The separate parts of the mouth of the bee and their power of moving having been considered, it remains to examine what use the bee makes of them in its different actions.

1. In order to empty the deepest honey tubes accessible to it, the bee stretches out all the moveable parts of its sucking apparatus (lora, cardines, laminæ, maxillar palpi, and tongue) in the same manner as is shown in Figs. 1 and 2, with the only difference that the two first joints of the labial palpi sheathe the tongue from beneath, and that the laminæ closely embrace the mentum and the basal part of the tongue from above. Then the terminal hairy whorls of the tongue, protruded as far as possible and advanced to the bottom of the honey-tube, being wetted with honey, the bee, turning backwards the cardines (*c*), withdraws the mentum, together with the tongue and the labial palpi, so far that the laminæ are no longer overtopped by the labial palpi, and that the laminæ and the labial palpi together, closely embracing the tongue, form a sucking-pipe, of which only the part *k-l* (Fig. 4) of the tongue is prominent. But almost at the same time the bee, folding the base of the tongue into the tubular extremity of the mentum, withdraws the terminal hairy whorls wetted with honey into the sucking-pipe, in which the honey is forthwith driven downwards to the oral opening by the erection of the whorls of hairs progressing quickly from the tip of the tongue towards its base, and simultaneously by the enlargement of the interior abdominal hollows connected with the œsophagus, which are visible from the outside by the swelling of the abdomen, and which must suck the honey towards the œsophagus.

Fig. 4 shows the head of a humble-bee in a medium sucking position. When from this position the base of the tongue is folded into the hollow extremity of the mentum (as illustrated by Fig. 3), the part *k-l* of the tongue wetted with honey is withdrawn into the sucking-pipe. Now when the lora (*l* in Fig. 4, directed downwards) are turned backwards round their food-points, the base of the sucking pipe (near *mp* Fig. 4) is withdrawn to the opening of the mouth (between the base of the two mandibulæ, *md* and the labrum, *lbr*, Fig. 4, below the epipharynx *ep*, Fig. 1), and the honey is, by pressing and sucking, driven to the œsophagus. When the lora (*l*) are again turned forwards, the whole sucking apparatus is pushed forward double the length of the lora; and now the cardines turning forward, the mentum with its appendages again advances double the length of the cardines, while the maxillæ remain at the same place, and the laminæ from this cause embrace only the mentum and the basal portion of the tongue; when at last the base of the tongue infolded in the tubular mentum is stretched out, the tongue is again protruded to its fullest extent, and the terminal whorls of hairs are again wetted with honey at the bottom of the honey-tube of the flower.

In a flower rich in honey, a humble bee may be observed executing four, five, and sometimes more, even eight or ten separate acts of suction, probably accompanied by as many protrusions of the tip of the tongue into the honey, and withdrawals of it and of the whole sucking-pipe.

I am fully convinced that the movements of the oral apparatus of the bees are as described; for by intoxicating honey- and humble-bees by chloroform, and immersing the tip of their tongue into a solution of sugar, I sometimes succeeded in seeing the movements described performed sufficiently slowly to discern each separate act very well. What occurred within the sheath of the tongue formed by the laminæ and the maxillary palpi, was of course not visible, but bending them aside after wetting the tip of the tongue with the solution of sugar, I sometimes saw the erection of the whorls of hairs progressing from the tip towards the base of the tongue.

