

REVIEW.

A Monograph of the Victorian Sponges, by ARTHUR DENDY, D.Sc., F.L.S., Fellow of Queen's College, and Demonstrator and Assistant Lecturer in Biology in the University of Melbourne. PART I.—The Organisation and Classification of the *Calcarea Homocœla*, with Descriptions of the Victorian Species (with plates i—xi). Melbourne, July, 1891.

UNDER the above title a most interesting paper on Sponges has appeared, giving, it is not too much to say, the first attempt at an accurate description of the histology of the lower *Calcarea* since Metschnikoff's paper in 1879. I have been working at the same group myself for about half of the last five years. As it is likely to be still some months before my results appear, I think that it may facilitate discussion, while noticing some of the principal features in Mr. Dendy's paper, to indicate at the same time the extent to which my work has led me to similar or different conclusions. And I may commence generally by saying that in the plates of this paper I have had for the first time the pleasure of seeing drawings which represent accurately the structures which have come under my notice.

The introductory criticism on Haeckel (p. 3) appears somewhat to underrate the power of variation in calcareous sponges, particularly their plasticity to environment. Thus *Sycandra raphanus* has formed a special variety in the Naples Aquarium,

unknown in the bay and hitherto undescribed. It outwardly resembles *S. capillosa*. Vosmaer's views on *Leucandra aspera* ('Mitt. Zool. Stat. Neapel,' vols. iii and iv) may require some modification, but its variation is certainly enormous. It is true that the *Homocœla* of Naples seem fairly constant in outward form and canal-system (*sensu* Dendy), but evidence points to their being identical with species of very different aspect in other localities. I disagree with Mr. Dendy that "there is no doubt that a species has no existence in nature." This, however, is an academic question of general zoology, which should be treated by more competent hands than mine. In his rejection of von Lendenfeld's *Homodermidæ* and *Leucopsidæ* he has taken the only course open. It is to general advantage that it should be stated plainly that the histology figured in *Homoderma* is alone sufficient to convince any student of *Calcarea* that the structures described were never seen.

The attempt to group the *Homocœla* according to structure is valuable and suggestive. It does not claim to be sufficiently developed to be considered as a natural classification. There are three sections of the *Homocœla*: I. *Simplicia*, solitary, or with individuals of easily recognised individuality. II. *Reticula*, anastomosing tubes, in which individuals are unrecognisable. III. *Radiata* (one species), a (large) central *Ascon*-tube bearing secondary radial tubes. The last group or species (*Leucosolenia tripodifera*) is perhaps the most important discovery recorded in the paper. The radial tubes branch and branch again, until they are set thickly together like a wall round the wide central osculate sac into which they open, so as to simulate precisely the canal-system of a *Sycon*. But the central tube retains its collar-cells and pores, and its true wall differs in no structural respect from that of its tributaries.

This observation and its treatment by the author appear to me most suggestive. I think that an examination of intermediate forms will convince him that there are many other *Homocœla* to be included in the *Radiata*. *Ascandra*

*Lieberkuhnii*¹ without doubt, as it is found at Naples, comes under his definition of the group, and in its fir-tree-like form, branching at right angles into smaller and smaller tubes, shows a stage antecedent to *L. tripodifera*. Its main oscular tubes are as much (in the specimen before me) as 1.5 cm. by .4 cm.; its smallest branches about .01 cm.; between these all intermediate sizes. A most suggestive feature, on which this is not the place to dwell, is that the unpaired rays of the spicules in the branches are mostly distally directed. In *Ascaltis cerebrum* the oscula (not pseudoscyla; Haeckel was probably misled by the outward appearance when he figured what Dendy would term an "inverted canal-system") open from spaces 0.3 cm. wide, lined with collared cells continuously up to the granular lip; its wide tributaries are not superficial as in the oscula of *Ascandra reticulum*, but deep, and covered with secondary ramifications, ranging down to about .01 cm. diameter. This sponge might seem almost to lead us to Dendy's *Leucosolenia stipitata*, placed by him in Section II. But without going further I would point out that the three previous forms all possess triradiates and quadriradiates more or less slender and pointed; that while those of *A. Lieberkuhnii* are of nearly the same dimensions as *L. tripodifera*, and the apical ray similarly curved, *A. cerebrum* possesses on its external surface the very tripods which give *L. tripodifera* its name. Will Mr. Dendy consider the possibility that his *Radiata* may already advantageously step forth as a genus? e.g. *Homocœla*. Genus 1. *Leucosolenia*. The growth of the tubes is mainly confined to new branches; type *L. clathrus*, *L. dubia*. Genus 2. *Nardoa*. The growth of the tubes is continuous, the newest branches have consequently smallest diameter; type *N. tripodifera*, *N. Lieberkuhnii* (?).

