It is shown that various flames, both earth-connected and isolated, have an exceedingly great power of discharging both kinds of electricity.

The effects in regard to discharge are shown to be similar when platinum wire, rendered hot by a galvanic current, is used, and also when the condensed electricity of a Leyden jar is experimented on.

As hot iron shows a preferential power of discharging — over + electricity, so it is found that white-hot but isolated iron refuses to be charged either with + or — electricity. As the iron cools, it acquires first the power of receiving — and afterwards of receiving +. Further, while white-hot iron in contact with an electrified body prevents that body from retaining a charge of either kind of electricity, as it cools it permits a + charge to be received, and subsequently a — one.

A suggestion is made as to the existence of an electrical coercitive force, the presence of which together with its diminution by heat would explain much of what has been described.

February 20, 1873.

Rear-Admiral RICHARDS, C.B., Vice-President, in the Chair.

The following communications were read :—

I. "On the Anatomy and Histology of the Land-Planarians of Ceylon, with some Account of their Habits, and a Description of two new Species, and with Notes on the Anatomy of some European Aquatic Species." By H. N. MOSELEY, M.A., Exeter College, Oxford. Communicated by G. ROLLESTON, M.D., Linacre Professor of Anatomy and Physiology in the University of Oxford. Received January 16, 1873.

(Abstract.)

The writer commences by expressing his great obligations to Professor Rolleston, whose pupil he formerly was. Professor Rolleston first informed him of the existence of Land-Planarians in Ceylon, and of the importance of investigating them. The paper was at first intended to be a joint one, and Professor Rolleston himself made a number of preparations of *Rhynchodemus*, one of which is figured. He likewise rendered great aid in the bibliography, and by constant suggestions and assistance during the progress of the work.

Two new species of Land-Planarians from Ceylon are described,—one belonging to the genus *Bipalium* (Stimpson), *B. Ceres*, the other to that of *Rhynchodemus*, *R. Thwaitesii*, so called after Mr. G. H. K. Thwaites, F.R.S., the illustrious curator of the Peradeniya Gardens, by whose assistance the specimens made use of were procured.

Lists are given of all the known species of *Bipalium* and *Rhynchodemus*, and also a map to show the distribution of *Bipalium* in space.

With regard to the habits of *Bipalium*, the most interesting facts noted are that these animals use a thread of their body-slime for suspension in air, as aquatic Planarians were observed to do for their suspension in water by Sir J. Dalyell, and the cellar-slug does for its suspension in air. The projection of small portions of the anterior margin of the head in the form of tentacles, originally observed by M. Humbert, becomes interesting in connexion with the discovery of a row of papillæ and ciliated pits in that region. The anatomy of the Planarians was studied by means of vertical and longitudinal sections from hardened specimens. The skin in *Bipalium* and *Rhynchodemus* closely conforms to the Planarian type, but is more perfectly differentiated histologically than in aquatic species, and approaches that of the leech in the distribution, colour, and structure of its pigment, and especially in the arrangement of the glandular system. The superficial and deep glandular system of the leech are both here represented. In *B. Ceres* peculiar glandular structures exist, which may foreshadow the segmental organs of Annelids, it being remembered that these segmental organs are solid in an early stage of development. Rod-like bodies (Stäbchen or stäbchenförmige Körper) are present in abundance, though, singularly enough, Max Schultze failed to find any in *Geoplana*. These rod-like bodies are probably homologous with the nail-like bodies of Nemertines; and it is possible that the setæ of Annelids are modifications of them. No light is thrown by the structure of these bodies in *Bipalium* on the question whether they are homologous with the urticating organs of Cœlenterata.

The muscular arrangement in *Bipalium*, which is very complex, throws great light on the homologies between the muscular layers of *Turbellaria* and those of other Vermes. It is commonly said that whilst in all other Vermes the external muscular layer is circular, and the longitudinal internal, in Turbellarians the reverse is the case. A wide gulf is thus apparently placed between these groups. In *Bipalium* there is an external circular muscular coat, which even presents the same imbricated structure which is found in it in leeches and other worms. In *Dendrocœlum lacteum* there is also an external circular coat. In cases where a distinct external circular muscular coat is absent, it is represented by a thick membrane, which is very probably contractile. The question resolves itself simply into a more or less perfect fibrillar differentiation of that membrane. All Turbellarians are built on the same essential type, as regards muscular arrangement, as are other worms. The general muscular arrangements in the bodies of the *Bipalium* and *Rhynchodemus* have become much modified from those of flat Planarians by the pinching together and condensation of the body, but they are nevertheless referable to the same type.