Hence undoubtedly the statement of zoologists, who, absolutely denying the sucking power of bees, assert that they lick or lap the honey in a manner similar to a dog or a cat when drinking, must be essentially modified. The terminal whorls of hairs are filled with honey by adhesion; this honey withdrawn into the sheath of the tongue is driven towards the œsophagus by a double cause, first by the pressure of the erect whorls of hairs, and secondly by suction. HERMANN MÜLLER

(*To be continued*)

*ON SOME REMARKABLE FORMS OF ANIMAL LIFE FROM GREAT DEEPS OFF THE NORWEGIAN COAST**

THE name of George Ossian Sars is honourably connected with a very interesting chapter in the history of deep-sea research. As early as 1850, his illustrious father, Dr. Michael Sars, had challenged Edward Forbes's conclusions respecting the bathymetrical terminus of animal life. He remarked,† that at least in the Norwegian Seas, it appeared to extend much beyond the limit which the English naturalist had fixed for it. Forbes had not dredged below 230 fathoms, and at this depth he had only obtained two living Mollusca and a couple of Serpulæ; hence he was led to place the zero of animal life at 300 fathoms. Sars, on the contrary, even at the early period just mentioned, had obtained from a depth of 300 fathoms a number of animals, including a species of Coral, Molluscs, Polyzoa, &c.; and he sagaciously remarked that there was evidence of the existence of a *vigorous* animal life at this great depth, inasmuch as some of the species (*e.g. Terabratula septigera* and *Lima excavata*) were the largest known representatives of their respective genera. In confirmation of his opinion, he was able to offer, in 1864, a Catalogue of 92 animals, which had been obtained in depths varying from 200 to 300 fathoms. More recently his son has devoted himself with much energy and success to deep-sea investigation, and in 1868 had extended his dredgings to 450 fathoms, and added no less than 335 species to those already published. He says:—"I found to my great surprise at this enormous depth, not . . . a poor and oppressed Fauna, but on the contrary a richly developed and varied animal life. . . . And so far was I from observing any sign of diminished intensity in this animal life at increased depths that it seemed, on the contrary, as if there was just beginning to appear a rich and in many respects peculiar deep-sea fauna, of which only a very incomplete notion had previously existed." Amongst the new forms thus obtained was the famous *Rhizocrinus Lofotensis*, descended from Oolitic ancestry, which furnished, according to Dr. Carpenter, "a principal 'motive'" of the *Lightning* expedition. It is interesting to learn that these productive dredgings at the great depth of 200-450 fathoms were accomplished in an ordinary fishing-boat with a crew of three men.

In the important paper which forms the subject of the present notice, Mr. G. O. Sars has given us an account of some of the results of his dredgings in the "great deeps" off the Coast of Norway, founded partly on the posthumous manuscripts of the late Prof. Sars, and partly on his own investigations. Various new species of Mollusca, Annelids, Corals, and Sponges, all of them dwellers in depths varying from 100 to about 500 fathoms, are described, and illustrated by excellent figures. But that which gives a peculiar and distinctive interest to the work is the elaborate memoir on a remarkable Polyzoon, taken in the year 1866, from a depth of 120 fathoms, at Skraaven, in Lofoten. This unique animal is not only

* Partly from posthumous manuscripts of the late Prof. Dr. Michael Sars. By George Ossian Sars.

† "Beretningom en i Sommeren, 1849, foretagen Zoologisk Reise i Lofoten og Finmarken," p. 13.

generically distinct from all the forms that had been recognised at the time of its discovery, but must be referred to a new Order or Sub-class: it is chiefly interesting, however, to the biologist from the light which it throws on the history and affinities of the tribe to which it belongs. Its occurrence was first recorded in 1868 by the elder Sars, who gave it the name of *Halilophus mirabilis*, but did not at that time enter upon the details of its structure. In 1869 Allman described a new Polyzoon, under the name of *Rhabdopleura Normanni*, which had been dredged up from deep water in Shetland, and which presented some remarkable peculiarities. Its polypides (according to Allman) were of the Hippocrepian type, having the tentacles disposed in the form of a horse-shoe, instead of circularly, an arrangement which had only been noticed so far amongst the fresh-water division of the Polyzoa. Another anomalous character was the presence of a rigid, chitinous rod, extending throughout the creeping portions of the polyzoarium, to which the polypides were attached at intervals by means of a long flexible cord. It now appears that the Shetland Polyzoon belongs to the same genus as the Lofoten form just mentioned. Allman, however, having only access to specimens preserved in spirit, was unable to master all the details of the structure or to apprehend fully the significance of the organism as a whole. For a complete knowledge of *Rhabdopleura* we are indebted to the careful observations of the younger Sars, who studied the living animal; while to his father we owe a most interesting interpretation of the facts which the son had established.

