fully know; probably, by the conversion of dextrine at once into cellulose, and by the return of the soluble albuminoids to the insoluble state in which we found them in the mature seed.

These three processes safely accomplished—solution, conveyance, and assimilation—the young plantlet, having, with marvellous dexterity, made use of its own laboratory, begins an independent existence. Its radicle elongates downwards at the root, and by "nutation," as it is called, penetrates the soil, fixes itself there, to absorb the nourishment it finds in "Mother Earth" for one year, or a thousand, as the case may be, as the tender garden-annual, or the giant of the Australian forest.

The plumule is quietly and unerringly drawn up under the gentle influence of the light which it needs must follow, to send out, first of all, *branches;* then *leaves*, which by their thousand "mouths" shall take in the food they find waiting for them in the air supplied by the animal creation; finally, as the highest result of its growth, the *flower*, in which shall reside the germ potential of the successors of the race. The plantlet has now solved the problem with which it started its existence—"How am I to grow?" and solved it in a wonderful manner, guided by the same Divine power that creates and governs both star and flower.

In following the plantlet through its devious course, we have been able to see how from a speck of protoplasm, microscopically minute, there can be evolved the seaweeds that fringe our shores, the ferns that grace our woodlands, the flowers that gladden us all our days, and the majestic forest-trees under whose shadows we can rest, and think of all the beauty and grandeur that can come from so simple an origin.

London; July, 1885.

The Microscope and How to Use it.

By V. A. Latham, F.M.S.

Part IV.—Practical Histology.

THE study of Histology is attended with more difficulty than that of Botany or Geology, and owing to the study being also an extensive one we can only give the simplest details. Nearly all the methods recommended have been tried with success, and are mostly gathered from British and foreign text-books, special prominence being given to the later methods of staining.

Tissues.—It is of the utmost importance that the tissues should be fresh, and the animals most suitable are cat, dog, rat, guinea-pig, and frog. As some fluids alter the normal appearance of the tissues, they should, in the first instance, be examined in their *own* fluid. It should be carefully borne in mind that the specific gravity of whatever fluid is employed must be the same as that of the tissue under examination; also that the solubility or non-solubility of the tissue in the particular fluid-medium employed must be carefully taken into consideration, as the following facts will show:—Earthy salts are soluble in chromic and nitric acids, oils in ether, albuminous matters in acetic acid, the object of adding a fluid being to regulate the degree of transparency of the tissue, according as its examination is facilitated by the augmentation or diminution of the same. The chemical relation between the tissue and the fluid-medium employed must necessarily be considered. The normal fluids most commonly used are lymph, serum, amniotic and pericardial fluid, iodised serum or dilute albumen. The methods of preparation will be given in a future part.

Single Staining.—The best and most useful stains are logwood, picro-carmine, Bismarck brown, carmine, and aniline blue, but numerous others will be given, so that students may try them and choose their own stains. Staining may be either single, double, or treble in its application.

Orchella, or French Archil: Staining with the extract.—Wedl uses this substance, which, after the loss of the ammonia, is dissolved in 20 cc. of absolute alcohol, 5 cc. of acetic acid, and 40 cc. of distilled water, so as to make a saturated solution. Protoplasm and matrix are coloured red. Sections hardened in Muller's fluid, chromic acid, or methylated spirit, must be washed in distilled water; touch the section on the back of the hand or blotting-paper to get rid of the water; apply a few drops of the staining fluid to the section, and mount. Fresh pathological formations stain well.

Gentian Blue.—Where *Bacteria* form the subject of observation, this stain must be genuine. That sold by Messrs. Hopkin and Williams is recommended by Dr. Gibbes. A half per cent. solution is the best strength to use.

Iodine Green is especially useful for observing the *nuclei* of osseous tissue. In growing bone it colours the unossified cartilage, giving a very striking result. It stains mucous glands green. A saturated watery solution should be made with distilled water; when required, make a 1 per cent. solution, and filter. This is really a multiple stain, as it gives different tints of the same colour. It stains rapidly, and *cannot* be removed by washing. The staining process should be carefully watched, and the sections removed when the required tint is gained. Mount in dammar, etc. Do not leave the stained sections long in spirit, which partially removes the dye. For botanical work use an alcoholic solution of iodine green—3 grains to the ounce of alcohol.

Methyl-blue, for examining bacillus in the breath of phthisical subjects. It is used as a contrast or ground-stain for Tubercle Bacillus. A strong, nearly saturated, solution is required; a good proportion (1 drachm to the ounce) of rectified spirit must be added to make it keep. In using, stain the tissue deeply, and wash away the superfluous pigment in water acidulated with acetic acid. The acetic acid dissolves out much of the pigment, and the washing must be continued till the proper tint is obtained. The sections must then be thoroughly washed in water, and mounted in glycerine or Farrant's solution. Dammar is unsuitable, as clove-oil discharges the colour. This is a most valuable dye, for in contact with certain tissues it gives a double stain. It decomposes into two colours: one a *red*-violet, the other a *blue*-violet, each of which acts on different tissues. It is useful for hyaline cartilage; the red-violet attaches itself to the matrix, and the blue-violet to the corpuscles. For fresh tissues it also forms a useful dye, and in the form of a one per cent. watery solution it may be used instead of magenta. It stains certain parts a beautiful violet, and is very useful for showing the corpuscles in connective tissue, or the nuclei in fresh cells, or for mucous tissue. It is best to mount in a saturated watery solution of potassic acetate.

Methyl-green.—This is a lighter green than the iodine, and is used in the same manner. A 2 per cent. solution is usually strong enough. This stain has a peculiar affinity for the heads of spermatozoa.

Spiller's Purple.—This is a very useful colour for double-staining, and also for *Bacteria*. For double-staining, a 2 per cent. solution in water is required, and the section must be very deeply stained, as a great deal of the colour is washed out by the spirit. For *Bacteria* a 1 per cent. solution, made with distilled water, is best. At first, this colour is difficult to fix, but after numerous trials we found it was less easily washed out if strong absolute alcohol (·795 sp. gr.) was used, than when methylated spirit was employed.

Green Colouration of the Nuclei.—To obtain this, Tafani employs a fluid containing three or four parts of a saturated watery solution of aniline-blue to some six or seven parts of a saturated watery solution of picric acid.

Rose-aniline Hydro-chloride.—This is useful for double and treble staining; and for this purpose a strong solution must be made in rectified spirit. Place some of the crystals in a glass mortar, and rub up with a little spirit; add spirit until all the crystals are dissolved. This will do for ordinary staining processes. It is also used in a special manner for the Tubercle Bacillus, and the method of making the stain is as follows:—Take of rose-aniline hydro-chloride 2 grains; methyl-blue, 1 grain; rub up in a mortar. Then dissolve aniline oil, 3 cc., in rectified spirit. Add the spirit slowly to the stains until all is dissolved, then slowly add distilled water, 15 cc.; keep in a stoppered bottle. (For method of using, see Tubercle Bacillus.)

Ferrier's Magenta Fluid.—Magenta crystals, 1 decigr.; distilled water, 15 cc. Dissolve and add rectified spirit, 5 cc.; glycerine, 20 cc. Useful for blood-corpuscles. Being of a specific gravity, similar to that of the Liquor Sanguinis, the coloured corpuscles of non-mammalian vertebrates alter but little in shape while they become stained.

Magenta.—Gibbes' Formula is a reliable stain; it does not fade like the others. Prepare as follows:—Magenta crystals, 2 parts; pure aniline, 3 parts; alcohol (sp. gr., ·830), 20 parts; aqua dist., 20 parts. Dissolve the aniline in spirit; triturate the magenta in a glass mortar to a fine powder, mix the spirit gradually while stirring, until all the colour is dissolved, then mix the water slowly, still stirring, and put in a stoppered bottle.

Ditto.—Ransome's Formula:—Rose aniline, 3 parts; alcohol anhyd., 42 parts; magenta or fuchsin, 1 part; distilled water, 45 parts. Mix and preserve as above.

Gibbes's Rose-aniline Acetate.—Must be rubbed up in a mortar with rectified spirit, and when thoroughly dissolved an equal quantity of distilled water added; 5 grams of crystals to 100 cc. of spirit, and thoroughly dissolved; then 100 cc. of distilled water added. This makes a good strength for general use, and is a useful stain for blood.

Aniline Blue (insoluble in water).—By treating it with sulphuric acid, the soluble blue may be obtained. This may be simply dissolved in water until it assumes a deep cobalt colour, or the following solution may be prepared:—Soluble aniline blue, 2 centgr.; distilled water, 25 cc.; alcohol, 20 to 25 drops. This fluid stains tissues preserved in alcohol a brilliant blue in a few minutes, but those preserved in chromic acid are coloured less rapidly. Tissues stained with this colour may be preserved in water, alcohol, and glycerine, and are not altered by the addition of acids. The lymphatic glands, spleen, walls of the intestines, and more particularly sections of brain and spinal cord, assume a fine appearance (Frey).

Heidenhain uses the neutral, reacting, aqueous solution in still higher dilution, so that, when poured on a watch-glass, it shows on a light ground a forget-me-not blue colour. The sections (from alcoholic preparations) should remain for a day in 4 ccm. of this fluid in a moist place, and are then to be immediately mounted in glycerine, and cemented. The colour and colouring power of the solution is considerably increased by the addition of a little acetic acid, or even its vapour; the vapour of ammonia deprives it of its colour entirely.

Soluble Aniline Blue is useful for some tissues, such as stomach and spinal cord. It is very easily made, but requires to be strong, nearly saturated. Some of the granules should be rubbed up in a mortar until quite dissolved, and some rectified spirit added—about 10 cc. of spirit to 100 cc. of water, as it is very apt to grow mouldy on the surface. Some authors recommend a 1 per cent. solution. Sections must be deeply stained, as a good deal of the colour comes out in the spirit. They should be only lightly washed in methylated spirit, and then transferred to absolute alcohol, which only slightly affects the colour. There are several soluble blues sold, but that of Messrs. Hopkins and Williams is thoroughly reliable (Gibbes).

Blue Black (1 per cent. solution in water).—If the section is overstained, the excess may be removed by steeping it in a 2 per cent. solution of chloral-hydrate. For the nervous system an alcoholic solution is most useful. Dissolve 1 decigrm. in 4 cc. of water; add to this 100 cc. of rectified spirit and filter. Preserve in a stoppered bottle. This solution stains rapidly, and gives a pleasant slate-grey colour. It is especially useful for nerve-centres. Sections may be mounted in dammar without any fear of removing the dye (Stirling).

Sankey's method.—Dissolve 5 centigrms. of the dye in 2 cc. of water; pour it into 99 cc. of methylated spirit and filter. The sections of brain are stained in a few minutes; clear with clove-oil, and mount in dammar in the usual way.* Dr. Lewis † recommends deep staining with an aqueous solution of the dye ($\frac{1}{4}$ to 1 per cent.), and the subsequent removal of superfluous pigment, by immersion for twenty minutes or so in an aqueous solution of chloral hydrate (1 to 10 per cent.). The chloral is then removed by washing in water, and the sections mounted in dammar or balsam.

Aniline Blue Black, 1 part; water, 40 parts. Dissolve and add rectified spirit, 100 parts. Keep in a stoppered bottle, filter a few drops into a watch-glass, and add eight or ten times as much alcohol to it. Stain the section from half to three minutes, and mount in Canada balsam and benzole.

Soluble Parme Fluid.—Obtained by treating diphenylate of rose-aniline with sulphuric acid; when dissolved in water in about the proportion of 1 to 1,000, it gives a gorgeous blue, running into violet, and colours the various tissues in a few minutes. They are then to be washed in water, and either examined in glycerine, or, after being deprived of their water by absolute alcohol, are to be mounted in Canada balsam and benzole (Frey).

Iron.—Dr. Frances E. Hoggan's method:—

1.—Steep sections, fresh or hardened, in alcohol for about five minutes.

2.—Transfer to a watch-glass full of tincture of steel for two minutes.

3—Remove into a 2 per cent. solution of pyrogallic acid in alcohol; and in one or two minutes, or when the desired depth of colour has been attained, wash the sections in distilled water, and mount them in glycerine or glycerine jelly. This is a very good method for staining cartilage, whether normal or morbid.

Blue Colours for Staining.—It is desirable in many cases to make use of a blue fluid, especially for staining specimens injected with carmine. Several methods are practical, as with sulph-indigate of potash (so-called indigo carmine), with aniline blue, and soluble parme.

* *Quart. Journal of Microscopical Science*, Vol. XVI., p. 95. † *Ibid*, p. 73.

Indigo-Carmine:—Oxalic acid, 1 part; distilled water, 22 to 30 parts; indigo-carmine as much as the solution will take up. If the blue colour is in excess, it may be removed with a solution of oxalic acid in alcohol. It tinges rapidly and uniformly, and is recommended for colouring axis cylinders and nerve-cells of brain and spinal cord previously hardened in chromic acid (Thiersch).

Carmine.—This is a useful stain, but it tires the eye. There are several ways of making this stain, of which the following are a few:—

(*a*) Take 2 grms., and rub thoroughly in a mortar with a few drops of water; then add 4 cc. liq. ammonia and 48 cc. distilled water; filter into a bottle, which should be left unstoppered for a day or two for the excess of ammonia to evaporate. This is a strong solution, which must be diluted before using (Klein).

(*b*) **Beale's Carmine Solution.**—Dissolve carmine, 1 grm., in liq. ammoniæ fort. 3 cc., warm, add distilled water, 120 cc., and filter. Then add glycerine, 30 cc., and rectified spirit of wine, 120 cc., and keep in a well-stoppered bottle.

(*c*) **Borax Carmine.**—Thoroughly mix carmine, 2 grms., and borax, 8 grms., in a mortar, dissolving in warm water for twenty-four hours. The supernatant fluid, which must be decanted, is then ready for use. All carmine-stained preparations, after being thoroughly washed in water, are improved by placing them for a few minutes in a 1 per cent. solution of acetic acid. This brightens the colour, and fixes the carmine in the nuclei, and also differentiates the stained from the unstained parts. Thus the stain becomes more selective.

(*d*) **Borax-Carmine** (Arnold's).—A saturated solution of borax is prepared in a wide-mouthed bottle. The borax should be in some excess. Carmine is now added to the solution under constant agitation, until after a while it no longer dissolves, and an excess remains at the bottom of the vial, mingled with the crystals of borax. After twenty-four hours the supernatant fluid is decanted. To this clear portion 2 fluid ounces of alcohol and 1 fluid drachm of caustic soda solution are added (U.S.P.) The staining solution is now ready, or the alcohol may be omitted (Arnold), and the liquid evaporated to dryness. The red amorphous mass is then to be powdered. Of this, 15 grains are placed in an ounce of water, to which 1 fluid drachm of alcohol is added. Sections, after staining, should be washed in alcohol to remove the superfluous colouring fluid, and then transferred to a saturated solution of oxalic acid in alcohol to fix the colour. The oxalic acid is then washed out in alcohol. Finally, the sections are cleared in oil of cloves, and mounted in dammar or Canada balsam in benzole.

Thiersch's Carmine Fluids.—(*a*) Red fluid:—Carmine, 1 part; caustic ammonia, 1 part; distilled water, 3 parts; this solution is to be filtered.

A second solution is made as follows:—Oxalic acid, 1 part; distilled water, 22 parts. One part of the carmine solution is to be mixed with 8 parts of the oxalic acid solution, and 12 parts of absolute alcohol are to be added and filtered. If the filtrate is orange-coloured instead of dark-red, more ammonia is to be added, and the orange becomes red. If crystals of oxalate of ammonia are formed, it must be filtered a second time. After staining from one to three minutes, wash in alcohol of about 80 per cent. When the colour has become too dark or diffuse, the preparation is to be washed out with an alcoholic solution of oxalic acid.

(*b*) **Lilac Carmine Fluid.**—Borax, 4 parts; distilled water, 56 parts; dissolve and add carmine 1 part. The red solution is to be mixed with twice its volume of absolute alcohol and filtered. Carmine and borax remain on the filter; the precipitate, when dissolved in water, may be again used. This fluid is especially useful for cartilage and bones which have been decalcified by chromic acid.

Alum Carmine.—Take a 1 to 5 per cent. solution of ordinary alum, or ammonia alum; boil with ½ to 1 per cent. powdered carmine for twenty minutes. Filter, and add a little carbolic acid to preserve it. This is a useful solution, and is recommended by Grenacher.

Acid Carmine.—An ordinary ammoniacal solution of carmine is to be mixed with acetic acid in excess, and filtered. The red solution thus obtained stains diffusely, but after the addition of glycerine, thus tempered with a little muriatic acid (1 to 2 per cent.) to the microscopic preparations, the cell-body is seen to gradually lose its colour, and the carmine only is retained by the nucleus. For mounting in glycerine, the preparation is to be washed with water containing acetic acid (Schweigger Seidel).

Hæmatoxylin (Boehmer's).—This is much preferred to the carmine, and there are a great many modifications. Dissolve 20 grains of hæmatoxylin in half an ounce of absolute alcohol; then dissolve 2 grains of alum in 1 ounce of distilled water. Some drops of the first solution are added to the second, which, after a short time, becomes a beautiful violet. It improves after keeping for a few days, and should always be filtered before using. (Thin.)

Kleinenberg's Solution (Foster and Balfour).—

(1) Make a saturated solution of crystallised calcium chloride in 70 per cent. of alcohol, and add alum to saturation.

(2) Make also a saturated solution of alum in 70 per cent. of alcohol. Add one part of No. 1 to eight parts of No. 2, and to the mixture add a few drops of a saturated solution of hæmatoxylin in absolute alcohol. The stained sections are placed at once in strong spirit.

Aqueous Logwood Stain.—Take 60 grms. of *dried* extract of hæmatoxylin, 180 grms. of powdered alum, and rub them thoroughly together in a mortar, adding slowly 300 cc. of distilled water; mix carefully, and afterwards filter. To the filtrate add 20 cc. of absolute alcohol and preserve in a stoppered bottle. This solution should be kept in a cool place for at least a fortnight before using. The older it is, the more excellent it becomes. (Harris and Power.)

