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XLI.—On the genus Mermis

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obtaining these saline ingredients for the manufacture of the artificial sea water, as many of them, not being usually kept for sale, would have to be made for the purpose. There cannot be a question that by far the simplest plan would consist in the evaporation of the sea water itself in large quantities at the source, preserving the resulting salt in closely stopped vessels to prevent the absorption of moisture, and vending it in this form to the consumer; the proportion of this dry saline matter being 56½ oz. to the 10 gallons of water, less the 3 pints. This plan was suggested by Dr. E. Schweitzer himself for the extemporaneous formation of sea water for medicinal baths, and, on inquiry since writing the above, I find that such a preparation is manufactured by Messrs. Brew and Schweitzer of No. 71 East Street, Brighton, under the title of "Marine Salts for the instantaneous production of sea water." Mr. H. Schweitzer writes me, that he has for many years made this compound in accordance with his cousin's analysis. The proportion ordered to be used is 6 oz. to the gallon of water and stirred well until dissolved.

Apothecaries' Hall, Nov. 1, 1854.

XLI.—*On the Genus* Mermis*. By Dr. G. Meissner. Analysis by Dr. W. I. Burnett†.

A memoir of great value has recently appeared upon these singular parasites, which has the double importance of quite clearing up the history of these animals in all their stages, and of furnishing a contribution to the histology of the lower animals of a most valuable character. This memoir has been prepared by G. Meissner of Munich, under the directions of Siebold, who furnished him with specimens and other opportunities for its successful prosecution. Seldom have we met with a paper of more careful and extended detail, and which leaves so little behind for investigators in the same direction. Added to this textual detail, every anatomical point is illustrated by admirably executed figures. With our limited space we can at best notice only a few of the more prominent points of this paper.

In the first place it should be remarked that the natural history of the *Gordiacei* was for a long time quite obscure and little understood, and many detached observations not of a parallel character did not improve the subject. To the sagacity

* Beiträge zur Anatomie und Physiologie von *Mermis albicans*. Von Dr. Georg Meissner. In Siebold und Kölliker's Zeitschrift für wissenschaftliche Zoologie, v. 1853, p. 207–285.

† From Silliman's American Journal of Science and Arts for July 1854.

of Siebold we are indebted for the successful solution of the whole enigma, and the results he has obtained are as singular as new*. It appears that these animals live part of their life as regular entozoons, and the rest as independent beings. And what is most remarkable, they enter the animals in which they are for a time parasites, not in the form of eggs, as do other Helminths, but as more or less developed forms. The animals in which they live as parasites are almost exclusively Insects of different orders, in both the larva and imago states. In the abdominal cavity of the larva of *Yponomeuta albicans*, Siebold found numerous undeveloped forms of *Mermis albicans*. Watching these he found that after further growth, they perforated the skin of these larvæ and made their escape. These freshly-escaped individuals were all sexless, but each contained a considerable *corpus adiposum*, at the expense of which their sexual parts were subsequently developed. These animals crawled about, and soon entered some damp earth, where they remained several months, during which time they were further developed, changed their skin, copulated and laid their eggs. The embryos hatched from these eggs had the filamentoid form of the adults, and as Siebold conjectured that they intended to come to the surface for the sake of entering in their turn young insects, he procured quite young larvæ of this same insect and put them in a glass vesael together with the young *Mermithes*. In a few hours they had entered the body of these larvæ, two or three in each. Siebold took the precaution to make this point certain by carefully examining the larvæ previously and determining that their bodies were free of these parasites. After this, the same round of life is again passed. It would appear, then, that these animals pass their earlier (but not their embryonic) conditions of life, during which they attain their development—in fact a proper larval state—in the bodies of insects, and that their life as distinct sexual individuals is free and non-parasitic. Siebold found this species in very many genera of Lepidoptera, also in different species of Orthoptera, Coleoptera, and Diptera. We may mention that the common Cricket, as also some other Orthoptera, are frequent recipients of *Mermis*, and we have seen many specimens of this kind. Until Siebold's recent contributions we had supposed, in common with other naturalists, that these Helminths merely hibernated in these insects, but this is now quite improbable.

So much for a brief reference to the mode of life of these

* Siebold. See the Entomol. Zeitung zu Stettin, 1848, p. 292, 1850, p. 329; also Beiträge zur Naturgeschichte der Mermithen, in Siebold und Kölliker's Zeitsch. für wissensch. Zool. v. 1853, p. 211.

animals; we will now turn and glance at some of the important histological points, as wrought out by Meissner.