Without entering into minutiæ, I shall endeavour to describe briefly the characteristics which mark out the *Rhabdopleura* as unique, and invest it with so high an interest, not only for the student of the Polyzoa, but also for the philosophical biologist. In the first place, it may be stated broadly that we find in this form the Polyzoan type in a rudimentary and half-developed condition. It clearly represents a very early stage in its evolution, if evolution be the method of Nature. The points which separate it most strikingly from its congeners are not the equivalent of the ordinary differences that occur amongst the members of the same class; they might rather be regarded as surviving features of another and very different type, from which it has diverged, and are strictly transitional in character. *Rhabdopleura* is a Polyzoon, and yet not *all* Polyzoon. A large portion of its structure, while clearly taking the Polyzoan direction, differs widely from that of all known Polyzoa. Some of the features which we should regard as most characteristic of this class are altogether wanting. And organs in which the Polyzoan type is most distinctly traceable, appear in a simpler and more rudimentary condition than in any other known form. In a word, two types of structure seem to blend in this remarkable animal, one, as it were, fading away, and the other dawning.

The polyzoarium in *Rhabdopleura* bears a striking resemblance to that of a Hydroid, and might belong to a *Coryne* or *Eudendrium*. It consists of a number of erect, chitinous tubes, distinctly annulated, which are united by a creeping, tubular stem. Each of the erect tubes (zoœcia) contains a polypide, and every polypide is attached by a contractile cord to a dark-coloured, cylindrical rod, which pervades the creeping portion of the polyzoary. The polypide differs from those of the normal Polyzoa in the following important particulars:—

1. It is without any sort of attachment to its cell, in which it lies quite free. In all other known Polyzoa a membrane (the endocyst) lines the cavity of the cell, and envelopes the polypide, to which it is attached above, at the base of the tentacular crown. When the animal retreats into its cell, it draws in with it the anterior portion of this membrane, which securely closes the aperture. Between the endocyst and the body of the polypide is a space (the perigastric cavity), in which the nutritive fluid is confined. But in *Rhabdopleura* the endocyst is altogether absent, or appears in a perfectly elementary condition, as a "thin, glassy skin," immediately surrounding the digestive apparatus. There is nothing to close the orifice of the cell, and the surrounding water passes freely into its interior. There is no perigastric cavity or fluid. The polypide is as free and unattached as a Hydroid in its calycle; and its only connection with the colony is through the contractile cord already referred to.

2. The digestive system is of the Polyzoan type, but of much lower grade than is found elsewhere. There is little specialisation of parts; the stomach and intestine consist of a simple tube, wider towards its upper extremity and narrowing off rapidly towards the posterior end, which is bent abruptly upon itself. The intestine is not separated from the true stomach by any valve, but is an immediate continuation of it, and passes off from its lower extremity in a straight line to the anal orifice.

In the normal Polyzoa, on the contrary, the stomach is divided into two well-defined regions; and the intestine, which is marked off by a distinct valve, takes the origin between the upper portion and the large, sub-globular sac, in which it terminates below. We have in *Rhabdopleura* the bent tube and the two orifices (oral and anal), but beyond this, perfect simplicity of structure.

3. The tentacular apparatus exhibits some remarkable features. It differs essentially from that of the marine, and also from that of the fresh-water Polyzoa, though it most nearly approaches the latter. It consists of two symmetrical lobes or arms, which extend out dorsally from the anterior part of the body, diverging to each side; and each of which bears a double row of ciliated tentacles. These lobes are very flexible, and exhibit great mobility, bending slowly in various directions; and in this respect they contrast strikingly with the unchanging lophophore of the fresh-water Polyzoa. The single tentacular crown, which belongs to all the other known members of the class has here disappeared; and instead of the circular verticil of the marine, and the crescentic but continuous series of the fresh-water species, we have here two series, borne on distinct flexible and movable appendages.