Mitchell's Hematin Staining Fluid.*—This is one of the best logwood stains, and we believe it will take the place of nearly all the older stains. Make as follows:—Finely ground logwood, 2 oz.; sulph. aluminium and potash alum, 9 drms.; glycerine, 4 fluid ounces; distilled water, a sufficient quantity. Moisten the ground logwood with sufficient cold water to damp it, place in a

* Academy of Natural Science, Philadelphia.

funnel, pack it loosely, and then percolate enough water through it until the liquid is but slightly coloured. Allow the logwood to drain thoroughly, remove from the percolator, and spread out on a paper to dry. Dissolve the alum in 8 fluid ounces of water, moisten the dry logwood with a sufficient quantity of fluid, and pack again in the funnel rather tightly, pour on the remainder of the alum solution. When the liquid percolates through and commences to drop, close the aperture with a well-fitting cork, and allow the logwood to macerate for forty-eight hours. Then remove the cork, and allow the liquid to drain off; pour sufficient water upon the drug, and percolate through 12 fluid ounces altogether. Mix this with the glycerine, filter, and place in a stoppered bottle. A few drachms of alcohol may be added to increase its preservative qualities. It yields good results when used undiluted, as a quick stain; but we prefer placing the tissues in a weak solution (10 drops to 2 fluid drachms), with warm, distilled water, for about twelve hours. Its advantages are: its permanency, beautiful violet colour, clear and sharp definition, and can be used with the very highest powers.

Gibbes' Logwood.—Extract of hæmatoxylin, 6 grms.; albumen, 18 grms. Mix thoroughly; while mixing, add 28 cc. of distilled water. Filter. Add to the filtrate 1 drachm of rectified spirits of wine; let it be kept in a stoppered bottle for a week before using. What remains on the filter can be mixed with 14 cc. of distilled water, and left soaking in it for an hour or so; then filter, and add to the filtrate ½ drachm of rectified spirit. The second solution is as strong as the first. The alum used must be potash without ammonia, and the extract of hæmatoxylin must be English.

Klein's Logwood Stain.—Mix 5 grms. of the officinal extract of hæmatoxylin with 75 grms. of alum in a mortar, and pulverise carefully. To this add gradually 25 cc. of distilled water, and filter. To the residue add 15 cc. of distilled water, and again mix in a mortar and filter. To this filtrate add 2 cc. of alcohol. Now mix the two filtrates, and keep in a glass-stoppered bottle. If the liquid ever becomes mouldy, filter again. Care must be taken to prevent any acid from intermingling with the fluid. Acids cause the hæmatoxylin to turn red; for this reason, sections which have been hardened in chromic acid should be placed in a watch-glass, and covered with distilled water, to which add a drop or two of a 40 per cent. solution of caustic potash. Allow it to remain therein 10 or 15 minutes. To use the fluid, add a few drops to an ounce of distilled water, so as to make a pale-violet solution; allow the sections to remain in this solution from twelve to twenty-four hours. Or, a stronger solution may be employed, which will stain specimens in from ten to thirty minutes, and still give good results. Mount either in glycerine, acetate of potash, balsam, and benzole, or, better, resinous turpentine.

Eosin Solution, for fresh tissues.—It is usual to have a strong solution of from 1 to 10 or 20 per cent. on hand. A few drops are then added to a watch-glassful of water or alcohol. It is apt to diffuse, unless special care is taken, and long soaking—say, for twenty-four hours—is practised. Renaut employs either a watery solution alone, or with the admixture of one-third of its volume of alcohol. The sections are then washed in distilled water, and may be preserved in a neutral solution of glycerine, to which 1 per cent. of chloride of sodium has been added to prevent the glycerine dissolving the eosin. In examining the fixed corpuscles of the subcutaneous tissue, Renaut injects beneath the skin a solution of eosin and water (1 to 500), and then removes a portion of the infiltrated tissue with the scissors. Eosin is a phenol dye, and stains epithelium a dark-red, axis cylinders of nerves, colours areolar tissue, nuclei of ganglion cells, and their processes. The amyloid substance in that form of degeneration stains bright red. Fresh tissues are hardened and stained simultaneously. It is valuable for the recognition of blood corpuscles. The solution is made as follows:—Eosin, 1 part; alum, 1 part; alcohol, 200 parts; mix. Gibbes uses 5 grms. of the powder, which should be rubbed up in a mortar, with 100 cc. of distilled water, making a 5 per cent. solution.

Cochineal Dye.—Take 7 grms. cochineal and 7 grms. alum in powder, rub thoroughly together in a mortar, and add 700 cc. distilled water, evaporate to 400 cc., filter twice, and afterwards add 1 or 2 drachms of absolute alcohol.

Safranine.—This colour is useful for the detection of amyloid degeneration. A 1 per cent. solution is made with distilled water and filtered. The sections must be left in the stain for half-an-hour, and then washed well in water; then placed in methylated spirit, and washed until the colour comes away very slowly. A little practice is required to do this properly, as if they are left too long all the colour will come out, and if they are not washed enough in the spirit, they have an opaque and blurred appearance.

Vesuvin.—A 10 per cent. aqueous solution may be made and diluted; it is a pleasant stain to the eye, and differentiates fairly well.

Chrysoidin is used as a ground-stain with sputum containing Tubercle Bacilli. It is of no use for tissues, as it fades very quickly on exposure to light. Add a crystal of thymol, dissolved in alcohol to an aqueous solution.

Rosein is soluble in spirit. It is useful for double-staining when sections are to be mounted in dammar, and is also useful for staining retina, etc.

Bismarck-Brown.—Make a watery solution of 2 grains to the ounce; heat and filter; soak in the solution about three minutes; set the colour with 4 per cent. of glacial acetic acid for half a minute. After dehydrating with alcohol, mount in dammar varnish.

To Combine Bismarck-Brown with Eosin.—Put the sections in a strong aqueous solution of Bismarck-brown; remove after about two minutes to 4 per cent. acetic acid; then place in a weak alcoholic solution of eosin, and then again in the acetic acid solution (Satterthwaite). Bismarck-brown is invaluable for staining sections of bone and young granulation tissue. For this purpose take of aniline brown, 1 part; anhydrous alcohol, 10 parts; distilled water, 100 parts. The sections must stain slowly, and the water in which the staining fluid is suspended must contain about 10 per cent. of methylated spirit. Make a straw-coloured solution, and allow the sections to remain in this for several days. Mount in Canada balsam and benzole. Where used as a contrast-stain, pour a few drops of the strong solution into a watch-glass, and allow the section to remain in this for about ten minutes. This gives a very transparent brown colour to the nuclei and the margins of the cells, leaving the protoplasm almost unstained. Weigert makes a concentrated aqueous solution by boiling in water, filtering from time to time. He also uses a weak alcoholic solution, and combines with other colours.

Naphthaline Yellow for Bone.—Immerse the sections for three days in Müller's fluid; then wash in water, and immediately dip in an alcoholic solution of naphthaline yellow (4 grains to the ounce); after eight to ten minutes, remove the sections, and dip in a watery solution of acetic acid (3 per cent.); then immerse for about ten minutes in an ordinary solution of ammonia carmine, rendered neutral by exposure to the air. Dip the sections again in the acetic acid in order to set the colour, and then place in alcohol of 80 per cent., and subsequently in absolute alcohol. It is excellent for staining fœtal bones, etc.; specimens thus stained show a matrix of deep transparent chrome-yellow. The young bone-corpuscles and osteoblasts, on the other hand, together with the fibrous tissue, will assume a brilliant rose-colour, thus affording an excellent contrast between formed and non-formed bone.

Quinoleine Blue is dissolved in rectified spirit, and an equal part of water is afterwards added. It is a powerful dye, and is greatly diluted when used. The staining has a distinctive shade in different elements of the tissues. It has a special affinity for fat, which it stains a deep blue (Ranvier).

Picro-Carmine.—There are so many modifications of this stain that we will only give Miller's (for others, see various text-books on Histology, and Vol. II. of the *Journal of Microscopy*). We would recommend students to purchase this dye ready made, as it is difficult and tedious to make:—Add 1 part of a saturated solution of picric acid to 2 parts of the 15-grain borax-carmine solution (Arnold's, p. 237). Sections should remain in this about twenty-four hours. Wash quickly in water, then in alcohol, transfer to oil of cloves. Another method is to take Beale's carmine without alcohol, and add picric acid in a similar manner.

METALLIC STAINING SOLUTIONS.

Nitrate of Silver.—A solution of from 1 to 4 grains of the nitrate to an ounce of distilled water, is much used for fresh tissues. In staining the mesentery, it is merely necessary to immerse it for two or three minutes, and then expose it to the light in distilled water for two or three days. The water should be changed several times. The whole mesentery may be removed with the intestine and stained in silver, and then hardened in spirit. Some portions will then be found to be stretched out naturally, and these can be cut out and mounted in Canada balsam and benzole.

Osmic Acid, 1 per cent., may be further diluted as required. It blackens fat and the medullary sheath of nerves. It is useful for hardening the internal ear.

Chloride of Gold, $\frac{1}{2}$ per cent. solution. Place a small quantity of the solution in a watch-glass, and immerse the tissue, which must be perfectly fresh in it. Let it remain in the dark for from half-an-hour to an hour or more; place in distilled water, which must be changed several times, and expose to diffused daylight until it becomes a violet-brown, which will take about twenty-four hours in summer. The tissue, if it is small, can be mounted in glycerine.

Chloride of Gold and Lemon-Juice.—Ranvier is in the habit of demonstrating the corneal nerves by using lemon-juice, in which the tissue is left for five minutes. Then it is soaked for fifteen to twenty minutes in 3 cc. of 1 per cent. solution of gold chloride, and finally for twenty-five to thirty minutes in distilled water, to which one or two drops of acetic acid have been added. It must then be exposed to the sun until the fibres become distinct. Formic acid is also used with gold.

Staining with Osmic and Oxalic Acids.—Little pieces of fresh or freshly-dried preparations are left for an hour in a 1 per cent. solution of osmic acid; then carefully washed and soaked in a cold, saturated solution of oxalic acid; and finally examined in water or glycerine. Elastic fibres are stained yellow and fat black, while the walls of capillaries and many connective-tissue substances are stained red.

Chloride of Palladium.—To dissolve in water, a slight quantity of muriatic acid must be added, strength about 0.1 per cent. Half an ounce or an ounce of this fluid hardens, ready for cutting, a piece of tissue the size of a bean, and also colours it in two or three days. It is especially adapted to striated and smooth muscles, which become brownish and straw-coloured; epidermoid and gland-cells become yellow; medulla of nerves become black by direct action; it renders nuclear formations more apparent. Unfortunately, with many tissues, as brain and epidermis, its action is quite superficial. Wash carefully and mount in glycerine.

Pond Life.

Lectures delivered to the Albany Naturalists' Club, Edinburgh,

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Second Lecture.

IN the last lecture we were chiefly concerned with the lower plants; I shall ask your attention to-night to the vegetable kingdom, and then go on to the animal. There are a very large number of plants in our ponds, but I do not think it would be worth while to enumerate their names. You will remember in the last paper that I told you how the Algæ reproduce themselves, and I showed you that in almost every case the reproduction was effected by means of two cells uniting with each other. One of these is generally larger than the other, and is fixed; it is generally spoken of as the *female* cell, while the smaller and more active cell, which moves or is moved towards it, is called the *male* cell.

The former are found in the ovules of flowering plants and the latter in the pollen; they usually exist in the same flower, but sometimes in different flowers, or even on different plants, as in a case of which I shall speak presently: and in order that seed may be formed it is essential that the contents of the pollen grains shall reach the ovule. The contents of the two cells mix and form an embryo, which, during the next season, grows into a new plant. I have alluded to this again because it is an example of the method of reproduction, which is most common among living bodies.

I will now describe this process in a very interesting plant, called *Vallisneria spiralis*, which is much higher in the scale of existence than those we have been considering. It lives at the bottom of ponds, and consists of two kinds of plants corresponding to the two cells which we saw in *Œdogonium*. The one bears flowers which contain only ovules (the large round cells); and the other, flowers producing only pollen (the small, moving cells). Now, it is necessary that these pollen-grains should reach the ovule, and this cannot take place under water, partly because the flowers grow on different stalks, and partly because water destroys the pollen. What happens is this:—The ovule-bearing flower grows up in a very long, spiral stalk to the top of the water, and then the flower opens out. The pollen-bearing flower has no long stalk; it adopts a simpler way of reaching the surface of the water. The bud simply breaks off and floats up to the surface, and is drifted about by the currents or the winds, until by-and-by it comes into contact with the fixed flower. Thus the contents of the two cells, similar to those which I have described before, find the means of uniting with each other. The fixed flower now closes and is drawn down again to the bottom by the contraction of its spiral stalk, and seeds are formed in a vessel contained in it, and thus the plant is enabled to reproduce itself. *Vallisneria spiralis* is one of the most curious of our fresh-water plants, and as it succeeds very well in small aquaria, any of you may have the opportunity of watching these processes.

With this I shall take leave of the vegetable kingdom, and proceed to the animals. Let me ask you for one moment to look back at the *Amœba* described in the last lecture to recall the three characteristics of living beings:—(1) they *move;* (2) they *feed;* (3) they *reproduce* themselves. Now this, as I say, we may take as typical of the lowest form of life there is, and I said that it is disputed among different authorities whether to call it a plant or animal; and perhaps the most satisfactory solution of the difficulty is to make a division of things which are neither plants nor animals to hold the *Amœba* and many others which resemble it.

There is a very large group of forms more or less closely allied to the *Amœba*, which you will find in the ponds and in the fresh-water ditches. One is like the creature I have just noticed in its motions and in its mode of feeding, but it makes a shell for itself. It is called *Arcella*, and is simply a mass of living matter, and is not divided up into parts or organs, but is simply what we call one "cell." One portion, however, of their substance is different from the rest; it is more solid and is called a "nucleus." All animals (leaving out of consideration low creatures, which may be regarded as intermediate between plants and animals) have this nucleus, and all animals which consist of only one cell, provided with a nucleus, form the lowest main subdivision of the animal kingdom, and we call them *Protozoa.* They are divided into several groups or classes, one of which is illustrated by the forms just alluded to. Another group, which is perhaps the most conspicuous, goes by the name of *Infusoria.* These animals are so called because they are commonly found in infusions of various substances when kept for a length of time; for instance, when vegetable matters, such as hay, pieces of potato, etc., are kept in water for a time and then examined, there would probably be found creatures in the water, and of course the natural conclusion was that these animals had been generated out of the vegetable matters. We believe now that this was a mistaken idea, for if due precautions be taken, vegetable infusions can be kept any length of time without any animals developing in them. There are enormous numbers of these *Infusoria*; if you examine water out of any of the ponds about Edinburgh, you will almost certainly find half a dozen different kinds of *Infusoria* in it, and altogether some thousands of different species are known. The different forms, the colourings, and habits of life are almost unlimited. So that it is quite impossible for me to-night to do anything more than give you a short account of one or two prominent forms, and I shall try to select those which illustrate points of general interest.

There is one little creature, of an ovoid form, called *Euglena viridis*, which you may find swimming about by means of a long hair-like process at one end of its body, and provided with a red spot either at one end or the other, which for a long time was described as an eye. Whether it be so or not is a matter which can only be settled by the most accurate observations, and as the creature is exceedingly minute, and very active, these are very difficult. As it moves, it twists round and round on the long axis of its body, with a curious wabbling motion, and by very close observation you may see that it has a long, fine hair projecting in front, and somehow or other it is by its means that the creature progresses, although it is rather difficult to see exactly how this takes place.

There are a good many different forms of these *Euglenæ*. Some are long and narrow, and others are short and broad. They illustrate one group of the *Infusoria*, characterised by having one long hair-like process, whence they are known as *Flagellata*.

There is another group, characterised by having a round body, which is generally stalked, and by a number of tentacles projecting in all directions, which when examined are seen to possess little sucker-like knots at their extremities. By means of these they catch their prey; suppose, for instance, that a small organism happens to come in contact with one of these little tentacles, it is instantly seized upon, and the small knobs flatten themselves out and suck the juices out of the prey, which may be another *Infusorian*, or perhaps one of the small water-weeds (*Algæ*). Generally two or three tentacles come to the assistance of the one which first captures the food, and bring their suckers also to bear upon the captured organism.

We have now considered two groups of *Infusoria*, one provided with a long cilium and another having a number of suckers. There is still another group, characterised by having a large number of these fine hairs or cilia. If you take a piece of weed from one of our ponds, you are very likely indeed to find springing from it a cluster of very fine threads, each of which bears a very beautiful urn. These are *Vorticellæ* or Bell-animalcules. If you look very closely you will find that each one contains a nucleus, and also you will notice a commotion in the water, so that any little floating bodies are caused to run round and round as if in a whirlpool. This is caused by a ring of hairs round the mouth of the urn, which are continually bending down and up again in turn, producing an appearance as though the rim of the urn were revolving. What really happens is this: one hair bends towards the one next it, which a moment later also bends towards the hair next beyond it. But by this time the first hair has straightened itself again, and by the time that a third has bent towards the fourth, the second is upright again, and so on around the whole ring. In this way the hairs round the rim of the urn convey the impression that it is rotating, and they move so fast that you cannot see the individual hairs, but only receive the general impression. If, however, you place a drop of chloroform in the water under the microscope you may observe the motion becoming gradually slower, and may see exactly how it takes place.

There is another structure in this animal which you must notice. In the centre of the bell is a kind of funnel leading down into its middle; it is in fact a funnel, and does duty as a mouth. It passes straight from the outside into the middle of the body, which consists of soft pulp. So that you observe in this animal an advance upon the very primitive structure of the *Amœba*; that is, that one portion of the body is set apart for the reception of food; it is in fact an "organ."

These Bell-animalcules, as they are called, are very sensitive to disturbance, and a very gentle tap on the microscope is sufficient to make a whole colony draw in, by the rapid contraction of their stalks. Although so fine, the stalk is very curiously constructed. Down the middle of it you may see a very thin hair-like fibre, much thinner than the rest of it, which shrinks when the animal withdraws itself, the consequence being that the stalk coils up into a series of spirals; this fibre, therefore, is the first instance which has come before us of a muscle.

Like the *Amœba*, and many of those plants we have considered, the *Vorticella* reproduces itself by dividing, and this it does longitudinally. One bell divides down the middle, with the result that there are now two on the same stalk. By-and-by, however, one of them swims away by means of the cilia, which when the animal is fixed make a whirlpool to catch its food. A stalk then grows like that of the others. This, however, is not the only way in which the Bell-animalcules reproduce their kind; a bell will detach itself from its stalk and swim about until it comes alongside another. The two melt into one, and form a thick coat round themselves, or in other words become "encysted." The protoplasm in the cyst then breaks up into a number of little portions, each having its own case, and then each of these becomes free and swims about. And now a very curious thing which happens in many of these forms, is that the creature which comes out of this germ where it is free and swimming about, is not a Bell-animalcule, but one of these sucker-bearing animalcules which I described to you just now, and only after another longer or shorter period does the sucker-bearing animalcule encyst itself, and give rise to other germs, which become Bell-animalcules.