The digestive tract consists of three tubes (one anterior, two posterior),

as in other Planarians, and as in the embryo leech before the formation of the anus. Characteristic of land-Planarians, and consequent on the condensation of the body, is the absence of all diverticulæ from the inner aspects of the two posterior digestive tubes. This is found to be the case in *Geoplana*, *Bipalium*, *Rhynchodemus*, and *Geodesmus*. The close approximation of the intestinal diverticula in *Bipalium* and *Rhynchodemus*, and the reduction of the intervening tissue to a mere membranous septum, is very striking, and seems to foreshadow the condition of things in Annelids. The great difference in the form of the mouth in *Rhynchodemus* and *Bipalium* is also remarkable, considering the many points in which these forms are closely allied.

A pair of large water-vascular trunks, or, as they are here termed, primitive vascular trunks, are conspicuous objects in transverse sections of the bodies of *Bipalium* and *Rhynchodemus*. A peculiar network of connective tissue is characteristic of these vascular canals on section, and is shown to present exactly similar features in *Leptoplana tremellaris*, *Dendrocœlum lacteum*, and *Bothriocephalus latus*. The close agreement in the relative position of the oviducts to the vascular canals in *Dendrocœlum* and our land-Planarians is very remarkable. This primitive vascular system is homologous with the body-cavity present in the embryo leech and in *Branchiobdella* throughout life. It is not necessarily an excretory system, though the term water-vascular system has been generally considered to imply such a function for it. The nerves and ganglia of Planarians lie within the primitive vascular system, as do the corresponding structures within the primitive body-cavity of the leech.

Branches from the primitive vascular system in *Bipalium* serve to erect the penis, and probably supply the glandular tissue with fluid for secretion; others possibly proceed to the ciliated sacs in the head, and perform an excretory function. A small marine Planarian was found to contain hæmoglobin. In *Bipalium* there are a series of separate testes disposed in pairs, as in the leech. In *Rhynchodemus* the testicular cavities are more closely packed, and follow no such definite arrangement. The ovaries are simple sacs in both *Bipalium* and *Rhynchodemus*, and are placed very far forwards in the head, a long distance from the uterus. In *Bipalium* short branches given off from the posterior positions of the oviduct are the rudiments of a ramified ovary, such as exists in *Dendrocœlum lacteum*. There are also glands present, which probably represent the yelk-glands and shell-making glands of aquatic Planarians in a more or less rudimentary condition. There is a comparatively simple penis and female receptive cavity in both *Bipalium* and *Rhynchodemus*. In *Bipalium* there is, further, a glandular cavity at the base of the penis (prostate). The organs described as nervous ganglia by Blanchard in *Polycladus* are almost certainly its testes and ovaries; and therefore the arrangement of these bodies in *Polycladus* is the same as that in *Bipalium*.

The chain of nervous ganglia described as existing in *Bipalium* (*Sphyrocephalus*) by Schmarda, and which has been referred to by so many authors, does not exist. There is no doubt that Schmarda mistook the ovaries and testes for ganglia. The real nervous system is ill-defined, but appears to consist of a network of fibres without ganglion-cells, which lies within the primitive vascular canals. In *Leptoplana tremellaris* the structure of the ganglionic masses is remarkably complex in the arrangement of the fibres; and well-defined ganglion-cells of various sizes are present and have a definite arrangement.