4. In *Rhabdopleura*, the complicated muscular system concerned in the protrusion and retraction of the polypide, which is so characteristic of the Polyzoa, and on which their lively and rapid movements depend, is suppressed along with the endocyst. *Retraction* is effected solely by means of the cord that passes from the body to the rod pervading the creeping stem. It is a very slow and sluggish process, the polypide exhibiting none of the sensitiveness and vivacity of its kindred. Under extreme provocation it retires very deliberately; an ordinary Polyzoon disappears with the speed of light, on the slightest alarm. This sluggishness, as our author remarks, is accounted for "by the want of special retractor-muscles, and by the slightly developed contractile elements, not distinguishable as evident muscular fibres, in the contractile cord."

Still more remarkable is the mode in which the protrusion of the polypide is effected. In the absence of the usual muscular appliances, it is difficult, at first sight, to imagine how the creature can raise itself from the lower extremity to the aperture of its tubular dwelling. It appears, however, that a special and most singular organ exists for the purpose, and that here also the *Rhabdopleura* departs altogether from the customs of its race. This organ consists of a large and prominent shield or disc, which projects from the anterior end of the body between the oral and anal orifices, and is thickly covered with cilia. It evidently corresponds with an anomalous structure (known as the *epistome*), which occurs only amongst the freshwater Polyzoa, and the function of

which has not hitherto been determined. Sars has observed that this ciliated disc is closely appressed to the wall of the cell, during the process of protrusion, and is in fact a kind of foot or creeping-organ, by means of which the polypide laboriously draws itself up towards the aperture of its tube. The Polyzoon, which, in its normal condition, is equipped with a powerful muscular apparatus, and remarkable for its vivacious habits, here literally crawls out of its cell.

5. It only remains to notice the dark-coloured cord, which runs throughout the creeping stem, and is a very marked feature of this curious form. It is described as a cylindrical tube, with firm, horny walls, inclosing a soft, transparent, cellular substance, from which branches are given off at intervals, and enter into the contractile cord of each polypide. This "axial cord" may no doubt be compared with the so-called nerve-trunk pervading the stem of other marine Polyzoa—the principal element of the supposed colonial nervous-system. Our author rightly regards the soft substance extending through the cord, as a sort of incompletely defined nervous trunk connecting all the individuals of the colony.

Of the development of *Rhabdopleura* little can be said at present. Both Sars and Allman, indeed, have recorded observations made on the formation of buds; but they disagree in their interpretation of several important points; and we must wait for further information before we can master this portion of the history.

From the foregoing account it is evident, as stated at first, that in *Rhabdopleura* we have the polyzoan structure in a very rudimentary condition, and half disguised by features that are alien to it as it now exists; some of its principal elements are fully established, though in a simpler form than we find them elsewhere; some are altogether wanting; while one important class of functions (the various movements of the polypide) is provided for by means which have no parallel whatever amongst other members of the tribe, and in part by an organ, which survives, reduced in size and with a different office, in one section only, as the so-called *epistome* of the fresh-water species.

Allman's examination of the Shetland *Rhabdopleura*, as preserved in spirits, led him to regard the Polyzoa as connected with the Mollusca, through the Lamellibranchiata, rather than the Brachiopods. Prof. Sars, relying on his son's investigations, takes a very different view of their affinities. He regards the *Rhabdopleura* as an organism "which stands as it were in the middle between the Hydrozoa and the Polyzoa," and forms a transition from one to the other. It is undoubtedly, he says, "like many other animals which at present inhabit the greater depths of the sea, . . . *a very old form*, which in its organisation has still retained several features from the time when the animal type that we call Polyzoa first developed itself from a lower type." He considers it to prove that the Polyzoa "are most closely related to the type of the *Cœlenterates*, and especially to the class *Hydrozoa*," from which they are probably derived.