Now, I must pass on to another creature, which bears the popular name of the "Slipper-animalcule" (*Paramæcium*). It has an irregular shape, and does not much resemble a slipper, unless it be that of a Chinese lady. It is covered all over with cilia, which are very fine and enable it to propel itself through the water at a great speed, so that it is almost always roaming about, and on that account is difficult to observe. At one end there is a funnel which leads into the soft tissue in the centre of its body. There is the usual nucleus which we find in all these creatures, and within this again is another little body called a "nucleolus." Some species have a number of little green specks scattered about in the body, which seem to be similar to those which impart the green colour to the leaves of plants; furthermore, it has what looks like two empty spaces, and which are called "vacuoles;" they are in reality filled with fluid. One is situated at each side of the body, and it has been seen that these vacuoles are continually shrinking and expanding again, one after the other. In addition to this there has been observed (though I do not think any of you are likely to see it), that a sort of star-like arrangement projects from the vacuoles just when they are in the act of contracting. This is really a series of little radiating tubes, such that when the vacuoles contract, the fluid which is inside them is forced out and carried along the tubes all through the creature's body. And this appears to be quite analogous to what is called a "circulation" in the higher animals; the little vacuole is, in fact, a heart, and the minute radiating tubes are blood-vessels.

There is still another point to be noticed in the *Paramœcium*, and that is, that the chlorophyll granules and certain other dark-grey granules are continually moving round inside the creature's body. It seems as though the semi-fluid substance of the body were always moving round and round, and always in one direction, the two vacuoles of course remaining still. As I said, the animal swims actively about in the water searching for food, and any little things that come against it are carried by the cilia to the funnel leading into the body substance. You can watch the fate of those *Diatoms*, becoming dissolved in the protoplasm, after which their indigestible shells are cast out through the same funnel by which they entered.

It has been noticed that this animal propagates itself by dividing down the middle, as do so many of these creatures, but in the autumn large numbers of these slipper-animalcules congregate in the bottoms of ponds or aquariums. Two unite, and their contents fuse together, and the nucleus and nucleolus unite with each other; the nucleus of the one with the nucleolus of the other, and *vice versa*. The one nucleus then becomes absorbed in the other, which then undergoes division, and after five or six days the whole protoplasm contained in the bodies of the two animalcules will have broken up into a number of little bodies, which make their escape, and singularly enough these germs are sucker-bearing animals—*Acinetæ*—such as we saw before sucking their nourishment from other organisms; and, perhaps, what is more singular still, they remain sticking to their parents and extracting their juice for nourishment, and this they do until they are of an age to capture food for themselves, when they detach themselves, and afterwards develop into complete slipper-animalcules, like their predecessors.

And with this very brief notice of the *Infusoria* our lecture to-night must conclude.

Half-an-Hour at the Microscope
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Sphæria (Pl. XVIII., Figs. 1—7).—The specimen before us is a portion of leaf, having on it one of the *Sphæriæ*. The genus is a member of the Ascomycetous fungi, and contains a vast number of species. For complete identification, it would be needful to dissect a portion, when the form and size of the *asci* (little transparent sacs containing the spores), and of the spores themselves, might enable the species to be named. In Greville's "Cryptogamic Flora of Scotland" are many beautifully engraved and coloured figures of *Sphæriæ*, by consulting which it is not unlikely that much assistance towards identification might be obtained. It is unfortunate that the specimen is mounted with an opaque background, because we are unable to see both surfaces of the leaf; that exposed to view appears to be the upper, but I am not acquainted with any leaf the structure of which entirely agrees with this. The leaf appears to be thick with a polished surface. By a fortunate accident we discover that it is from a plant having Sphæraphides, and so another clue is obtained which may materially facilitate identification. The diagrams on Pl. XVIII. illustrate the interesting structural relationship between the *Sphæriæ* (Ascomycetous) and *Æcidia* (Coniomycetous) Fungi.

Hairs of Onosma tauricum (Pl. XVIII., Figs. 8—10).—The plant yielding this belongs to the natural order *Boraginaceæ*. It comes from the Caucasus, and is occasionally cultivated in this country. The long, sabre-like hairs, with six smaller arranged star-wise around them on an expanded base, form a pleasing object. The specimen should have been mounted so that the other surface of the leaf could have been seen as well. I judge that the under-surface is presented to the eye, but do not distinctly make out the stomata, which are relatively very small in plants of this order. A point of special structural interest attaches to hairs like these, rough with outward projections. "What are these projections?" "How are they produced?" In the "Histological Catalogue of the Royal College of Surgeons," Vol. 1, p. 3, we are informed that it is by a "deposit of new matter on the external surface of the membrane." And that in the collection at the College (Ppn., A. 13) is "a preparation of the portion of a hair from the fornix of the corolla of *Anchusa italica*, exhibiting a deposit of tubercles of new matter on its external surface. Each tubercle contains two or more cavities, and a defined margin exists between them and the hair, to which the tubercles adhere as so many scales." The date of this publication is 1850. This statement is repeated in the first volume of "Quekett's Lectures on Histology" (p. 12), and figures given; date of publication 1852. Multiplied observations made with the greatest care show that this is not a correct statement of the facts. In reality, the protuberances are part and parcel of the cell-wall itself, which becomes bulged out here and there—a simple form of "*corrugation of surface*," a principle applied with endless detail in animal and vegetable structures, and often in a very beautiful, interesting, and instructive manner. Sectional views may easily be obtained to substantiate the statements here made. The "fornix" is the throat of the flower; in this part of the common pansy are hairs showing the structure beautifully; and in the same part of the garden verbena it is shown still more conclusively because of the larger size of all the parts. I do not think that external deposit on vegetable cell-walls has ever been proved to take place.

Spine of Amphidotus cordatus (Pl. XVIII., Figs. 11—14).—The genus *Amphidotus* is so closely allied to *Spatangus* that few authors recognise its distinctness. The structure of the spines in the two appears to be absolutely the same. Sections are required in order to explain the structure.

Calcareous Plates from Skin of Holothuria (Pl. XVIII., Fig. 15).—The species from whence these were obtained should have been ascertained and stated. In order to understand what we have before us, a portion of the skin should be shown, with plates, etc., *in situ;* also, a transverse section. The double columns are homologous with the "anchors" of *Synapta;* the plates, formed of a calcareous network, are imbedded in the skin, and serve as "*points d'appui*" for the former. They have a strong resemblance to those exhibited by another member, and called "Spines of *Thyone papillosa;*" so strong, in fact, that I suspect their identity.

Cheyletus eruditus (Pl. XIX., Figs. 1—5).—This creature preys upon other acari, and, as would be guessed from the powerful antennal forceps and the lancets forming the oral apparatus, is amongst them like a very tiger, in a flock of defenceless lambs. An extremely interesting description of its structure and habits has been given by Richard Beck, in the 14th Vol., new series, of "Transactions of the Microscopical Society of London." He first found one or two specimens only, which it was desired to keep alive for continuous observation; ascertaining the proper food, he was enabled to do this without difficulty. The male he never saw; the females he ascertained to be capable of agamic reproduction to (so far as his observations went) an unlimited extent. He found, too—and gives a figure of the same—that the female sat upon her eggs with the same continuous care that a hen does when seeking to hatch out a brood of chickens. It is most interesting to observe here and there traces of this strong maternal feeling, where (as in this case) one would least expect it. Some spiders have it to a marked degree. The female earwig watches over and leads about her young very much as does a hen; so also does *Pentatoma grisea*, a large plant-bug, not uncommon on furze-bushes. *Cheyletus* is one of the *Trombidina*.

Trombidium (Pl. XIX., Figs. 6—11).—The species in this genus are numerous and not well characterised. The best work upon them I consider to be "Hermann's Mémoire Aptérologique," a large folio, with numerous carefully-coloured illustrations, published about the end of the last century. There has, however, been other good work done at them since. But there is still a vast deal of such yet wanted to elucidate them satisfactorily. In Rymer Jones's "Outlines" (at page 365), we have, on the authority of Dujardin, the startling information that posterior to the pharynx "no traces are perceptible of either œsophagus, stomach, or intestine, so that apparently the juices of organised bodies, which constitute the sole food of these creatures, must be lodged in lacunary spaces, destitute of any proper walls, in the middle of a brown, parenchymatous mass, which probably performs the functions of the liver. The lacunæ, into which nourishment is thus received, must necessarily be prolonged among the tissues, and in the interspaces between the muscular fasciculi throughout the entire body, thus replacing altogether the circulatory fluid; and even when living specimens of such genera (*Dermanyssus*, *Gamasus*, *Bdella*) as are sufficiently transparent are submitted to examination under the microscope. Although it is easy to see that the blood or other nutritive juices upon which the creatures live, and with which their bodies are filled, occupies a lobed or symmetrically-multifid space, there is no appearance of any canal possessing distinct walls, but the whole seems diffused through lacunæ that extend even into the bases of the legs." I do think there must be error here arising from the extreme thinness of the parieties of the abdominal walls. The great fault of Rymer Jones's work consists in its being such a pure compilation—clever, undoubtedly—but without original observation to guide in the choice of materials for building his fabric.

I was interested in finding recently amongst some drawings, made a great many years ago, a figure of the remarkable antennal forceps of *Cheyletus eruditus*. I found the specimen amongst rice.

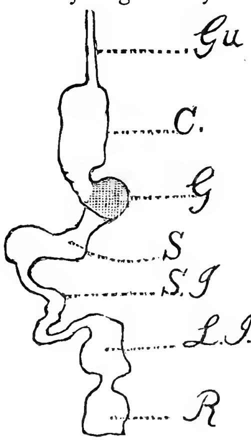
Trombidium holosericeum (Pl. XIX., Fig. 7).—I am glad to be able to add a fragment on the life-history of *Trombidium holosericeum.* Walking one sunny morning at the end of March, along a grassy lane, my eye lighted on a dead specimen of *Carabus granulatus*, crushed by the rude hoof of some ignorant clown. On lifting it up, a remarkably fine specimen of this acarus was found, absorbed with feasting on the juices of the dead Goliath. A few yards further on was another crushed beetle of the same kind, with a second and equally fine specimen of the same acarus. These were eagerly secured, and the attempt made to keep them alive, but without success, for my health and engagements do not permit of the constant attention requisite for success in such studies. Nor have I had better luck since with other attempts of a similar kind. The above observation, however, favours the idea that they do not (in the *mature* state, at least) feed upon *living* prey. What are their eggs like? What their young? Are they parasitic in their early stages, like *Leptus?* These are some of the many questions to be (and which may be) solved by working naturalists like ourselves. Another point to note is the presence of a pair of *stalked* COMPOUND (!) EYES *of two single ocelli each!!* These were noticed by Hermann, and furnish a good example of rudimentary limbs for purposes of vision.

Sting of Wasp (Pl. XX.) is so fully explained in the description of the figures, that little need here be added. It would increase the interest and value of this slide to supplement it by preparations of other stings—as of hornet, named bees, etc.—as introductory to a comprehensive view of ovipositors, of which these are merely a modification. One of our English observers has lately laid claim to the merit (? T. W.) of propounding that the sting of Hymenoptera is only a transformed leg!!! The merit (? ? T. W.) of being the first to enunciate this view is disputed by a talented American observer. Now, if it be as stated, there must either be a serious error of interpretation, or there is nothing more in it than is already well recognised. Limbs are lateral appendages to body-segments; and so the *lancets* may be well spoken of as "modified limbs," but the sheath is a modified *body-segment*, or part of such, and cannot therefore be a "limb," or lateral appendage. This bare allusion to the subject must suffice for the present; other opportunities will probably present themselves for a fuller consideration of it.

Saws of Saw-Fly (Pl. XIX., Figs. 12, 13).—This is another of our friend, E. Tutte's masterly dissections of these parts. It is really important that such good material should be correctly identified, and so render the work capable of reception into the general body of science. Surely, some of our members will take this desiderata up. E. T. thinks it is from a gooseberry saw-fly *(Nematus grossulariæ).* Well, then, get one of these, dissect it, and see. If his supposition be correct, well and good; if not, still a sound knowledge of these parts in this insect will have been attained, and inquiries must be continued till the insect has been truly ascertained. I must be pardoned for pointing out that to the eye of science none of these things have more than a very trifling value until their *habitus* be known.

Gizzard of Curculio, and

Gizzard of a Beetle (Pl. XXI., Figs. 1—8) (see notes by Dr. Case and A. Nicholson (p. 257).—If our friend's reason for not giving the name of his beetle be (as we may, perhaps, be justified in suspecting) that he does not know it, the retort might be permissible, "Well, doctor, you ought to know!" The contributor of Curculis Gizzard says (if I read his remarks aright) that it came from a beetle of the same species, and this would fix its origin to a weevil. But amongst so numerous a tribe, and of which the minute internal anatomy has been so little studied systematically, this does not carry us a *very* great step forward. And as there appears some serious errors with description, it will be necessary to say a few words introductory to a consideration of the subject generally.



The alimentary canal in insects is composed of (*gu.*) œsophagus or gullet, (*c.*) crop, (*g.*) gizzard, (*s.*) true stomach, (*s.i.*) small intestine, (*l.i.*) large intestine, and (*r.*) rectum. The food taken in at the mouth passes first through the gullet to the crop, which is often very large, and is then passed on for trituration to the mill seated in the gizzard. The teeth with which the latter is furnished vary much according to the nature of the work to be done. In the cockroach they are few, of large size, dense and horny. In the cricket the teeth are numerous, arranged in bands of differing form. In the weevil, as we see in the drawing, the form of lepidopterous scales is assumed. In the earwig, minute crowded spines in patches. In the flea there appear to be two kinds: at the upper part, long, sharply-pointed prisms; at the lower, short teeth, with three, four, or five curved cusps. In the bee they resemble simple hairs.

Whilst in some cases these projections from the inner walls of the gizzard become true teeth, in others they might be considered rather as modifications of ciliated epithelium. Where the gizzard opens into the stomach, there is a series of valves, sometimes mistakenly called "*pyloric*." Our anatomical readers will see at once how it is that this name cannot be strictly applied to valves seated at the *cardiac* orifice of the stomach. These valves, so far as I know them, are inflated, ciliated processes; in some instances, as the house-cricket, they constitute a beautiful and interesting object.

Abnormal formation of Shell of Hen's Egg (Pl. XIX., Fig. 14).—I am much pleased to see this specimen, but do not know exactly how to account for its formation, but believe that we have the secret of calcification of egg-shell and other animal tissues displayed in diagrammatic form before us, as so lucidly set forth by G. Rainey. An attempt has been made on two or three occasions to explain the subject in these notes. It is one of vast and varied interest. How was it found? Are fowls kept in chalk districts more liable to such malformation of the shell than others? I have some very rough eggs obtained at various times, the most remarkable one being from a blackbird or thrush, but have not had time to work over them. The subject will be found to repay, and I hope will be taken up.

Selected Notes from the Society's Note-Books.

Gizzard of Beetle possesses much wonderful beauty in its structure. It has been cut into and turned open in a lateral direction, as is represented in Mr. Tuffen West's drawing (Pl. XXI., Fig. 4). At one end of this object may be observed an abundance of muscular fibres of the ordinary character in such organs. When I first observed these, I thought by some chance the scales of a butterfly had got on the glass, and the resemblance may be curiously farther traced by observing that these muscular plates (so to call them) are composed of a large number of minute muscular fibres, so fine as to require a high power and very careful manipulation to be well seen. This system of plates makes up the greater part of the organ, and their mutual arrangement will be regarded with pleasure.

WILLIAM CASE.

This object, I think, consists of a multitude of exceedingly thin plates, attached at one end to a delicate network, some of which are presented to the eye endwise, others lying flat, all of them marked with extremely close striæ, and terminating in a frill at the upper end. This frill presents an objection to Dr. Case's theory, that the longitudinal lines are muscular fibres of extreme tenuity. I rather think they are bendings in the plate, to give strength similarly to the iron plates used for building purposes.

A. NICHOLSON.

Sting, Maxillæ, and Labium of Melecta punctata (Pl. XXII., Figs. 2—6).—This pretty and, when on the wing, weird-like bee is parasitic on *Anthophora*. It has five joints to the maxillary palpi and four to the labial. It is not very common in this neighbourhood (Kirton-in-Lindsey), yet I have frequently taken it feeding on the small dead nettle.

C. F. GEORGE.

Aclysia Dytisci (Pl. XXI., Figs. 9—11) is thought to be rare. Although I have caught lots of the beetle, I have only found the parasites on one. But I was fairly beaten in my endeavour to get them off whole; they stick so fast, that almost invariably six or seven out of the eight legs would be pulled off.

W. O. NICHOLSON.

Sting, etc., of Melecta punctata (Pl. XXII., Figs. 2—6).—*M. punctata* is a jet-black bee, with tufts of quite white hair about the abdomen, legs, face, etc., and is a very pretty insect. It is parasitic on *Anthophora;* but the curious part of it is that it is nearly allied to *Anthophora*, being, I believe, another genus of the same family. It is tolerably frequent at Oxford in the spring and early summer. It frequents sandy banks, where *Anthophoræ* make their burrows.

Its anatomy is rather interesting. The ridges on the maxillæ (of which there are a few on the maxillæ of *Apis mellifica*, and a very great many on those of *Bombus muscorum*) are quite absent. This is a characteristic of bees that burrow in the ground. The maxillary palpi are long; so are the paraglossæ (Pl. XXII., *pr.*, Fig. 5). Both of these organs are very short in *Apis mellifica.* In some of the nomad bees the maxillary palpi are as long as they are in wasps. The pharanx, which in the slide is forced out of proper position, is shown in natural position in the plate. I regard the "sideways" position a much better one for mounting bees' mouths than the orthodox way. Of course, one should have specimens in both positions, but they are far more natural sideways.

Not the least curious part of a bee's mouth is the tip of the labium. Examples from various bees may be seen at Fig. 6:—*a* is from *Melecta*, which has no distinct "spoon"; *b* is from a cuckoo-bee, and is very simple. The hairs on the labium are scale-like, while in *a* they are hair-like. *c* is exceedingly curious and complicated. It comes from the carder or moss-bee, *Bombus muscorum*. The hairs are narrow. The labium ends on a plate, underneath which is a brush of hairs, very like tenent hairs from a beetle's foot; and last of all is a veritable spoon, shaped just like a teaspoon. *d* comes from an *Anthophora*, the bee on which *Melecta* is parasitic. The hairs here are long, thin scales, and the spoon is flat, like a spatula. *e* is from a worker honey-bee (a Ligurian, I think). The hairs are narrow, and the "spoon" is tolerably flat. Its peculiarity is its having a row of *trifid* hairs at its edge. I believe that in ordinary bees a slightly different arrangement prevails.

The shape of the labium is probably influenced by the habits of the bee, but why should one have a brush and spoon at the tip, and another a spatula, and so on?