Numerous eye-spots are present in *Bipalium*, most of them being grouped in certain regions in the head, but some few being found all over the upper surface of the body, even down to the tail. The eye-spots appear to be formed by modification of single cells. In *Rhynchodemus* two eyes only are present. All gradations would appear to exist between the simple unicellular eye-spot of *Bipalium* and the more complex eye of *Leptoplana* or *Geodesmus*, where the lens is split up into a series of rod-like bodies, forming apparently a stage towards the compound eyes of Articulata. It is quite probable that these compound eyes have arisen by such a splitting up into separate elements of a single eye, and not by fusion of a group of unicellular eyes, such as those of *Bipalium*. A peculiar papillary band runs along the lower portion of the margin of the head of *Bipalium*. The delicate papillæ are in the form of half cylinders, ranged vertically side by side. Between the upper extremities of the papillæ are the apertures of peculiar ciliated sacs. The papillæ, from the mode in which the animal makes use of them, are probably endowed with a special sense-function. The sacs may have a similar office, or they may be in connexion with the primitive vascular system, and have an excretory function; they may further be homologous with the ciliated tubes in Nemertines.

In considering the general anatomy of *Bipalium*, it is impossible to help being struck by the many points of resemblance between this animal and a leech. Mr. Herbert Spencer has, in his 'Principles of Biology,' placed a gulf between Planarians and Leeches by denoting the former as secondary, the latter as tertiary aggregates, so called because consisting of a series of secondary aggregates formed one behind the other by a process of budding. It is obvious, however, that a single leech is directly comparable to a single *Bipalium*. The successive pairs of testes, the position of the intromittent generative organs, the septa of the digestive tract, and, most of all, the pair of posterior cæca, are evidently homologous in the two animals. Further, were leeches really tertiary aggregates, the fact would surely come out in their development, or at least some indication of the mode of their genesis would survive in the development of some annelid. Such, however, is not the case. The young worm or leech is at first unsegmented, like a Planarian, and the traces of segmentation appear subsequently in it, just as do the protovertebræ in vertebrates

which Mr. Spencer calls secondary aggregates. If Mr. Spencer's hypothesis was correct, we should expect to find at least some Annelid developing its segments in the egg as a series of buds. It is not, of course, here meant to be concluded that Annelids are not sometimes in a condition of tertiary aggregation, as *Nais* certainly is when in a budding condition, but that ordinarily they are secondary and not tertiary aggregates; and if so, then so also are Arthropoda.

Much more information concerning the anatomy of Planarians will be required before it will be possible to trace the line of descent of *Bipalium* and *Rhynchodemus*, and determine what was the form of their aquatic ancestors. In the absence of accurate accounts of the structure of the American Land-Planarians, and even of the European *Rhynchodemus terrestris*, the question is very puzzling. The formation of either one of the two forms *Bipalium* or *Rhynchodemus* might be accounted for with comparative ease, from the arrangement of parts in the flat head of *Bipalium*. From the tree-like branching of the digestive tract in that region, the corresponding ramification of the vascular system, and general muscular arrangement, it might be imagined that *Bipalium* had come from a flattened parent of the common Planarian form, and that all the body except the head had become rounded and endowed with an ambulacral line. In nearly all points, except the eyes and the absence of branches to the oviduct, *Bipalium* seems more highly specialized than *Rhynchodemus*. We might imagine that *Rhynchodemus* and *Bipalium* had a common parent, and that when an ambulacral line was just beginning to be developed, the two forms took different lines—*Rhynchodemus* losing all traces of the original flatness of its ancestor, and never developing any ciliated sacs or papillæ, but cherishing a single pair of large eyes at the expense of all the rest which it possessed, its testes, moreover, remaining in a comparatively primitive condition. But then comes the difficulty about the great difference in shape in the pharynxes of the two forms; and if it be suggested that, as is highly probable, several or many aquatic Planarians have taken to terrestrial habits, and that *Bipalium* has been derived from a form like *Leptoplana*, with a folded pharynx, whilst *Rhynchodemus* came from an ancestor with a tubular one, it is difficult to account for the many points of close resemblance between these two forms, and especially their similarity in external colouring, though this latter may perhaps be explained by mimicry. On the whole, it is evident that a close study of the anatomy of Land-Planarians cannot fail to lead to interesting results, and it is hoped that this memoir may lead to further work of the same kind. It would be of especial value to have a good account of the anatomy of *Geodesmus* and *Rhynchodemus sylvaticus*.