It is my present object merely to report results, and not to offer any criticism upon them; but it may safely be said that the paper, a portion of which I have summarised, is one of the most interesting and important contributions to biological literature, that have lately appeared.

It is right to add that the author, considering "one of the great universal languages" preferable to his mother-tongue, as the vehicle of scientific research; and as a graceful acknowledgment of the services rendered by our countrymen in recent times to zoological science, has courageously, and to the relief of many of his readers, written his memoir in English.

THOMAS HINCKS

NOTES

AT the Midsummer Commencements, held last week in Trinity College, Dublin, the honorary degree of LL.D. was conferred by the University of Dublin on Dr. Andrews, of Belfast, and Professor Wright, of Cambridge.

DR. JAMES MURIE, Professor of Anatomy in the Edinburgh Veterinary College, has been elected to the newly-founded lectureship of Animal Physiology in the Edinburgh School of Arts.

ARCHÆOLOGISTS will be interested, and no doubt pleased, to hear, that Sir John Lubbock has just bought Silbury Hill, the grandest tumulus in Great Britain, if not in Europe.

WE have a number of earthquakes to chronicle this week; that in India, it will be noticed, preceded only by a day those of Italy. The earthquakes in Chili, on the 15th May, were of a very serious character. They affected Valparaiso, Santiago, Quillota, La Ligua, Canquenes, and Salvados. At Chillan, Concepcion, and Talchuano, in the south, so far as we can understand, it was slight. At Valparaiso, it commenced at 12.32 P.M., and lasted forty-two seconds, with a vertical motion, so that the ground danced under foot. Two churches and many buildings were damaged. Gas branches were wrenched from the ceilings, and books thrown from the shelves. In Salvados, in Central America, the earthquakes had ceased in May. At 2 P.M. on the 28th June, Asseerghur Fort was visited by an earthquake which lasted for about three or four seconds, direction from north-west to south-east. On the morning of June 29, about five o'clock, an earthquake visited several parts of Italy. At Verona, Treviso, and Venice, though the shocks were severe, little damage was done; but at Feletto, north of Piane, and near Conegliano, the church fell in-and thirty-eight people are reported to have been killed. At Belluno four persons were killed and several wounded. At Pieve del Alpago several persons were injured. Two persons were killed at Torres, four at Curago, eleven at Puos, two at Visione, and one at Cavessago.

WE regret to hear that difficulties have arisen in the management of the Brighton Aquarium, which are likely to lead to the resignation of Mr. Saville Kent, who lately vacated a post in the British Museum for that of Curator and Resident Naturalist to the Aquarium. Of the nature of the dispute we are not informed, but it seems unfortunate if some means may not still be found by which an amicable arrangement may be arrived at between Mr. Kent and his colleagues by which his services may be retained to the institution.

THE female Octopus at the Brighton Aquarium still continues to guard her clusters of ova with the greatest vigilance, refreshing them at short intervals by turning upon them a powerful stream by means of her tubular funnel; no increase to the number deposited having taken place since last week, the usual complement produced may be presumed to have been excluded. The truncate "*Hectocotylus*" arm of the male, in this instance the third on the left side, is fast recovering its normal condition, a new slender filamentous process has sprung from the ruptured extremity, resembling, in detail, the reproduced arm of an *Ophiocoma* or Brittle Starfish. Mr. Saville Kent is of the opinion that the *Octopus tuberculatus* of D'Orbigny will prove on closer investigation to be the mate of *O. vulgaris*; the difference in appearance between individuals of the same species but the opposite sex being most marked when once recognised; the general surface of the integument in the female is comparatively smooth, while numerous rugosities and elevated papillæ adorn that of the male, more particularly in the neighbourhood of the head.