The Sting (Pl. XXII., Figs. 2, 3, 4).—This is rather curious. It will be seen that the poison-duct leads from the gland to the sheath, and not to the barbs. The barbs of a bee's sting are very curious. They always have a little stop (*f.*, Fig. 2) to prevent their being pushed out too far. This will work up and down in the swollen part of the sheath, but is stopped at the shoulder at the point *sf.* I cannot exactly make out whether or no the barbs are serrated, but at any rate they have no more than one tooth.

A wasp's barbs are not furnished with the little stop, *f.*, and the sheath is not swollen at the base. At the point, *sp.*, is something that looks like a spiracle, but I am not sure what it is.

H. M. J. UNDERHILL.

Aclysia Dytisci.—These are not so rare as Mr. Nicholson thinks. Although I have never found them on the *Dytiscus*, I once found them on a very long insect allied to a water-scorpion, and frequently on the water-scorpion (*Nepa cinerea*), and rather commonly on the great water-boatman (*Notonecta glauca*). They are bright-red in colour. I doubt if they are mites. They look to me like Crustacea. If the legs (?) on the *head* of one of these specimens be carefully examined, it will be seen that they are strongly suggestive of Entomostraca. The mouth, too, is not mite-like.

H. M. J. UNDERHILL.

Trophi of Bee (Melecta).—There is a good article on the mouths of insects, by Dr. Lowne, in "Science Gossip" for 1873, p. 229, etc. He gives figure of trophi of carpenter-bee, and makes some interesting remarks on the subject. He remarks that the hairs on the labium (or ligula) can be erected or pressed flat on the organ by special muscles. If, as is stated, the tongue has 300 joints, each with separate muscles, and each hair on the surface has its own pair of muscles to elevate and depress it, what a vast number of muscles must be situated in this minute organ!

H. E. FREEMAN.

Foraminifera, to fix to the slide.—Use gum Tragacanth in acetic acid, diluted with a little water. A very little gum is sufficient, as it swells enormously when wetted; some add a little gum Arabic, but it is not necessary. The gum Tragacanth dries a dead surface, and does not show if a little by accident gets on the object. This has been used by a great mounter of Foraminifera for years.

H. E. FREEMAN.

Scale Insect from Rind of Orange.—It is said that this insect may be found in all its stages on the rind of *one* orange; but I have not been so fortunate, but have generally found the scale and mature female and scale filled with eggs. These form good slides when mounted dry. The specimen I have mounted is a female previous to the production of eggs. The long, curling proboscis, by means of which it perforates the thick rind of the orange, is well worthy of notice. I have never been fortunate enough to meet with the mature male insect on the orange, although I have seen it, or a very similar insect, on the pear-tree, and this year several have been found on apples, but I have not watched their development. This creature is an example of the female being apterous, whilst the male is well furnished with wings.

[For drawing, see "Trans. Micro. Soc." Vol. IX., N.S., Pl. V., illustrating Mr. R. Beck's paper on the "Metamorphoses of a Coccus found on Orange."]

C. F. GEORGE.

Nycteribia from Bat.—This parasite is very uncommon. I had a large quantity of bats brought me from one hole in a tree, and on looking over them I found any quantity of *Pteroptus*, *Dermanysus*, and odd *Pulex;* but on only one specimen were there any *Nycteribiæ*, and on that eight only were found.

J. BEAULAH.

The *Nycteribia* shows its relation to the Diptera by the rudiments of wings, which may be seen like a pair of curved combs on the meso-thorax, near the base of the pro-legs. I believe the *Nycteribia* is eyeless, and that its tiny head consists almost entirely of mouth-organs.

F. J. ALLEN.

Aclysia Dytisci is of much interest to me, departing, as it does, so much from the ordinary type of a mite. There can be no doubt that it does really belong to the order *Acarina.* I cannot see any Crustacean character about, as has been suggested by Mr. Underhill. It must be a very difficult job to get the mites off the beetle, and it is certainly no easy thing to mount them when secured. I have now before me four specimens mounted in different ways, and I notice that they possess only *three* legs between them.

I have made an attempt to restore a specimen of *Aclysia* from all the specimens. Pl. XXI., Figs. 9—11, is the result. The mouth seems to be a suctorial disc. All the specimens that I have seen had only six legs; this most probably proved them to be immature. The legs are just like those of other aquatic mites, and most probably they terminate with a couple of claws, but they cannot be seen on any of the specimens. The eyes are four. Palpi conspicuous and armed with spines.

T. BALL.

[In Mr. Ball's drawings, only six legs are shown.—*Ed.*]

Bird-Fly, Ornithomyia.—A fly very similar to this is very common in India, and is there called the Bot-fly. Horses, and in fact all animals, are much troubled by it; the former most so. The flies congregate below the anus, and are a source of great annoyance to the horse, as the tail cannot touch them. They have to be removed by hand, and as each is pulled off it leaves a drop of blood. They fly with great rapidity, and it is very difficult to catch them. Some call them "Flying Ticks," from their similarity to that creature.

H. BASEVI.

Bleaching Leaves.—One cannot do better than follow Dr. Beattie's instructions, as given in "Science Gossip." Some members appear to confound *Chloride of Sodium* with *Chlorinated Soda*. A solution of the latter should be used, or else a solution of Sodic Hyperchlorite. Either of the two latter will bleach sections very rapidly, and whole leaves in from a few hours to a week.

W. H. BEEBY.

Nycteribia from Bat.—Those from India have much larger legs in proportion to the body, and are said to be very quick in their movements.

H. E. FREEMAN.

Pteroptis from English Bat is a very curious mite, and bears a strong resemblance to a young EIGHT-*rayed* star-fish.

H. E. FREEMAN.

The Mule-Ticks, referred to by Col. Basevi, are like the *Hippobosca Equina*, but somewhat larger, and both are without ocelli, which are present in *Ornithomyia*. The term Bot-fly is very inappropriate. The latter does not bite the skin, and indeed the mouth is so rudimentary that it is doubtful if it takes any food when in the imago state. The Bot-fly is more like a bee, and makes a very shrill hum when on the wing, or confined in a box.

H. E. FREEMAN.

Combs of the Black Scorpion.—Cuvier says:—"The abdomen is composed of twelve rings comprehending those of the tail. The first is divided into two parts, the anterior of which supports the sexual organs, and the other the two combs. These appendages are composed of one principal piece, narrow, elongated, articulated, mobile at its base, and furnished along its lower side with a series of small lacunæ united with it by an articulation, elongated, hollow internally, parallel, and resembling the teeth of a comb. Their number is more or less considerable, according to the species; sometimes it varies within a certain quantity, and perhaps according to age, in the same species. The use of these appendages has not yet been ascertained by any positive experiments.

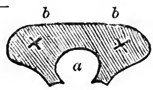
C. F. GEORGE.

Ferret-Tick.—Some years ago, six or seven ticks which had been taken from a ferret were brought to me. I was much out of health at the time, and do not know if they were preserved. Of what species is the ferret-tick? It agrees very nearly with the dog-tick; so nearly, that one feels compelled to ask, "Do the two belong to the same species?" Can it be that ferrets and dogs, carnivorous animals, having much in common in their habits, both become hosts to the same species of tick? And what are the sexual characteristics? I am inclined to think the one under consideration is a male. How is the union of the sexes effected? What are the eggs like? They are described as being "laid in large numbers, quite round, and of a reddish-brown colour, smooth and very bright, having the appearance of small glass beads; mean diameter of egg, 1–34th of an inch. They hatched out in a very few days."—*Science Gossip*, June, 1874, p. 121. Now, the little things, freed from their shells, and, as we may suppose, very hungry, having fed on nothing to speak of as yet, naturally run hither and thither seeking food. The further history of these ticks will be found in Vol. III. of this Journal, p. 33, and on Plate VI. drawings of the rostrum, etc., are given. It will be well to compare the figure of the rostrum of dog-tick, given in Vol. III., Pl. VI., Fig. 4, with that from ferret-tick, accompanying these notes (Pl. XXIII., Fig. 1). How closely they agree in robustness and in the small number of their dentations!

A figure of the rostrum of mature hare-tick is appended (see Fig. 2, same plate), for comparison with that of the immature condition, as shown in Pl. VI., Vol. III.

TUFFEN WEST.

Tongue of Drone Fly (Pl. XXIII., lower portion) is a very common object of the Microscope; I will, however, take the opportunity of its presence to say a few words on the mouth-organs of this insect, as compared with that of the Blow-Fly; pointing out the differences between them, which in the main characterise the families to which they respectively belong, viz., the SYRPHIDÆ and the MUSCIDÆ. Of these differences the most important is that which relates to the maxillæ, their development in the former insect, and their suppression, or at least their concealment, in the latter. In both the maxillary palpi are very clearly distinguishable, but while in the former they are connected with a pair of setiform maxillæ, in the latter they arise direct from the integument of the second joint of the proboscis, without the intervention of anything which may be fairly called a limb in any sense of the term (see lower half Pl. XXIII., Figs. 9 and 10). Mr. Lowne thinks that the maxillæ of the Blow-Fly are represented partly by a scale-like portion of the integument bearing stiff setæ, from which the palpi arise, and partly by the lateral portions of the operculum, an organ which he defines as consisting of a central portion of the labrum, and the two lateral portions referred to, which he regards as the homologues of the terminal portions of the maxillæ of Bees. I would not like to express a very decided opinion on this point, but I have never been able to distinguish any such separation of parts in the operculum as is here indicated. In Figure 7 of my plate the lateral portions referred to are marked x x, as they are also in annexed diagram—



from which it will be seen that the organ consists of a central tube *a*, surrounded by an external sheath *b.b.*, the intervening space being occupied by muscles. This being the case, I can neither find any marked separation into central and lateral portions, nor do I see how it is possible to regard the organ as other than one indivisible whole, viz., the labrum or upper lip. Again, if, as Mr. Lowne says, these lateral portions of the operculum are to be regarded as portions of the maxillæ, where does this hypothesis land us in the Drone-Fly? For here also that which he calls the operculum, and what I have marked as the labrum in Fig. 9, consists of an internal tube and an external sheath, similar to those in the Blow-Fly, and consequently the lateral portions of the organ here also must by a parity of reasoning be accounted as the homologue of the maxilla, *i.e.*, of organs which are here seen to have a perfectly separate and independent development, being the slender lancets marked *m x* in the same figure; *quod est absurdum*, as Euclid would have said.

The only thing I can see which gives any colour to Mr. Lowne's theory, is that these lateral portions of the operculum are supported by the anterior extremity of the apodemes, and, therefore may be thought to bear the same relation to them which the maxillæ do in the Drone-Fly, in which insect the terminal setaceous portions of these organs are continuous, with a broad internal basal process (shaded in Fig. 4). Now, these basal portions are connected by muscles (*m.*, Fig. 9) with the anterior portion of the pharynx in very much the same way as are the apodemes of the Blow-Fly, and on this account it is difficult to think that they are otherwise than homologous with those apodomes; and inasmuch as they are in the one case evidently continuous with the maxillæ, and in the other NEARLY continuous with the lateral portions of the operculum, it may be thought that these latter are really the homologues of the terminal portion of the maxillæ. But *nearly* is not quite, and the difference is well expressed in Mr. Lowne's own words, where he says (at bottom of p. 45*) that they "form joints with their apodemes," and this joint will, I think, be found on examination to mark too great a separation between the parts to allow much force to an argument drawn from their supposed continuity. Although, therefore, I am disposed to doubt whether the lateral portions of the operculum represent any portion of the maxillæ, yet it must be thought that in the Blow-Fly these organs are to be sought for in that portion of the integument from which the palpi arise, namely, in the scales and septiferous bands.

It may be presumed that the differences of organisation in the mouths of these two insects have reference principally to their respective habits of feeding. The broad, expanded lobes of the Blow-Fly, shown in Fig. 2, are doubtless well adapted for sucking up the variety of fluid substances upon which the insect feeds. The proboscis of the Syrphidæ are much longer, and therefore better suited to their flower-haunting habits; the lobes too are more compressed.

The basal joint of the proboscis, called by Mr. Lowne the fulcrum, is similar in principle in both insects, but somewhat different in shape, as may be seen by comparing the part marked *f.* in Figs. 9 and 10. The position of the fulcrum within the head is shown in Fig. 6.

Another important difference between the mouths of these two insects is the absence in the Drone-Fly of the forked character in the rings of the false tracheæ, as seen in Fig. 8, which represents a portion of one of these channels in the Blow-Fly, flattened out. This seems to point to a less perfect development in the former insects, as compared with the latter, which is further confirmed by the absence also in the former of the chitinous teeth, and their intermediate pillars referred to by Mr. Lowne in his work, and shown in my Figure 14. I believe that both the teeth and the pillars are modifications of forked rings.

A. Hammond.

EXPLANATION OF PLATES XVIII., XIX., XX., XXI., XXII., XXIII.

Plate XVIII.

Fig. 1.—Represents the specimen of *Sphæria* of the natural size, the outline of the leaf being simply diagrammatic to indicate that the piece shown formed only part of the leaf.

* "Anatomy and Physiology of the Blow-Fly."

Fig. 2.—One of the "Peridia" enlarged, viewed from above, × 25.

,, 3.—Portion of the cellular structure of "ectoderm" of leaf, × 100.

,, 4.—Another portion, showing supposed "spermatium" (male organ of fructification), × 100.

,, 5.—Sphæraphides exposed by accidental removal of part of the outer skin ("ectoderm"), × 100.

,, 6.—Diagrammatic section of *Sphæria*.

,, 7.—Diagrammatic section of *Æcidium*. The same letters indicate corresponding parts of each.

Sp., spermatium.

Stg., sterigmata, pollen in the higher plants.

Per., peridium; receptacle for *sp.*, spores—seeds in the higher plants—which are contained in little transparent cases, called asci, *as.*, in the figures.

,, 8.—Portion of leaf of *Onosma tauricum*, probably the under-surface, × 25.

,, 9.—Part of one of the large hairs, more magnified to show the roughness of the surface, × 100.

,, 10.—Base of a hair, showing the cluster of cells forming the support, and sectional view of the prominences, × 100.

,, 11.—One of the smaller spines of *Amphidotus cordatus;* the smaller connected figures at the side are to show outlines of sections at their respective places.

,, 12.—Base of a larger spine, showing the powerful ridge for attachment of levator and depressor muscles, and the part of its broken extremity, whence the enlarged view (Fig. 13) is obtained.

,, 14.—Diagrammatic section of part of a spine.

,, 15.—Calcareous plates from skin of *Holothuria*.

a.a.a.a.—Plates in form of a calcified network, supposed to be situated at and parallel with the surface.

b.b.—Arched pieces supposed to be articulated by their extremities with processes arising from the centre of the former. From the middle of the arch, on its convex border, arise two short columns, united at their free extremities, where they bear two or three dentations. These double columns are supposed to represent the anchors of *Synapta*, and to be for the same purpose—viz., to enable their possessor to hold on more firmly to the sea-bottom.

Drawn by Tuffen West.

Plate XIX.

Fig. 1.—Represents the male *Cheyletus eruditus*, × 50.

,, 2.—Represents the female ditto, × 50.

Fig. 3.—Rostrum, showing lancets (maxillæ ?), × 250.

,, 4.—End of left antennal forceps (mandible ?), × 250.

,, 5.—End of fourth limb of the left side, showing the two claws and "scopulæ."

,, 6.—*Trombidium*, slightly magnified. The relative proportions of the limbs, and the joints composing them, the oral organs, and the hairs, are the parts by which specific identification will be obtained.

,, 7.—A crushed specimen of *Carabus granulatus*, with a very large female *Trombidium holosericum* feeding at the anterior end of the abdomen.

,, 8.—The stalked and compound eye of two facets.

,, 9.—Sickle-like mandible from Fig. 6, × 100. *a*, teeth on the cutting edge, more magnified.

,, 10.—End of left limb of the second pair. The excision of the last joint for reception of the claws when not in use is well shown.

Sc., the "scopula," an organ for imparting the power of moving over smooth surfaces (*scopula*, a brush). It is homologous with the "pulvillus" of flies, and is composed of hairs with expanded, sucker-like ends, attached to two or more back pieces.

,, 11.—Plumose hair, × 200.

,, 12.—One of the saw-blades from "Gooseberry Saw-fly." The upper outline shows the place of the saw-back (which is not presented on slide) in a groove, in which the saw, when in use, slides backwards and forwards.

,, 13.—Portion of the cutting edge, enlarged, to show the finer dentations and canals in the substance.

,, 14.—Illustration of abnormal formation on shell of Hen's egg, × 15. The pearly granules are seen to be of very different sizes, and more or less coalesced. In my own specimen the very small ones are much more numerous than in this. They are found to be firmly adherent to the general shell.

Drawn by Tuffen West.

Plate XX.

Fig. 1.—Sting of Wasp, as shown on slide: *sh.*, sheath; *st. st.*, the two lancets or stings, × 25.

,, 2, 2.—Barbed extremities of the latter, × 100.

,, 3.—Diagrammatic representation of the mouth of a small Hemipteron (Saw-fly), from a specimen in the possession of a member.

,, 4.—Diagrammatic sectional view of same: *lbr.*, labrum; *mx. mx.*, maxillæ (!); *md.*, mandibles (!).

Fig. 5.—Sheath of Wasp-Sting, evidently homologous at the posterior end of the body with the mandibles (?) at the anterior, the stings representing the serrate pair of organs (maxillæ, ?).

,, 6.—Diagrammatic section of the latter: *s.*, sheath; *st.*, stings.

,, 7.—A dissection, giving a natural view of the parts connected with a Wasp's Sting: *d.*, duct for bringing the poison from its secreting gland to *pr.*, a large, sub-pyriform organ, covered with spirally-arranged and interlacing *voluntary* muscles; hence it is carried by *p.d.*, the excretory duct, to the base of the sheath of sting; *sh.*, sheath; *st.*, lancets, which are moved backwards and forwards in grooves in the latter by *mm.*, powerful muscles, longitudinal and transverse; *it.*, end of intestine; *ap. ap.*, anal palpi.

Drawn by Tuffen West.

Plate XXI.

Fig. 1.—Weevil of Pine-trees (*Hylobius abietis*), slightly enlarged.

,, 2.—Dissection from same, showing head, namely:—*lbr.*, labrum; *md.*, mandible; *s.at.*, situation of antenna; *oc.*, eye; *œ.*, œsophagus; *pr.*, proventriculus (gizzard); *bk. bk.*, portions of back.

,, 3.—Diagrammatic section of Gizzard of a Weevil, seen from above.

,, 4.—Figure of Gizzard taken from slide, showing the eight double lines of scale-like teeth, bent at a right angle at about half their length, horny, deep-brown in their free portions; of a pale transparent yellow at the part attached to the walls of the gizzard.