Cutaneous System.—Omitting the very full details given of the structure of the skin in these animals, its composition of three distinct layers, &c., we will allude only to the fact that *chitine* enters into its formation. This fact is important as corroborative of other observations. Chitine was formerly supposed to belong exclusively to the teguments of the Arthropoda, being particularly prominent in the skin of insects; but recent chemical analyses of the teguments of lower animals show that it occurs in nearly every class of the Invertebrata*. It can therefore no longer be regarded as having diagnostic characteristics for certain classes, but sustains relations to the external dermic skeleton of the Invertebrata generally, analogous to those of bone in the four classes of Vertebrata.

Muscular System.—This was found quite developed, and it is a singular fact that all the muscles have a longitudinal direction. Transverse muscles do not exist. But Meissner has indicated a histological feature of the muscular tissue in these animals, which deserves notice. It is well known that striated muscular fibre is rather limited in its distribution among the Invertebrata. We have not observed it below the Articulata, and have regarded it as actually absent in the remaining classes—the Cephalopoda, Cephalophora, Acephala, Annelides, Turbellaria, Helminthes, Echinodermata, Acalephæ, and Polypi. Now, we have hitherto supposed from observations that the fibre being the true embryological element of muscle, a further division into fibrillæ occurred only in the higher form of this fibre, the so-called *striated* muscle; in other words, that a fibrillated structure of muscular fibre was found only in the striated form. But Meissner describes the fibre of *Mermis* as readily capable of being split up into longitudinal fibrillæ of the most regular and delicate character, and yet neither these fibres nor fibrillæ are properly transversely striated. He remarks however, that an appearance like striation is sometimes observed during a wave-like contraction of the fibre†. Results of this character which the more careful research of the present day is developing, in the study of the lower animals especially, fully indicate that the subject of muscular tissue is not well understood as to its manifold variations of

* Besides the present case we would refer to the following: Grube, Müller's Arch. 1848, p. 461, and Wiegmann's Arch. 1850, p. 253; Schultze, Beitr. zur Naturgesch. d. Turbellarien, p. 33; and Leuckart in Siebold und Kölliker's Zeitsch. 1851, p. 192, and Wiegmann's Arch. 1852, p. 22.

† We suspect it is this same wave-like aspect that has been often mistaken for striation in the muscles of some of the lowest animals, thereby leading to no little discrepancy among observers in their statements.

form; at least, after we have left the typical forms of the higher animals. Thus, I may mention that Leydig* found the muscles of the alimentary canal of *Artemia* among the Crustacea, composed of spindle-shaped instead of disk-like elements, so arranged, with the points and bases alternating, as to form a symmetrical fibrilla. In conclusion, we may remark upon this system, that Meissner found no sarcolemma, and no perimysium of the muscular layer.

Nervous System.—The researches of Dr. Meissner in this direction have particular interest, because the existence of this system in the *Gordiacei* has been generally denied, and, if seen by previous observers, their statements were most unsatisfactory†. But the histology of this system is quite as interesting.

Meissner found it so developed that he divides it into three portions: a central, a peripheric, and a splanchnic portion.

The *central portion* is divided into two parts, one at the cephalic, the other at the caudal extremity of the body. In the first are two anterior and two posterior cephalic ganglia, and an œsophageal ring composed of a superior and an inferior ganglion united by lateral commissures. In the second part, situated in the tail, there are three fusiform ganglia of like character, but smaller than those of the head.

The *peripheric portion* consists of six filaments given off from the upper part of the anterior cephalic ganglia, which go to as many papillæ on the head, which are probably organs of sense,—of two lateral cords arising from the superior œsophageal ganglion, which traverse the sides of the body, giving off filaments to the muscles, the skin, &c., and of some smaller twigs from the cephalic centres for the muscles of that region.

The *splanchnic portion* consists of two lateral trunks arising from the œsophageal ganglion, which soon meet and unite on the median line of the body, forming one cord which extends to the tail. From this cord are given off filaments to the organs of vegetative and reproductive life.

The three cords thus formed, having traversed the body, end each in one of the three ganglia above described. We can here allude to only one more point in the disposition of the nervous system; this is the final termination of the nerve-filament in muscle. According to our author, a twig enters the muscular fibre at right angles to the course of the latter, and upon its entrance divides into two twiglets, one of which runs with the

* Ueber *Artemia salina* und *Branchipus stagnalis*, in Siebold und Kölliker's Zeitsch. iii. p. 280, Taf. 8. fig. 6.