,, 5.—Some of the teeth from another specimen, showing the dentations at their free extremities, and the striæ on the expanded portion.

,, 6.—Represents a Gizzard removed from its attachments, and looked into from above, one of the six teeth is seen to be much larger than the remaining five, and to represent an anvil on which the others play.

,, 7.—Another Gizzard, cut open, showing the six teeth and tendinous attachments for the powerful muscles which move the organ, *t.m.a.* and *m.m.* The portion of intestine leading on to the stomach proper is seen at the lower part of the figure; it is of a funnel shape, and guarded by six ciliated valves, *v.v.*

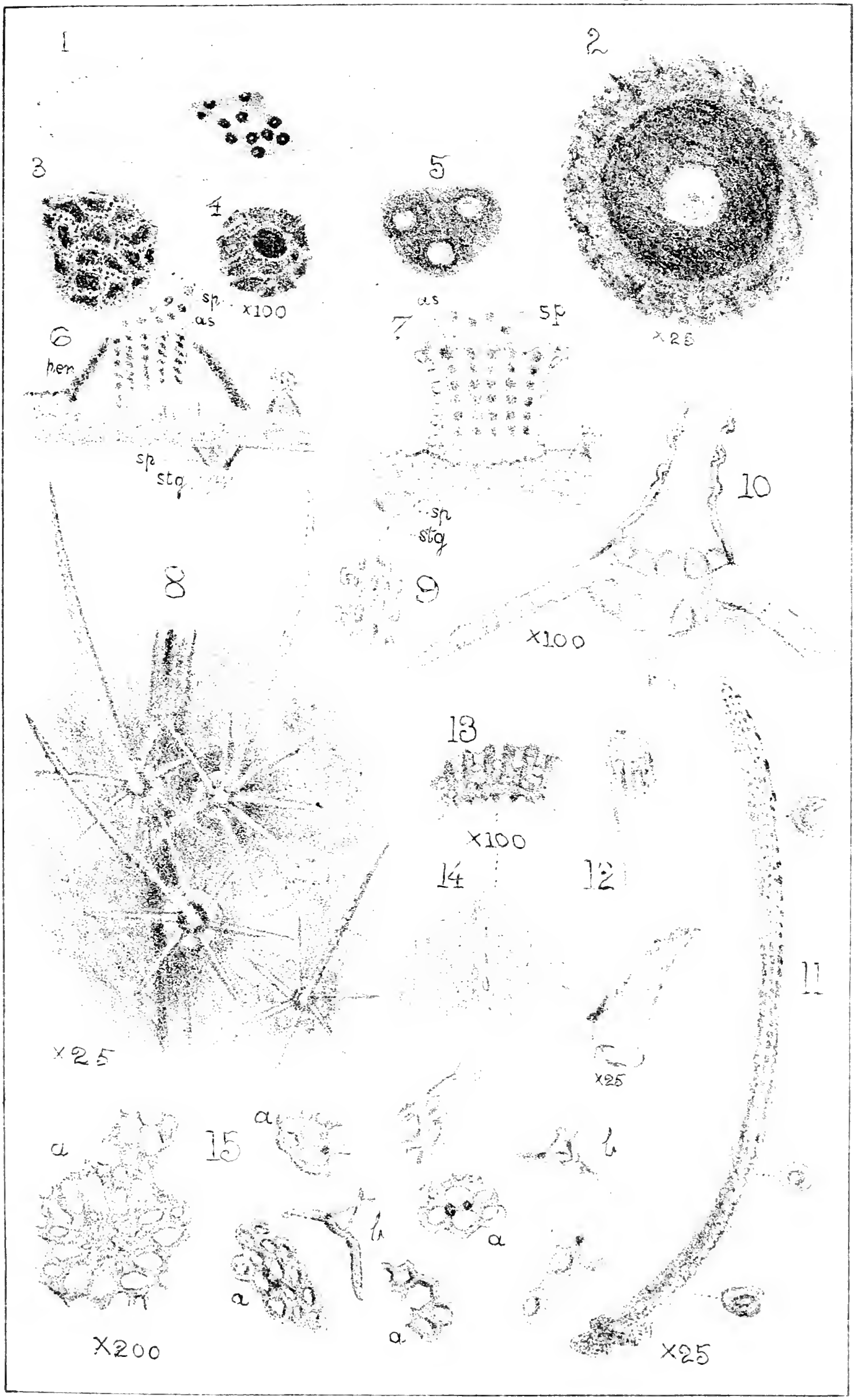
,, 8.—In which these valves are better shown, it having been taken from a recent dissection, Figs. 6 and 7 being from dried specimens, in which the parts are somewhat shrivelled and obscure.

Drawn by Tuffen West.

,, 9.—*Aclysia dytisci*, represented as seen unprepared, × 20.

,, 10.—The same, more enlarged, and prepared by pressure and washing.

,, 11.—Palpi of same. Drawn by T. Ball.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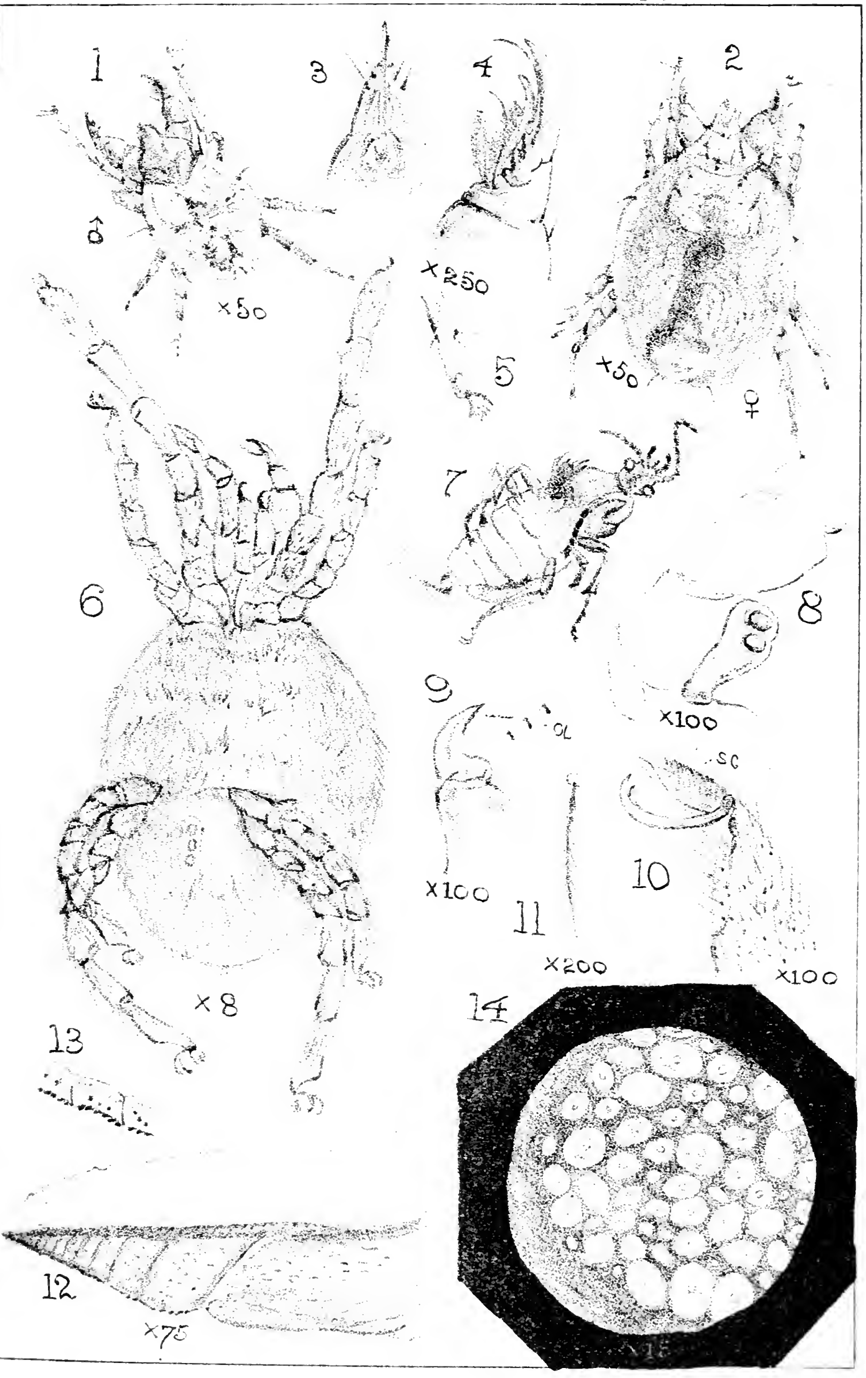
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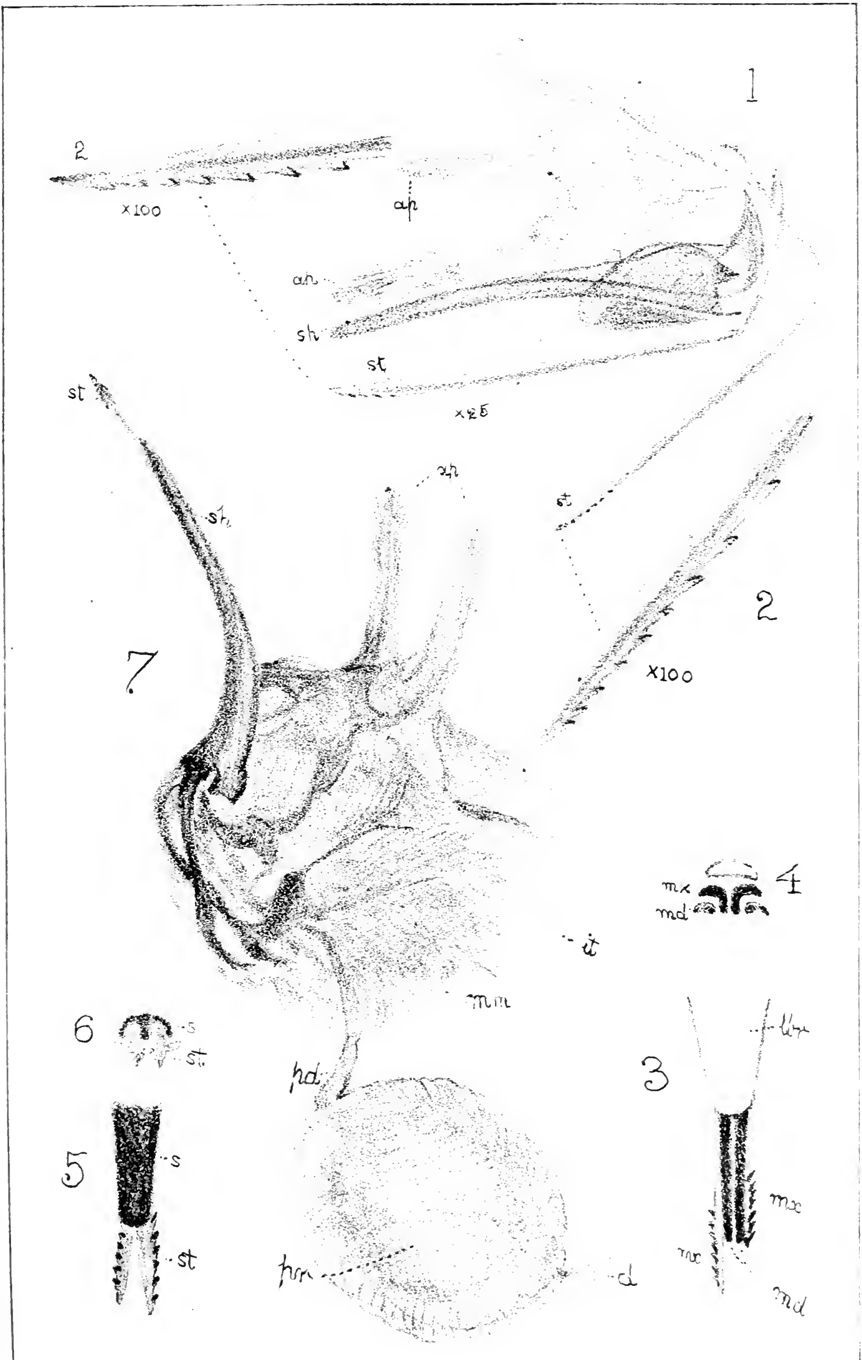
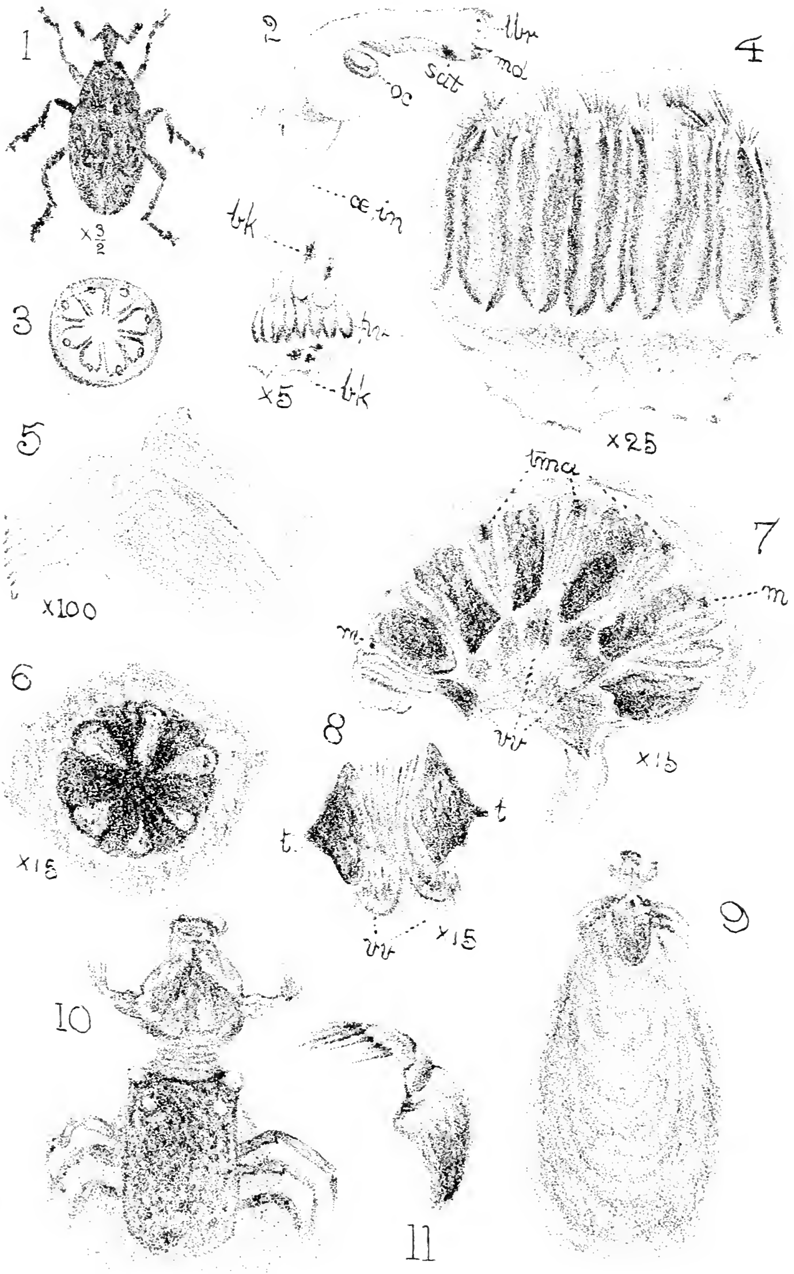
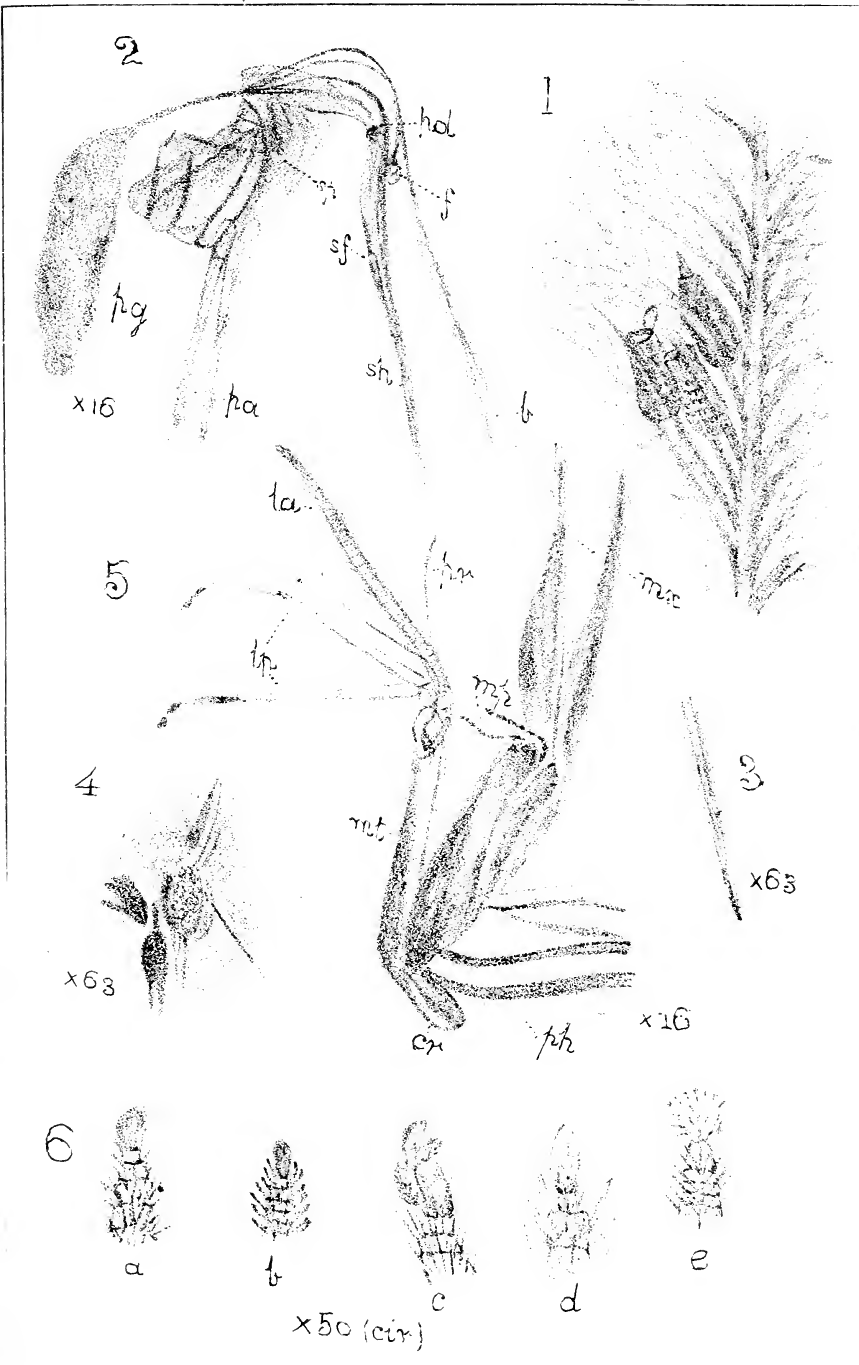


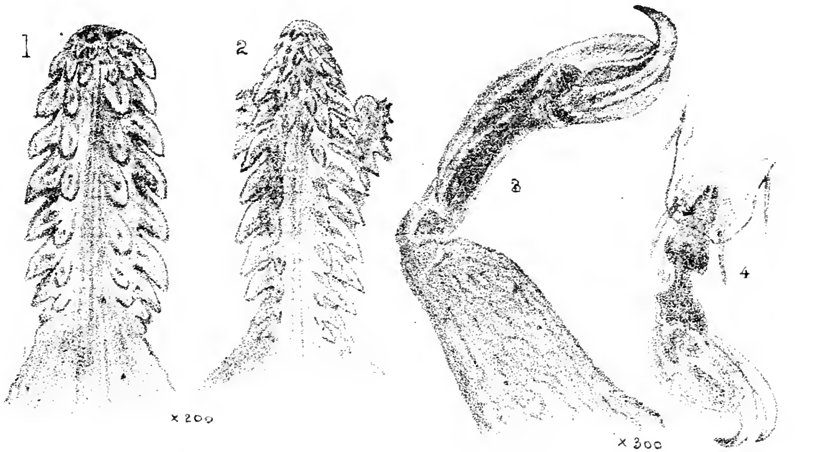
String of Wasp, &c



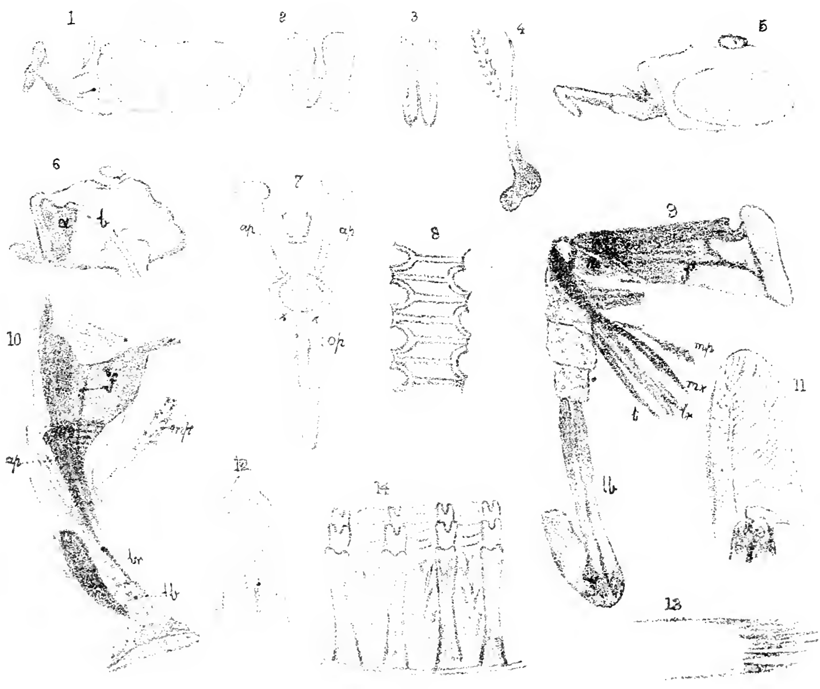
Gizzard of Beetle, &c



Mouth and Sting of Bee, &c.



Rostrums and Feet of Ticks.



Diagrammatic Sketches of
Mouths of Drone Fly and Blow Fly

Plate XXII.

Fig. 1.—Feather of Ostrich, with Eggs of Parasite, *in situ*.

Drawn by R. H. Moore.

[No notes appeared in connection with this drawing.—*Ed.*

,, 2.—Sting and Poison-gland of Bee (*Melecta punctata*): *sh.*, sheath; *b.*, barbs; *f.*, the "stops" which control the barbs by preventing them from being pushed out too far; *s.f.*, the bend where the "stops" are arrested; *pa.*, palpi; *sp.*, spiracle (?); *p.g.*, poison-gland; *p.d.*, termination of duct of poison-gland, × 16 diam.

,, 3.—Tip of one of the barbs.

,, 4.—Spiracle (?), × 63 diam.

,, 5.—Mouth of *Melecta punctata;* the labrum and mandibles are removed: *mx.*, maxillæ; *m.p.*, maxillary palpi; *la.*, labium; *l.p.*, labial palpi; *pr.*, paraglossæ; *mt.*, mentum; *cr.*, cardo or hinge; *ph.*, pharynx.

,, 6.—Tips of the labia of various Bees, showing different forms of spoons:—

a. *Melecta punctata*, as Fig. 5, viewed sideways.

b. Cuckoo-Bee, *Nomada*.

c. Carder-Bee, *Bombus muscorum*, viewed sideways.

d. Burrowing Bee, *Anthophora retusa*, on which Melecta is parasitic.

e. Common Hive-Bee, neuter, *Apis mellifica*, probably a Ligurian.

Drawn by H. M. J. Underhill.

Plate XXIII. Upper Portion.

Fig. 1.—Trophi of Ferret Tick, × 200 diam.

,, 2.— ,, Hare tick, × 200 diam.

,, 3.—Foot of Hare Tick; first limb of the left side.

,, 4.— ,, ,, third limb of the left side.

The much larger size of this portion of the first limb will be noticed; the feet of the second, third, and fourth limbs agree in size.

Drawn by Tuffen West.

Lower Portion.

Probosces of the Blow-Fly and of Drone-Fly compared.

Fig. 1.—Head of Blow-Fly, side view.

,, 2.—Lobes of Proboscis of ditto, front view.

,, 3.— ,, ,, of Drone-Fly, front view.

,, 4.—Maxilla and palpus of ditto. The lowest shaded portion is internal, and is homologous with the apodemes of the Blow-Fly.

Fig. 5.—Head of Drone-Fly, side view.

,, 6.—Longitudinal vertical section of ditto, showing the position of the fulcrum at *a*, and the œsophagus at *b*.

,, 7.—The apodemes (*ap.*, *ap.*) and operculum (*op.*) of the Blow-Fly ; front view.

,, 8.—The forked rings of the false tracheæ of the Blow-Fly.

,, 9.—The Proboscis of the Drone-Fly : *f.*, the fulcrum ; *mx.*, the maxilla ; *mp.*, palpus ; *lr.*, labrum ; *t.*, tongue ; *lb.*, labium.

,, 10.—The Proboscis of the Blow-Fly ; parts as above.

,, 11.—One of the lobes of Drone-Fly.

,, 12.—Extremity of labrum of Blow-Fly.

,, 13.— ,, ,, of Drone-Fly.

,, 14.—Teeth of Blow-Fly.

Drawn by A. Hammond.

Reviews.

Micro-Chemistry of Poisons, including their Physiological, Pathological, and Legal Relations; with an Appendix on the Detection and Microscopic Discrimination of Blood. By Theodore G. Wormley, M.D., Ph.D., LL.D. With 96 illustrations on steel. Second edition, pp. 741. (Philadelphia, U.S.A., and London: J. B. Lippincott and Co. 1885.) Price $7.50=£1 11s. 6d.

The second edition of this large and valuable work has just reached us. The author commences with a definition of the term Micro-Chemistry of Poisons; Classification of Poisons; Sources of Evidence—*e.g.*, symptoms, post-mortem appearances, and chemical analysis. A large number of Inorganic Poisons are then treated of, and their special chemical properties considered; this is followed by a description of the Vegetable poisons and the various methods of separating their complex organic mixtures. The appendix is devoted to the Nature and Properties, Detection and Discrimination of Blood; here we have described its Physical Characters and Composition, Chemical Tests, and Optical Properties. In the chapter on the Microscopical Detection and Discrimination of Blood is considered Oviparous and Mammalian Blood, Limit of determining the Differences, Measurement, and Methods of Examining Dried Blood. The microscopist's library will not be complete without a copy of this work.

Comparative Anatomy and Physiology. By Jeffrey Bell, M.A. pp. ix.—555. (London: Cassell and Co. 1885.) Price 7s. 6d.

This is one of Cassell's Manuals for Students of Medicine. The author has endeavoured to illustrate details of structure by a notice of such experimental enquiries as he has either considered himself, or has reason to believe to be correctly stated. The various chapters treat of the Amœba; General Structure of Animals; Organs of Digestion, Respiration, Excretion, Secretion, Movement; Vocal Organs; Organs of Reproduction, etc. The author maintains that there has been an evolution of organs as well as of animals, and that he who desires to understand the most complicated organs must first know the structure of such as are more simply constructed.

The Dissection of the Frog. By J. Cossar Ewart, M.D.

Directions for the Examination of the Amœba, Paramœcium, Vorticella, Hydra, Lumbricus, Hirudo, Asterias, and Echinus. By J. Cossar Ewart, M.D., and J. Duncan Matthews.

The Dissection of the Skate. By the same. (Edinburgh: James Thin. 1884). Price 1s. 6d. each.

In the above works, which are published for the use of Students in the University of Edinburgh Laboratory, full instructions for dissection and examination of the object, with directions for making drawings of the various parts, are given on the left-hand page, the right-hand page being left blank, we suppose, for the drawings. These books appear to us to be most useful.

Johnstone's Student's Atlas of Bones and Ligaments. By Charles W. Cathcart, M.A., M.B., F.R.C.S., etc., and F. M. Caird, M.B., F.R.C.S.E. (Edinburgh: W. and A. K. Johnstone. 1885.) Size of page, 14½ in. by 11 in. Price 15s.

This fine work contains 30 plates, each accompanied by descriptive letterpress. On each plate we notice also that the origins of the muscles are marked in red, and their insertions in blue, which has been supplemented by printing the names of the muscles in corresponding ink, and in washing a shade of blue over the articular surfaces. A similar shade has been used to express the various ligaments, and in some cases a mottling of red has been put in to draw attention to sections through the bone. Letterpress has been used on each plate to indicate the various points which the student should remember.

Notes from the Physiological Laboratory of the University of Pennsylvania. Edited by N. A. Randolph, M.D., and Samuel G. Dixon. pp. 88. (Philadelphia, U.S.A.: J. B. Lippincott. 1885.)

The papers forming this little volume are records of facts of interest brought to light in the course of physiological study, and embrace Notes on the Fæces of Starch-fed Infants; a Study of the Distribution of Gluten in the Wheat-grain; on the Digestion of Raw and Boiled Milk; on the Nutritive Values of Branny Foods, etc.

The Essentials of Histology, Descriptive and Practical, for the Use of Students. By E. A. Schäfer, F.R.S. pp. x.—245. (London: Longmans, Green, and Co. 1885.) Price 6s.

Those who are not already the happy possessors of Dr. Schäfer's large and more elaborate work will doubtless be much pleased with this elementary and condensed one, which is sure to prove of much value in class teaching. For the convenience of students, it is divided into forty-two lessons, each of which may be supposed to occupy the class from one to three hours. Each lesson takes a special list of tissues for microscopical examination, clear and detailed directions being given for their preparation.

PATHOLOGICAL MYCOLOGY: An Enquiry into the Etiology of Infective Diseases. By G. Sims Woodhead, M.D., F.R.C.P. Ed., and Arthur W. Hare, M.B., C.M. Section I., Methods, with 60 illustrations. pp. x.—174. (Edinburgh: Young J. Pentland. 1885.) Price 8s. 6d.

An important and valuable work for the medical student, inasmuch as the authors have collected together and clearly explained the methods employed in the examination and cultivation of those Micro-Organisms in sterilised media which bear such important relations to diseases, whether infectious or otherwise. A work which so much facilitates the study of these organisms must be very welcome to those whose life-work it is to combat their effects. The illustrations are beautifully executed, and a number of them are coloured.

A TREATISE ON PRACTICAL CHEMISTRY and Qualitative Inorganic Analysis, adapted for use in the Laboratories of Colleges and Schools. By Frank Clowes, D.Sc. Lond. Fourth edition. pp. xvi.—376. (London: J. and A. Churchill.) Price 7s. 6d.

A useful work for young students, containing detailed instructions and tables to assist in the analysis of the more commonly recurring salts. It is a very handy text-book. There are 55 illustrations.

AN INTRODUCTION TO THE STUDY OF ORGANIC CHEMISTRY. By Adolph Pinner, Ph.D. Translated and revised from the fifth German edition. By Peter T. Austen, Ph.D., F.C.S. Second edition, pp. xxi.—403. (New York: John Wiley and Sons. 1884.) Price $2.

This is decidedly a theoretical book. Dr. Austen tells us that his endeavour has been to explain the subject systematically, so that with but a slight knowledge of chemical science the student is able to advance easily to the most complicated compounds, and can at any place trace out the relationship of the particular compound to the simple ones from which it is derived.

AN INTRODUCTION TO THE STUDY OF THE COMPOUNDS OF CARBON, or Organic Chemistry. By Ira Remsen. pp. x.—364. (Boston, U.S.A.: Ginn, Heath, and Co. 1885.) Price $2.

A work intended for pupils commencing the study of organic chemistry. We cannot too highly commend the plan adopted by the author, who gives instructions for the preparation of a series of organic compounds, together with such theoretical explanations of the reactions which occur as are likely to lead the student "through a careful study of the facts, to see for himself the reasons for adopting the prevalent views in regard to the structure of the Compounds of Carbon." The experiments appear well adapted to the end in view.

AN INTRODUCTION TO PRACTICAL CHEMISTRY, including Analysis. By John E. Bowman, F.C.S. Edited by Charles L. Bloxam, F.C.S. Eighth edition, pp. xvi.—248. (London: J. and A. Churchill. 1885.) Price 6s. 6d.

This is an old and valued friend, containing many improvements and additions; it contains about 90 illustrations. We believe the present improved edition will be found as useful to students of the present time as earlier editions were to us in our student-days.

AN OUTLINE OF QUALITATIVE ANALYSIS FOR BEGINNERS. By

John T. Stoddard, Ph.D. Second edition, pp. 60. (Boston: Harris and Rogers. 1884.) Price 75c.

A small, nicely got-up work, giving the more common reactions of the principal metals and more commonly occurring "Inorganic" acids, with which are grouped Ferrocyanides, Ferricyanides, Oxalates, Tartrates, and Acetates. The teacher using this work must be prepared to give a large amount of personal attention to his pupils.

Outline of Lecture-Notes on General Chemistry: The Non-Metals. By John T. Stoddard, Ph.D. pp. 84. (Northampton, Mass.: Gazette Publishing Co. 1884.) Price 75c.

Another book of the same series, giving a short account of the chief non-metals, together with Bismuth and Antimony, which are grouped with Nitrogen.

Outlines of Lecture Notes on General Chemistry: The Metals. By John T. Stoddard, Ph.D. pp. 131. (Boston, Mass.: Harris, Rogers, & Co. 1885.) Price $1.

This work, by the same author, contains a short account of the more important metals and their compounds. Under each metal we have a short account of its occurrence, but in some cases we are not told either the name of the ore in which it is found, or the locality.

An Introduction to Practical Organic Chemistry: Adapted to the requirements of the first M.B. Examination. By George E. R. Ellis. pp. 72. (London: Longmans, Green, and Co. 1885.) Price 1s. 6d.

The Medical and Chemical Student will find this a convenient little handbook. Rather than suggest to the student too great a number of tests, the author has selected only those which will prove of use in general analysis. The directions for general examination will be found of value.

Medical Rhymes: A Collection of Rhymes of ye Anciente Time, and Rhymes of the Modern Day; Rhymes Grave and Rhymes Mirthful; Rhymes Anatomical, Therapeutical, and Surgical; all Sorts of Rhymes to Interest, Amuse, and Edify all Sorts of Followers of Esculapius. Selected and Compiled from a variety of Sources, by Hugo Erichsen, M.D. With an Introduction by Prof. Willis P. King, M.D. Illustrated. pp. xx.—220. (Chicago, Ill., U.S.A.: J. H. Chambers and Co. 1884.) Price, $2.50.

We have here a series of all kinds of Doctors' Ditties, from the earliest times up to the present.

The Medical Directory of Philadelphia, Pennsylvania, Delaware, and the Southern Half of New Jersey, 1885. pp. 397. (Philadelphia: P. Blackiston, Son, and Co. 1885.) Price, $2.50.

Contains in a compact form lists of Medical and other Associations, with their Officers: Physicians, Chemists, Druggists, Dentists, Veterinarians, etc.: in fact, everything likely to interest the Medical Professor.

A Manual of Health Science. By Andrew Wilson, F.R.S.E., F.L.S., etc. pp. xiii.—238. (London: Longmans, Green, and Co. 1885.) Price 2s. 6d.

A valuable and interesting little book, treating the subject of health under various aspects, in a simple and practical way; first taking the formation of the body and the functions of the various organs; then treating of food and clothing; water in its pure and impure condition; air, and the impurities which it may contract: the sanitary arrangements of houses, cities, etc. We have also a well-written and illustrated paper on ambulance work, etc.

A Text-Book of Hygiene. By George H. Rohé, M.D. pp. ix.—324. (Baltimore, U.S.A.: Thomas and Evans. 1885.)

The author tells us his desire has been to place in the hands of the student, practitioner, and sanitary officer, a trustworthy guide to the principles and practice of preventive medicine. The work treats of the composition and physical conditions of the air, tests for impurities in the air and water, sewage, the germ theory of disease, etc.

Hygienic Physiology: With special reference to the Use of Alcoholic Drinks and Narcotics. By Joel Dorman Steel, Ph.D. pp. xii.—276. (New York: A. S. Barnes and Co. 1884.)

For correctness and beauty of illustration, terseness of explanation, and the admirable way in which the work is got up, we thoroughly commend it as one of the best manuals we have met with. Many of the plates are coloured.

Elements of Hygiene: for Schools and Colleges. By John Campbell. pp. vi.—120. (Dublin: W. M. Gill and Son. 1885.) Price 1s.

The subject of Hygiene is treated in this little book in a popular manner. It was originally written to serve as a text-book in the author's classes for the training of National school teachers.

Hygiene for Young People: Adapted to the Intermediate Classes and Common Schools. By A. B. Palmer, M.D., LL.D. pp. 207. (New York: A. S. Barnes and Co. 1885.)