† Berthold and Blanchard both supposed they saw cords which might be nerves, but their observations were wholly unsatisfactory;—for references see Siebold and Stannius' Comp. Anat., Amer. ed., vol. i. § 104. note 5.

fibre one way and the other the opposite, becoming lost in the muscular tissue*.

The histology of this system in animals so minute as these, worked out by an observer so expert and faithful as Meissner, presents many note-worthy points.

The ganglia in question are composed exclusively of ganglion-cells or globules which appear to be the infundibuliform expansions of as many nerve-fibres that compose the nervous cord connecting these ganglia with the general system. There are none of the so-called nerve-cells usually found in nervous centres—in fact these central masses rather resemble true ganglionic formations, excepting that they are terminal instead of on the course of a nervous cord. Meissner's description and figures, especially the latter, are so good, as to leave no doubt that there is here a direct continuity of the nerve-fibre with the ganglionic vesicle.

In a former notice we alluded to some discrepancy on this point, and as this continuity had been observed by some, and yet not seen by others who had searched carefully for it, we suggested that this direct connection, when present, might be an exceptional condition. But numerous researches since published, and especially the very complete memoir of Axmann†, represent this as a very common disposition of the elements of nervous centres in Man and the Mammalia. The subject is indeed somewhat obscure in a functional point of view, for what is the interpretation of this direct continuity of the vesicular with the tubular portion of this system? Certainly it is not the essential condition of function between the two, or all nerve-fibres would terminate in this manner, and there would be no ganglionic vesicles but those having this connection. But this, as is well known, is far from being the case. We leave the subject until another time. As to the structure of the peripheric nerves, our author describes them as having at first a distinct fibrillated structure as usual, but that this gradually disappears and the nerve appears as a homogeneous cord. But from our own investigations upon the terminal nerves of some insects, we suspect that this disappearance of the true fibrillæ may have been apparent and not real; for we have, in the cases referred to, thought that such was the case, but by using higher powers with some reagents, the fibrillæ were seen. We think therefore that whatever may be the mode

* As Meissner observes, a similar disposition is mentioned by Doyère (Ann. d. Sci. Nat. 1840, xiv. p. 346) in the muscles of the Tardigrada, and by Quatrefages (*ibid.* 1843, xix. p. 300) in the Eolidina, some Annelides and Rotatoria.

† Beitr. z. mikroskop. Anat. u. Phys. d. Ganglien-Nerven-systems des Menschen u. d. Wirbelthiere. Berlin, 1853.

of termination of the nerve-fibre, the fibrillar structure is never lost.

Digestive Apparatus.—This structure, according to Meissner, presents so many peculiarities and is so widely different from anything observed in other animals, that we almost relinquish any attempt to give even a brief description of it, without the aid of figures. In the first place, the alimentary canal has no anal or excretory passages, and therefore the food and assimilation must be such as to leave little or no so-called fæcal matter.

From the circular buccal orifice a semi-canal proceeds a short distance, when it passes into another structure. This semi-canal is the œsophagus. The structure into which it passes is a tube quite small at first, but which soon expands ; it is filled with a finely granular sponge-like substance, and is alternately dilated on each side into sacs. Through this laterally varicose tube the semi-canal of an œsophagus extends to its very end. Suppose then a tube with alternate lateral dilatations, filled with a spongy substance, and through which runs a semi-canal or half-tube like an œsophageal groove. Each of these dilatations has an inversion—a folding in of its internal membrane, producing an infundibuliform body in the dilatation itself. This body opens through a prolongation of the external membrane of the dilatation, which is continuous into a tube connecting with some adipose receptacles.

The food passes along the semi-canal or groove, is gradually absorbed by the spongy substance filling the dilatation, thence passes into the invested body by endosmotic absorption, and is then conveyed as assimilated material into the fat-receptacles which lie in the cavity of the body. These receptacles are storehouses of nutriment and are particularly enlarged and developed during the larval condition,—their contents being used for the formation of the sexual parts afterwards. Now as there is no vascular system in these animals, the dispersion of the nutrient material for the growth and substance of the various tissues must take place by permeation and endosmosis from the fat-bodies which extend over and between all the organs. This assimilation without any particular excretion is a remarkable fact ; but it appears more conceivable when we bear in mind the œconomy of the animal. Its larval or parasitic state is like that of insects —merely preparatory for the ulterior changes of its full development. During this time its food is probably mostly pure fat, which has only to be taken up and stowed away as material for the development of the reproductive organs. This last ensues during a quiescent state, and after the full discharge of the sexual functions, the animal probably dies.