This book was prepared under the direction of the Department of Scientific Instruction of the Women's National Christian Temperance Union. Enough of the Science of Hygiene has been introduced to give a general knowledge of the laws of health, whilst direct and special reference has been made to the effects of alcoholic drinks and other narcotics. There are about 30 very good engravings.

Lessons in Hygiene: An Elementary Text-Book on the Maintenance of Health, with Rudiments of Anatomy and Physiology, and the Treatment of Emergent Cases, comprising also Lessons on the Action of Stimulants and Sedatives. By John C. Cutter, B.S., M.D. pp. 180. (Philadelphia, U.S.A.: J. B. Lippincott and Co. 1885.) Price 50c.

We have here, in a concise and orderly form, some of the essential facts concerning bathing, clothing, air, water, food, cooking, mental work, physical exercise, contagious diseases, disinfection, tobacco, alcoholics, etc., as bearing upon health and the prevention of disease. The book is well illustrated, and contains a useful glossary.

In Case of Accident. By Dr. D. A. Sargent, of Harvard College Gymnasium. Illustrated, pp. 126. (Boston, U.S.A.: D. Lothrop and Co.) Price 60c.

Dr. Sargent has noticed that many persons of superior intelligence are rendered powerless in time of excitement and danger, by the want of a little self-control. In the book before us he has made the structure and function of different organs and parts of the body the basis for a brief consideration of some of the injuries and accidents that may interfere with the function of these various parts, and in so doing impair the health and endanger life.

OUR BODIES AND HOW WE LIVE. By Albert F. Blaisdell, M.D. pp. vi.—285. (Boston, U.S.A.: Lee and Shepard. 1885.)

This is one of Lee and Shepard's excellent "Young Folks' Series" of little books. Here we have presented in a clear and logical manner, some of the most important facts about the build and health of our bodies. Prominence has been given to such Anatomical and Physiological facts as are proper to the necessary understanding of the laws of hygiene. Everything has been made clear and practical by the use of a simple style of writing. The subject of stimulants and narcotics has been fairly and plainly treated.

PRACTICAL PHYSIOLOGY, being a School Manual of Health for the use of Classes and General Reading. By Edwin Lankester, M.D., LL.D., F.R.S. Second edition; pp. xxiv.—152. (London: W. H. Allen and Co. 1880). Price 2s. 6d.

A useful book for the School and for general home use; it is written in a clear and interesting style, and illustrated by fairly good plates. It not only gives an accurate course of physiology, but affords valuable hints as to food, dress, exercise, and education in relation to health.

DIET FOR THE SICK: a Treatise on the Value of Foods, their application to special conditions of Health and Disease, and on the best methods of their preparation. By Mary F. Henderson. Illustrated, pp. ix.—234. (New York: Harper Bros. 1885.)

A proper dietary is doubtless as necessary for the recovery of the sick as is medicine: a perusal of this book will supply the nurse with much useful information.

TEXT-BOOK OF GENERAL BOTANY. By W. J. Behrens, translated from the second German edition; Revised by Patrick Geddes, F.R.S.E. With 408 illustrations; pp. viii.—374. (Edinburgh: Young J. Pentland. 1885.) Price 10s. 6d.

A most useful addition to the list of Text-books on this subject, and one that may be highly recommended to teachers of the science. The student is at once and by easy stages introduced to the Morphology of the plant, the more difficult study of the Anatomy and Physiology being left till later in the book. The flowering plants are first treated, the system of classification employed being original and differing from that of most of the text-books in general use. The subject of fertilisation and cross-fertilisation by Insects is treated in a very interesting manner. The last portion of the book is devoted to Cryptogams. The illustrations are original and exceedingly good, and we find also a series of tables giving the characteristics of the various orders according to the author's system of classification.

AMERICAN MEDICINAL PLANTS: an Illustrated and Descriptive Guide to the American Plants, known as Homœopathic Remedies. Their History, Preparation, Chemistry, and Physiological Effects. By Charles F. Millspaugh, M.D. (New York; Boericke and Tafel. 1885.)

This is a splendidly illustrated work, containing a list of the American plants used as Homœopathic remedies. We have before us two fascicles, each containing 30 folio plates of flowers, beautifully drawn and coloured from nature, with full descriptive text, as, *e.g.*, we have first the place occupied by the plant, both according to the Natural and to the Linnæan systems; then the botanical synonyms and the common names of the plant, followed by a description of the Plant History and Habitat; the part used and method of preparation, chemical constituents, and physiological action. The coloured plates are all executed by the author, in remarkably good style, from the original plants *in situ*. Each fascicle is published at $5, and the work will be completed in about two years.

WHERE TO FIND FERNS, with a special chapter on the Ferns round London. By Francis George Heath. pp. vi.—153. (London: Society for Promoting Christian Knowledge. 1885.) Price 1s. 6d.

In the little volume before us, we have well executed illustrations of all the species of British Ferns. These are reproduced with Photographic accuracy from "The Fern Portfolio," a larger work by the same author. The object of the author is briefly to indicate the habitat, distribution, and cultivation of Ferns. This is a very cheap book and deserves a large sale.

CHAPTERS ON PLANT-LIFE. By Sophie Bledsoe Herrick. Illustrated, p. 206. (New York: Harper Bros. 1885.) Price $1.

This is a capital little book for young people; the instruction is given in so interesting a manner that all who read it are sure to retain a great deal in their memory. There are 84 illustrations, all very good.

DICTIONARY OF THE NAMES OF BRITISH PLANTS. By Henry Purefoy Fitzgerald. pp. 90. (London: Baillière, Tindall, and Cox. 1885.) Price 2s. 6d.

This useful little book is intended for the use of amateurs and beginners as a help to the knowledge of the meaning and pronunciation of the scientific names of British Wild Plants. Such a work has long been wanted. We should now like to see a similar one, embracing all the names in the animal kingdom.

TEXT-BOOK OF STRUCTURAL AND PHYSIOLOGICAL BOTANY. By Otto W. Thomé and Alfred W. Bennett, M.A., B.Sc., F.L.S. Illustrated with about 600 woodcuts and a coloured map. Fifth edition, pp. xii.—480. (London: Longmans, Green, and Co. 1885.) Price 6s.

We have much pleasure in directing the attention of our readers to the new edition of this important work. Since the publication of the first edition, great advances have been made in various branches of botanical science, and in the present edition the life-history of many of the lower forms of plants have been followed out, and much light thrown on their genetic relationships. Several portions of the book have been entirely re-written.

WILD FLOWERS WORTH NOTICE: A Selection of some of our Native Plants which are most attractive from their beauty, uses, and associations. By Mrs. Lankester. With 108 coloured figures, from drawings by J. E. Sowerby. pp. xx.—159. (London: W. H. Allen and Co.) Price 5s.

In the handsome little book before us, we have short and popular accounts of a number of our well-known native plants. These are systematically arranged, certain plants being selected from each of the natural orders. The 28 plates are nicely coloured, and the book will doubtless become a favourite.

Fruit Culture, and the Laying Out and Management of a Country House. By W. C. Strong. pp. xii.—205. (Boston, U.S.A.: Houghton, Mifflin, and Co. 1885.)

A book intended for the professed horticulturist and orchardist. The author has endeavoured to explain the fundamental principles for the culture of each species of fruit without going into an exhaustive discussion of differing methods and theories. There are 34 woodcuts, illustrating methods of grafting, insect pests, etc.

Home Studies in Nature. By Mary Treat. Illustrated, pp. 243. (New York: Harper Bros. 1885.)

Miss Treat's book is written in such a charming manner that it is really a treat to read it. It is divided into four parts, viz.—Observations on Birds, Habits of Insects, Plants that consume Animals, and Flowering Plants. The plates and smaller engravings are all well executed.

Mushrooms of America: Edible and Poisonous. Edited by Julius A. Palmer, Jr. (Boston, U.S.A.: L. Prang and Co. 1885.) Price, $2.

This valuable work contains four pages of letterpress and twelve beautifully coloured plates, which have been prepared more for public use than for botanical students, all technical terms being, as far as practicable, omitted. The plates, size 10½ in. by 7½ in., are coloured to nature; the mushrooms also being first accurately described, and in the case of the edible varieties, instructions are given for cooking them. The last four plates describe poisonous varieties.

Useful Plants. Series 1 and 2. (London: A. N. Myers and Co.) Price 7s. 6d. each.

We have before us two sets of large diagrams, each consisting of 12 plates, size 19 in. by 15 in. The first set contains coloured representations of 31 plants as food; the other, of 33 plants employed in manufacturing, dying, carpentry, building work, etc. Each series is accompanied by a book of descriptive letterpress. These diagrams and notes are intended for Elementary Instruction in schools, and will prove very useful in class work.

Physical Expression: Its Modes and Principles. By Francis Warner, M.D. Lond., F.R.C.P. With 51 illustrations, pp. xx.—372. (London: Kegan, Paul, Trench, and Co. 1885.) Price 5s.

One of the volumes of the "International Science Series," addressed to those who are interested in studying man as a living and thinking being. It has been written as the outcome of observations made on children and adults; children being more often referred to.

The author states that all physical phenomena are due to physical causes. The term expression is used to include all outward manifestations of hidden things. Detailed observations are given of various modes of expression, as shown in certain movements and postures of the head, face, eyes, and hands.

The Common Sense of the Exact Sciences. By the late William Kingdon Clifford, with 100 figures. Second edition, pp. xiii.—271. (London: Kegan, Paul, Trench, and Co. 1885. Price, 5s.

This work, another of the "International Science Series," was commenced by the late Mr. Clifford in 1871 under the title of Mathematics for the Non-mathematical, but he afterwards expressed a wish that the book should appear under its present title. It is divided into five divisions or chapters, which embrace—Number, Space, Quantity, Position, and Motion. The work has been well carried out by subsequent editors, and will prove valuable to the mathematician and others.

YEAR-BOOK OF THE SCIENTIFIC AND LEARNED SOCIETIES of Great Britain and Ireland. Second annual issue, pp. v.—231. (London: Charles Griffin and Co. 1885.) Price 7s. 6d.

The first issue of this most useful work furnished an account of the history, conditions of membership, and organisation of over 500 Societies engaged in Scientific Research in Great Britain and Ireland. In the present issue, 1885, we have a Chronicle of the work done by these Societies, together with information as to official changes. All engaged in scientific pursuits will be glad to refer to the year-book, and those who have not the first issue should lose no time in securing it.

PRACTICAL MICROSCOPY. By Geo. E. Davies, F.R.M.S., F.I.C., F.C.S., etc. Second edition, pp. viii.—335. (London: W. H. Allen and Co. 1882.) Price 7s. 6d.

We are pleased to have an opportunity of noticing this book, which enters fully into every department of the microscopist's work: the Microscope and its Accessories; Micro-Dissections; Section-Cutting; Delineation of Objects; Polariscope; Staining and Injecting; Preparing and Mounting Objects, etc. It is illustrated with 258 woodcuts and a coloured frontispiece representing five double-stained sections of wood.

GRUNDZUGE DER ALLGEMEINEN MIKROSKOPIE. Von Dr. Leopold Dippel. pp. xiv.—524. (Braunschweig: Friedrick Vieweg und Sohn. 1885.) Price 10s.

The "Outlines of General Microscopy" are divided into three parts. The first treats of the Theory and Regulation of the Compound Microscope; the second, Helps to Microscopical Observation; the third treats of the Use of the Microscope—its general principles, adjustment of objects, methods of observation; and Drawing and Preservation of Microscopic Preparations. The work is illustrated with 215 engravings in the text, a few of which are coloured.

HALF-HOURS WITH THE MICROSCOPE: A Popular Guide to the Use of the Microscope as a means of Amusement and Instruction. By Edwin Lankester, M.D. Sixteenth edition, pp. xx.—13. (London: W. H. Allen and Co.) Price 2s. 6d.

This well-known work, now in its sixteenth edition, should be in the hands of every microscopist.

MANIPULATION OF THE MICROSCOPE. By Edward Bausch. Illustrated, pp. 96. (Rochester, N.Y., U.S.A.: Bausch and Lomb Optical Co. 1885.) Price 50c.

The author tells us that he has started out in this little manual with the supposition that the purchaser or owner is a beginner, and absolutely ignorant of the Microscope and everything which pertains to it; he has therefore attemped to convey, step by step, and in simple language, information which will lead to ease of manipulation and pleasure in its use. We think he has succeeded.

Das Sauerstoff Bedürfniss des Organismus. Eine farben-analytische Studie von Professor Dr. P. Ehrlich. pp. 167. (Berlin: August. Hirschwald. 1885.)

The author asserts "that it may be positively laid down that the living tissue, through its cells, draws and stores up the oxygen of the blood with a certain force, in order to use it up according to laws as yet unknown. This need of oxygen may be in general explained by the fact that the living protoplasm is enabled to enter into a chemical union with the oxygen, which must differ in kind according to the nature of the organs."

Lehrbuch der Geophysik und Physikalischen Geographie. Von Dr. Siegmund Günther. In 2 vols. (Stuttgart: Ferdinand Enke. 1884—5.)

Dr. Günther, who is an able physicist, has given us two very fine volumes, the first of which treats of terrestrial physics under such heads as the Relations of the Earth to the other Planets, the Form of the Earth, the Effect of its Motion, and the Condition of its Interior; these are followed by a discussion of volcanoes and earthquakes. The second, and by far the larger, volume treats of Magnetism and Electricity, the Atmosphere, Oceanography and Physics of the Ocean, Geology, etc. We should much like to see an English edition of this work.

The Theistic Conception of the World: An Essay in Opposition to Certain Tendencies of Modern Thought. By B. F. Cocker, D.D., LL.D. pp. vii.—426. (New York: Harper Bros.)

A closely-argued and well-written book. The learned professor attacks the tendency of the present day to remove the Divine Being from any care or control over His works. Chapters viii., ix., and x. are specially interesting, and, as we think, completely successful in their reasonings and true in their conclusions.

The Origin of the World, according to Revelation and Science. By J. W. Dawson, C.M.G., LL.D., F.R.S. Third edition, pp. 438. (London: Hodder and Stoughton. 1884.) Price 7s. 6d.

The intention of the author is, as he tells us, to throw as much light as possible on the present condition of the much-agitated questions respecting the origin of the world and its inhabitants. We scarcely think he has succeeded in his bold attempt of reconciling the present state of cosmic knowledge with revelation. There are several chapters of much interest, and particularly so are the appendices to the work.

The Elements of Moral Science: Theoretical and Practical. By Noah Porter, D.D., LL.D., President of Yale College. Pp. xxv.—574. (London: Sampson Low, Marston, and Co. 1885.) Price 10s. 6d.

We very heartily commend the book to our readers. It is most careful and practical, and touches upon all the relations of man to the Almighty, to himself, and to the world around. It is difficult to point out any one special subject as most worthy of reading and attention amidst such a mass of matter, but we were much struck with chapters iv. and v. in Part I. on the Will of Man, and to certain chapters in Part II. on Man's Duties towards himself and society and towards animals. It is most healthy reading, and will well repay study.

Morality: An Essay on some Points thereof. [Addressed to Young Men.] By Maurice Charles Hime, M.A., LL.D., Barrister-at-Law, Head Master of Foyle College, Londonderry. Ninth edition, pp. 204. (London: J. and A. Churchill. 1884.) Price 1s. 6d.

This book comes very opportunely just at this time. It carries testimonials from a great number of newspapers and journals of all denominations, most of which we think we can endorse.

Popular Lectures on Scientific Subjects. By Sir John F. W. Herschel, Bart., K.H., etc. New edition, pp. xii.—507. (London: W. H. Allen and Co.) Price 6s.

A series of lectures on various subjects, some of which were delivered by the author in his own parish. Lecture X.—on the Yard, the Pendulum, and the Metre—was delivered at the Leeds Astronomical Society, and is of much interest.

The Elements of Physiography, for the use of Science Classes, Elementary and Middle-Class Schools, and Pupil-Teachers. By John J. Prince. Sixth edition, pp. 262. (Manchester and London: J. Heywood. 1885.) Price 2s. 6d.

This little book has been prepared with special reference to the Syllabus for the Elementary stage of Physiography, recently issued by the Science and Art Department, and will doubtless be found useful to all who wish to enquire into the physical features of the earth, its atmosphere, etc. The first portion of the work is devoted to Physics generally, or Nature's forces and their measurements; the second to Light, Planetary Motions, Form, Size, and Motions of the Earth, the Heavenly Bodies, their distance, physical constitution, etc.

The Land and Fresh-Water Shells of the British Isles, with Illustrations of all the Species. By Richard Rimmer, F.L.S. Pp. xxxii.—208. (London: W. H. Allen and Co.) Price 10s. 6d.

The author gives us, in the first place, a short account of the sub-kingdom Mollusca, followed by Instructions for collecting and arranging shells. Then, entering on the general purpose of the work, we have a full account of the British Aquatic and Terrestrial Shells, followed by a Glossary extending over 14 pages. The work is illustrated with wood engravings and 10 plates, mostly photographic.

British Butterflies. By W. S. Coleman. Pp. vii.—179. (London: George Routledge and Sons.) Price 3s. 6d.

This volume contains figures and descriptions of every species of British Butterfly, with an account of their development, structure, habits, localities, mode of capture, and preservation. It contains 16 plates, printed in colours.

Birds I Have Kept in Years Gone By. With Original Anecdotes and Full Directions for Keeping Them Successfully. By W. T. Greene, M.A., M.D., F.Z.S., etc. pp. viii.—198. (London: L. Upcott Gill. 1885.) Price 5s.

Dr. Greene gives descriptions of a long list of birds, many of which are foreign, with instructions for their keep and management. The book is illustrated with 16 nicely-executed coloured plates.

Talks with My Boys. By William A. Mowry. Pp. 266. (Boston, U.S.A.: New England Publishing Co. 1885.)

A little book which every schoolboy may read with profit. The author tells us it has grown out of the practical necessities of the schoolroom. It treats of Concentration of Mind and how to acquire it, a Purpose in Life, Elements of Success, Exact in Thought and Work. We are much pleased with it.

Windsor and Newton's Shilling Hand-Books on Art. With Illustrations, etc.

1—Half-Hour Lectures on Drawing & Painting. By Henry Warren, K.L.
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5—The Art of Marine Painting in Water-Colours. By J. W. Carmichael.
6—Hints for Sketching in Water-Colours from Nature. By Thomas Hatton.
7—The Art of Portrait Painting in Water-Colours. By M. Merrifield.
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15—A Manual of Illumination. By J. W. Bradley, B.A., and T. G. Goodwin, B.A. (New edition by J. J. Laing.)
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19—Artistic Anatomy of the Human Figure. By the same.
20—The Artistic Anatomy of the Dog and Deer. By B. Waterhouse Hawkins, F.L.S., F.G.S.
21—The Artistic Anatomy of the Horse. By the same.
22—The Artistic Anatomy of Cattle and Sheep. By the same.
23—The Art of Painting and Drawing in Coloured Crayons. By Henry Murray, F.S.A.
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33—The Art of Etching Explained and Illustrated. By H. R. Robertson, F.S.P.E.

34—The Art of Painting on China; with a chapter on Terra Cotta Painting in Oil and Water-Colour. By the same.

35—Plain and Simple Rules for the Study of Perspective. By Charles Runciman. Edited, adapted to Practical Use, and Illustrated by M. M. Runciman, with Letters of Approval from Professor John Ruskin, M.A., Hon. LL.D., etc. (Mr. Runciman's former pupil.)

36—A Dictionary of Water-Colour Technique: adapted to the Requirements of the Landscape Painter in Water-Colours. By Charles Wallis.

We have before us a perfect library, consisting of 36 small volumes, each containing from about 60 to 90 pages of practical hints and instructions for the Art Student; each volume is carefully written and well illustrated. We notice that several of these little books have already reached to between 50 and 60 editions, and that one has attained its 56th edition; this, we think, proves the estimation in which they are held. Many of the authors are well known by their works.

Wilson's Photographics: A series of Lessons, accompanied by notes on all the processes which are needful in the Art of Photography. By Edward L. Wilson (Editor of Philadelphia Photographer). pp. 352. (Philadelphia: E. L. Wilson.) Price $4.

This is a grand compendium of the whole art of Photography. The principal instructions are given in bold type and in simple language; these are followed by the more intricate working details, in small type. The work is embellished with upwards of 100 engravings and phototypes, together with a fine portrait of the author.

The Progress of Photography since the year 1879. By Dr. H. W. Vogel of Berlin. Translated by Ellerslie Wallace, Jun., M.D. pp. 347. (Philadelphia: E. L. Wilson. 1883.) Price $3.

This work, as further set forth in the title, is "A Review of the more important discoveries in Photography and Photographic Chemistry, within the last four years, with especial considerations of Emulsion Photographs, and a chapter on Photography for Amateurs."

Wilson's Lantern Journeys. By E. L. Wilson.

We have before us Vol. 3 of the series, which conducts the student through Egypt, Palestine, Syria, the Sinai Peninsula, and Arabia Petra. In this lecture no fewer than 204 slides are described.

Photographic Mosaics. An Annual Record of Photographic Processes. (Philadelphia: E. L. Wilson. 1885).

The work is similar in its subject matter, to the year books published in this country, giving a *resumé* of the work of the past year.

Burton's Modern Photography. By W. K. Burton, C. E. pp. viii.—130. (London: Piper and Carter. 1885.) Price 1s.

Gives practical instructions in all departments of the Science, including the working of gelatine dry-plates, printing, etc.

THE STUDIO AND WHAT TO DO IN IT. By H. P. Robinson, pp. viii—143. (London: Piper and Carter. 1885.) Price 2s. 6d.

The author briefly describes the leading types of studios, and devotes a chapter to the form which his long experience leads him to consider to be the best. The chapters on Posing and Management are more voluminous, and embrace nearly every style in which a portrait may be taken. Much useful information will be found here.

THE MAGIC-LANTERN MANUAL. Second edition. By W. J. Chadwick. With 105 illustrations, pp. 154. (London: F. Warne and Co.)

Treats of the Magic-Lantern, Sciopticon, Magnesium Lantern, Lime Light, Electric Light, Photographic Slides, etc., and all that appears necessary for the exhibitor to know.

WORK AND ADVENTURE IN NEW GUINEA, 1877 to 1885. By James Chalmers, of Port Moresby, and W. Wyatt Gill, B.A. With 2 maps and many illustrations, pp. 342. (London: The Religious Tract Society. 1885.) Price 6s.

A very interesting book, giving us much information about the Island of New Guinea, its delightful scenery, the manners and customs of its inhabitants, etc., and of the work now being done by our missionaries there. The illustrations are from original sketches and photographs.

A NATURALIST'S WANDERINGS IN THE EASTERN ARCHIPELAGO. A Narrative of Travel and Explorations, from 1878 to 1883. By Henry O. Forbes, F.R.G.S. pp. xx.—536. (London: Sampson Low, Marston, & Co. 1885.) Price 21s.

In this handsome and most interesting volume, the author, who is a naturalist of no mean order, relates his travels, dividing them into six parts: I.—In the Cocos-Keeling Islands. II—In Java. III.—In Sumatra. IV.—In the Moluccas and in Timor-Laut. V.—In the Island of Bura. VI.—In Timor; describing in a very graphic style, the manners and customs of their inhabitants. He gives us also entertaining accounts of their natural history. The volume is illustrated with several maps and plates, besides a great number of wood-engravings, and is one of the most interesting books of travel we have seen for some time.

NATURE'S SERIAL STORY. By Edward P. Roe. Illustrated by G. W. Hamilton Gibson and T. Dielman; pp. xx.—430. (New York: Harper Brothers. 1885.)

We have here a large amount of valuable information relating to Natural History, charmingly mixed up in a most interesting story. The book, like all those published by this enterprising firm, is got up in a very handsome manner The plates and other engravings, of which there are a great number, are perfect works of art.

PATERSON'S GUIDE TO SWITZERLAND, with Maps and Plans, pp. 162. (Edinburgh: W. Paterson; London: E. Stanford. 1885.) Price 1s.

A very convenient little hand-book: cheap, concise, and no doubt reliable.

LABRADOR: a Sketch of its People, its Industries and its Natural History. By Winfrid Alden Stearns. pp. viii.—295. (Boston, U.S.A.: Lea and Shepard. 1884).

Until the publication of this book, it appears that only one work, in two volumes, and now out of print and very scarce, contained all the knowledge to be gained respecting this region. The author has made three trips to Labrador: the first in 1875, again in 1880, and last in 1882; of these visits he gives us an interesting account.

BOOTS AND SADDLES; or, Life in Dakota, with General Custer. By Elizabeth B. Custer. With portrait and map, pp. 312. (New York: Harper Bros. London: S. Low and Co. 1885.) $1.50.

Here we have a very charming biography of one of the heroes who fell fighting in the Battle of the Little Big Horn. Mrs. Custer accompanied her husband in all his dangers, and gives in the pages before us a most interesting account of the difficulties and pleasures of cavalry and camp life.

STUDIES OF FLOWERS FROM NATURE. By Kate Sadler. With instructions for copying.

STUDIES OF TWELVE BRITISH BIRDS FROM NATURE. By Alice A. West. (London: Windsor and Newton.)

We have before us two high-class reproductions in chromo-lithography, each set containing 12 fine pictures, those of flowers being particularly pleasing. The price of the set of flowers is 18s., or 1s. 6d. each; that of the birds 12s., or 1s. each.

THE WINDS: An Essay in Illustration of the New Principles of Natural Philosophy. By William Leighton Jordan, F.R.G.S. Third edition, pp. 47. (London: David Bogue. 1885.) Price 3s. 6d.

This little book forms with slight modifications the third and fourth chapters of "The New Principles of Natural Philosophy." It treats of the action of Solar Heat, Lunar Gravitation, the Earth's Rotation, the Trade-Winds, etc.

SPECTRUM ANALYSIS, in its application to Terrestrial Substances and the Physical Constitution of the Heavenly Bodies. Familiarly explained by the late Dr. H. Schellen. Translated by Jane and Caroline Lassell. Edited, with notes, by Captain W. de W. Abney, R.E., F.R.S. With numerous woodcuts, coloured plates, and Angstrom's and Corme's maps. Second edition, pp. xxiv.—626. (London: Longmans, Green, and Co. 1885.) Price £1 11s. 6d.

This noble work will render much valuable assistance to the physicist and to the astronomer. It is divided into eight parts, and treats of:—1—The Artificial Sources of High Degrees of Light and Heat; 2—Spectrum Analysis in its application to Terrestrial Substances; 3—Its application to the Sun; 4—Stellar Spectroscopes and Investigation of the Moon and Planets by Spectrum Analysis; 5—Application of Spectrum Analysis to the Fixed Stars; 6—Results of the Spectroscopic Investigation of Nebulæ and Clusters; 7—And of Comets and Meteors; 8—And of the Zodiacal Light, Aurora Borealis, and Lightning; followed by an Appendix. There are fourteen plates, many being coloured. The frontispiece to the work is the Nebula of Orion, enlarged from a photo taken by Mr. Common, and 291 finely executed wood engravings. The work is one of no common degree of excellence.

OUTLINES OF PSYCHOLOGY: Dictations from Lectures by Hermann Lottze. Translated, with a Chapter on the Anatomy of the Brain, by C. L. Herrick. Illustrated, pp. ix.—150. (Minneapolis, U.S.A.: S. M. Williams.

The works of this German philosopher are rapidly gaining recognition. The book before us professes to give outlines only, and embraces but the dictated portions of an extended lecture course, and is suited to form the framework of a course of valuable lectures. The portion of the work devoted to the anatomy of the brain is illustrated with two anatomical plates.

MIND-READING AND BEYOND. By William A. Hovey. pp. 200. (Boston, U.S.A.: Lee and Shepard. 1885.) Price $1.25.

Our readers are aware that an association of gentlemen has been formed under the designation of "The Society for Psychical Research," their object being to examine the nature and extent of any influence which may be existing by one mind over another. A vast number of experiments have been made, many of which are described in the volume before us.

THE LENAPE AND THEIR LEGENDS, with the Complete Text and Symbols of the WALUM OLUM. A New Translation and an Enquiry into its Authenticity. By Daniel G. Brinton, A.M., M.D. pp. 262. (Philadelphia: D. G. Brinton. 1885). Price $3.

This volume is the fifth of Dr. Brinton's Library of Aboriginal Literature. In it the learned Doctor, who is Professor of Ethnology and Archæology at the Academy of Natural Sciences, Philadelphia, etc., has grouped a series of Ethnological Studies of the Indians of Eastern Pennsylvania, New Jersey, and Maryland, around what is asserted to be one of the most curious records of Ancient American Histories. This record, the "Walum Olum," was for a long time supposed to have been lost, but having recently obtained the original text complete, the Doctor has spared no pains to publish a correct translation.

It may interest our readers to know that this remarkable record gives, in the rudest possible characters, an account (mythical, certainly) of the creation of the world, continued into a history of this people up to a comparatively recent date.

THE LENAPE STONE, or the Indian and the Mammoth. By H. C. Mercer. Pp. 95. (New York: G. P. Putman and Sons. 1885.) Price $1.25.

In 1872, a young farmer, living near Doylestown, Bucks County, Penn., picked up a "queer" stone, which he took home and placed in a box with other Indian curiosities. It proved to be part of a broken "gorget stone," on which was roughly engraved a party of Indians hunting the Hairy Mammoth. There appears to be no doubt as to the genuineness of the stone itself, but of the carvings upon it some doubt does exist. Should it be acknowledged to be a genuine Indian relic, it will prove a very valuable acquisition to the American archæologist. The author gives an interesting account of its discovery, and a very fair report of the arguments for and against its genuineness.

THE PHRASE: A Monograph. By F. G. Morris, M.A. pp. 72. (Easthampton, Mass., U.S.A.: The Author. 1885.) Price 50c.

This is a Scientific exposition of Shorthand Phrase-Writing. The author does not profess that it is a new system, but that it is new in its methods, occupying a place not filled by any other work on the subject. He endeavours to show that Shorthand is of great practical utility and scientific value, and that, other things being equal, the most intelligent practitioner will be the most expert in its use. We believe "The Phrase" may be advantageously used with any system of shorthand.

WHERE IS IT? A Geographical Hand-book. Compiled by Arthur Bishop, Principal of Winchester House School, Great Yarmouth. pp. 184. (London: Simpkin and Marshall. 1885.) Price 1s.

This very little hand-book (size of page, 4¾ in. by 2¾ in.) contains a list of the Principal Towns, Islands, Lakes, Rivers, and Mountains of the World, with certain facts respecting them. It affords much useful information, but would have been much more valuable had an alphabetical arrangement been adopted.

THE TELESCOPE. The Principles Involved in the Construction of Refracting and Reflecting Telescopes. By Thos. Nolans, B.S. pp. 75.

THE ANEROID BAROMETER: Its Construction and Use. pp. 126.

HEALTHY FOUNDATIONS FOR HOUSES. With 51 Illustrations. By Glenn Brown. pp. 143.

CHEMICAL PROBLEMS: With Brief Statements of the Principles Involved. By James C. Foye, A.M., Ph. D. pp. 141.

TESTING-MACHINES: Their History, Construction, and Use. By Arthur V. Abbott. pp. 190.

STADIA SURVEYING. The Theory of Stadia Measurements. By Arthur Winslow. pp. 148.

POTABLE WATER, and the Relative Efficiency of Different Methods of Detecting Impurities. By C. W. Folkard. pp. 138.

THE FIGURE OF THE EARTH. Sec. I., Historical; Sec. II., The Oblate Spheroidal Hypothesis. By Frank C. Roberts, C.E. pp. 95.

MODERN GRAPHIC PROCESSES. By Jas. S. Pettit. pp. 127. (New York: D. Van Nostrand.)

The above are a portion of "Van Nostrand's Science Series," a set of some 70 or 80 18mo vols., each published at 50c. They are written in a clear and concise manner; many of them are well illustrated.

NUMBERS IN NATURE: An Evidence of Creative Intelligence. By Edward White. Price 3d.

SCIENTIFIC STAR-BUILDING. The Nebular Theory Examined. Price 9d.

GEOLOGICAL EVOLUTION: An Examination of its Pedigree, Pretensions, and Predictions. Price 9d.

THE ORIGIN OF LIFE: Was Man Evolved from Granite? Price 6d.

DARWINISM: The Origin of Species. Price 9d. (London: S. Bagster and Sons.)

These little books form a part of the Anti-Infidel Library. The last four form together one book entitled the Errors of Evolution. By Robt. Patterson, of San Francisco.

WHY NOT EAT INSECTS? By Vincent M. Holt. pp. 99. (London: Field and Tuer.) Price 1s.

Our author acknowledges that he has to battle against long-existing and deeply-rooted prejudice. He writes as if confident of success, and, indeed, the subject has already attracted attention in the public press.

OUR LIVING WORLD: An Artistic Edition of Rev. J. G. Wood's Natural History of the Animal Creation. Revised and adapted to American Zoology by Joseph B. Holder, M.D. (New York: Selmer Hess.) To be completed in 42 parts, at 50c. each.

The first eight parts of this fine work have been forwarded to us. In addition to a number of illustrations in the text, each part contains two full-sized plain and one coloured plate. The descriptions, commencing with the quadrumana, are written in an exceedingly interesting and popular manner. The size of the page is 13 in. by 10 in. The engravings and general get-up are good.

THE STARS AND CONSTELLATIONS: A New Method, by which all the more Conspicuous Stars, Constellations, and other Objects of Interest in the Heavens that are Visible to the Naked Eye can be Easily and Certainly Identified. By Royal Hill. Size, 12 in. by 10 in.; pp. 32. (New York: Funk and Wagnalls, London: 44, Fleet Street.) Price $1.

A handsomely got-up volume on extra stout paper. The plan adopted by the author consists of two accurately-drawn time-charts, giving the exact time of rising and southing for every day in the year of 25 of the brightest stars, which are more distinctly identified in the text; from their position, other objects are so described that an ordinary observer will scarcely be able to miss finding them.

Correspondence.

The Editors do not hold themselves responsible for the opinions or statements of their Correspondents.

Utica, New York, U.S. America;
July 24th, 1885.

To the Editor of the Journal of Microscopy and Natural Science.

DEAR SIR,—

Your suggestion *in re* a Monthly Supplement to the *Journal of Microscopy and Natural Science*, at p. 214 of the July number, and your call for the opinion of subscribers thereon, might perhaps invite a word from a reader as far off as America.

I am the possessor of all the numbers of the Journal, from Vol. I. inclusive, subscribing through Mr. Collins, of Great Portland St., London. I like the Journal very much, and I do not feel as if I could do without it. We have nothing to compare with it in this country. I have often felt that I wished the Journal was a little larger, and I shall cheerfully support the proposed supplement if issued.

Very truly yours,
A. L. WOODWARD.

Exeter; 4th August, 1885.

To the Editor of the Journal of Microscopy and Natural Science.

DEAR SIR,—

Replying to your invitation on p. 214 of your invaluable Journal for the current quarter to subscribers, to drop you a line *in re* the "Lett-Worsley-Benison" question, I have much pleasure in saying that I think your idea of a "Monthly Supplement" a capital compromise between the suggestions of these two gentlemen, and likely, if acted on, to provide many like myself with what I find to be a great desideratum—a somewhere to go with my questions, technical and otherwise; questions which I am sure would be freely answered by many subscribers when the projected medium of communication is established.

I feel certain also that a series of papers devoted to common objects, where to find, how to view to best advantage, and how to permanently prepare them, would be of inestimable value.

I am, etc., F. R. BROKENSHIRE.

Current Notes and Memoranda.

Important Notice.—We beg to announce that in addition to the *Journal of Microscopy and Natural Science*, we shall, on January 1st, 1886, publish Part I. of THE SCIENTIFIC ENQUIRER. Its chief aim will be to furnish information on all matters of scientific interest, and will embrace the following:—

1.—Questions on all subjects relating to any branch of Natural Science.

2.—Answers to the same by subscribers.

3.—Contributions on points of interest in any locality—*e.g.*, occurrences of certain plants and insects, and notes on observed habits, etc.

4.—Extracts from recent Foreign Journals.

5.—Letters to the Editor.

6.—Answers to Correspondents.

7.—An Exchange Column, free; and a Sale Column, for the use of which a nominal charge will be made.

THE SCIENTIFIC ENQUIRER will be published monthly, price 4d. Messrs. Baillière, Tindall, and Cox will be our London agents.

We shall be glad to receive contributions for each of the departments of THE SCIENTIFIC ENQUIRER as early as possible. They should be written on separate pieces of paper (a half-sheet of note will be a convenient size), and numbered; so that in case too many be received for the first issue, the early numbers of each will be chosen. Every contribution must bear the name and address of the writer (not necessarily for publication).

We have received promises of many valuable and most interesting papers for our fifth volume.

Mr. A. C. Coles' Studies in Microscopical Science, accompanied by slides of the usual degree of excellence, arrive monthly with great punctuality. We have not this time space to enumerate the various specimens; suffice it to say that slides and notes are fully up to the standard.

List of Plates.

Index to Vol. iv.

Vol. 4.] JANUARY, 1885. [Part 13.

THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE:

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CONTENTS.

Vol. 4.] APRIL, 1885. [Part 14.

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