Genitalia.—*Males.*—The disparity in numbers of males and females was remarkably wide—our author having found only three males among several hundred specimens examined. He divides the internal organs into *testis, vas deferens, vesicula seminalis,* and *ductus ejaculatorius;* but these are all continuous, forming a cæcal tube stretching from the anterior portion of the body to the caudal extremity. The testis consists of the infundibuliform cæcal extremity of this tube and is lined with nucleated, epithelial (?) cells.

The external organs consist of two penises situated one on each side of the *ductus ejaculatorius* in a sheath. They are composed of two somewhat curved half-canals disconnected when unprotruded with the internal organs; but when protracted, they form a more or less closed tube projecting beyond the external orifice of the duct.

Females.—Meissner divides the internal female organs, which are double, into five portions: *ovary, vitellus-organ, albumen-sac, tuba,* and *uterus.* Their names indicate their respective functions, and we can here enter into no description of their intimate structure.

In connection with this should be noticed one point not a little remarkable, that is, a kind of hermaphroditism occurring in these animals.

Meissner found individuals which had perfectly well-formed internal female genital organs, but whose caudal extremity was wholly male. Thus, there were the penises, with their protractor and retractor muscles, their sheaths—in fact, all the external organs of the male, yet in these individuals no trace of internal male or of external female organs could be found. Moreover these organs present precisely the same characteristics as though in proper males and females, and had also a functional activity,—eggs being found in the ovaries, &c. But this anomaly was never found in the inverse sense, that is, female external and male internal organs. Here then is presented the striking peculiarity of an animal having double systematically-developed internal organs of one sex, and at the same time perfectly-formed external organs of the other sex. This hermaphroditism, it will be seen, is like that of other animals only in name; for in these last the double sex is at the expense of the symmetry, one side being female and the other male, or it is due to modifications of analogous facts by different grades of development, thereby destroying generally the functional perfection and completeness of each or one of the forms of the sexual organs. But here we have a perfectly symmetrical female internally, with an equally symmetrical male externally, with no fusion of parts.

In regard to the development of the spermatic particles, our author's researches have been minute and quite complete. His results confirm the doctrines of Kölliker, Wagner, and ourselves; that is, there are parent sperm-cells in which are formed daughter-cells; in each of these last there is formed a spermatic particle. But Meissner is undecided whether this formation occurs through a metamorphosis of the nucleus of the daughter-cell. Our own observations have led us fully to think that this nucleus is thus metamorphosed.

The development of the egg is very remarkable, as it shows, what we have never clearly understood before, viz. how botryoidal ovular masses are formed, and moreover carries out the beautiful analogy existing. even to minute details, between the functions of the parent sperm-cell and the ovular cell. An ovular or egg-cell from the ovary is seen; it increases in size and its nucleus segmentates, several nuclei being formed. These nuclei approach the surface of what we will now call the parent egg-cell; diverticula are given off from the cell-wall by protrusions containing each a nucleus. These protrusions become constricted and at last appear as little daughter-cells, on the surface of the parent-cell. They now increase at the expense of this last, become pedunculated, and finally appear as larger pedunculated cells attached around a common, insignificant centre. These are the ova, and form groups of variable number—Meissner having observed as many as twenty, though there are generally less. Thus formed, their peduncles break off, and they pass from the ovary proper into the other sections of the genital tube.

There is one other point taken up in connection with this subject by Meissner, to which we shall briefly allude. We refer to the wonderful *micropyle* of Keber, by which it is alleged that the spermatic particles penetrate the interior of the egg and impregnate it. Meissner has seen nothing to justify the view that such a structure exists in the eggs of *Mermis* excepting the remains of the peduncle above mentioned, and he is not sure of this being hollow. Moreover even if it were hollow, it appears to us wholly different from the special structure insisted upon by Keber.

As to the embryonic development of *Mermis*, our author found nothing essentially different from what had been described by previous observers upon this order (Grube, Leidy, &c.). No proper metamorphosis appears to occur, and therefore the newly-hatched embryos more or less closely resemble in form, &c., the adults.

In conclusion, we repeat what we said in the beginning, that this memoir is one of the most excellent of its kind we have ever seen, and the care, patience and fidelity displayed therein will ensure attention towards its author as one from whom much may be expected.