The *Reticulata* are again divided according as the gastral cavity is or is not traversed by ingrowths of mesoderm. I must state my strong suspicion that the "ingrowths of meso-

¹ For my own observations I use Haeckel's names to avoid the coining of new combinations.

derm" are the amœboid cells observed long since in the gastral cavity of certain sponges after digestion, which, as in *Ascetta clathrus*, form such traversing processes, and which I believe, with the older workers, to be collar-cells; to the amœboid metamorphosis of which Dendy makes no allusion. In these Australian sponges there appears to occur none with a many-layered endoderm. This structure, observed by Haeckel and since universally discredited, certainly appears in *Ascetta clathrus*, and—I hope I am not wrong in saying—was observed some years ago by Mr. Hardy, of Caius College, Cambridge, in a *Leucosolenia* found by him at Plymouth.

Turning to histology, Dendy finds "the ectoderm of the Homocœla agrees precisely with what Schulze has described for *Sycandra raphanus*." Although this form occurs in the Homocœla, it is in my experience rare. The typical ectoderm (e. g. *Ascetta clathrus*) I find composed of onion-shaped gland-cells containing a nucleus and granules, and provided with a usually fine duct, the expanded end of which forms the hexagonal area whose boundaries are, in the case of most sponges, all that has been observed. In *Ascetta clathrus* and *blanca* almost the whole ectoderm is of this type, and at least a large part of it in *Ascaltis cerebrum*, *Ascandra reticulum*, and *Ascetta primordialis*; on the external surface in *Sycandra raphanus*, *Leucandra aspera* (sensu Vosmaer), and a new sponge which I provisionally name *Sycaltis leuconides* (having a *Sycaltis* skeleton and a *Leucon*-like canal-system, and thereby necessitating a change of classification among the Heterocœla). Making such a statement without details or figures, I will add that in 1887 Dr. Vosmaer very kindly volunteered to me permission to quote him as being convinced with respect to the ectoderm of *Leucandra aspera*. This structure of ectoderm was described and figured by Merejkovsky for *Halisarca* in 1878 ('Mém. Acad. Petersburg'), by Metschnikoff for *Ascetta blanca* in 1879 ("Spong. Studien," 'Z. f. w. Z.,' 32). Though occurring in one of the latter's

best known papers I have never seen this description alluded to, and the entire paper has curiously escaped Dendy's notice. Metschnikoff's pl. xxi, fig. 1, gives evidence of the flask-shaped epithelium in the young *Halisarca*, corroborating Merejkovsky's description, with which, indeed, the figures of Schulze and similar ones of Metschnikoff's are at variance only in interpretation. I have found this glandular ectoderm in a horny sponge (*Aplysina* ?), an *Axinellid*, and a *Renierid*. Von Lendenfeld's "mesodermal gland-cells" are certainly nothing else in *Calcarea*, and as the descriptions are identical they are probably the same in horny sponges; many "æsthocytes" and similar structures in all likelihood have the same foundation in fact. I therefore personally believe that the typical ectoderm, not only of *Calcarea*, but of sponges, is a glandular epithelium of flask-shaped cells with dilated mouths, and that on external surfaces this is probably the usual form.¹ Mr. Denby has shared with most others the disadvantage of working on specimens more or less shrunk by preservation in alcohol; to this shrinking, to generalisation from the epithelium of canals (more easy to observe than the defended exterior), and to deduction of the existence of a flat epithelium from mere hexagonal silver lines, I attribute the overlooking of this structure by all but the two Russian authors.

Dendy has not found cilia on the ectoderm of *Homocœla*, and throws much doubt on the figures of Lendenfeld, where they are invariably introduced. After long comparison of Dr. von Lendenfeld's descriptions of *Calcarea* with the original structures I have no hesitation in saying that his "low flat plates filled only partially with protoplasm; from this plate threads extend which pervade the cell-cavity," are completely imaginary. His flagella certainly do not exist in the *Calcarea* I have examined; they are probably a generalisation from some structures he has seen in horny sponges. In *Aplysina* (?) I have found threads standing vertically from the ectoderm and precisely simulating flagella; they are undis-

¹ I think that it may prove the primitive Metazoon ectoderm, and will probably be found in various larvæ.

solved in 30 per cent. caustic ammonia, and are probably vegetable.

In the case of the sheath on the apical ray of gastral spicules, Dendy most justly says that there is no evidence to prove their mesodermal origin, and I differ from him in that I am thoroughly prepared to accept them as endoderm. The time has come to free the study of the Porifera from the fetish of mesoderm, and to render to her grasp only that to which embryology can prove her entitled. The presumption lies in favour of the old layers, the ectoderm and endoderm; the *onus probandi* is on the new-comer.

My own work has led me to regard the endoderm not only as multiform, but as most proteic. Dendy recognises it as "polymorphic," but this appears only to refer to the relative state of "retraction" of the collars and flagella. I agree with all his description and figures of these, both in this and preceding communications, and I have now myself observed, in the living *Sycandra raphanus*, the coincidence of flagella and Sollas's membrane which (in *Halichondria panicea*) he was the first to meet with. But I have come to the conclusion that this coincidence is only transitory; and while he most generously yields priority for the theory of filtration, I have been brought to relegate it to the disunited collars, and to believe that the membrane of Sollas is a valvular adaptation to prevent the reflux of water past satiate and therefore inactive cells. Where he writes "retraction" I would write "disappearance," and I believe that in the old "Verwandlung der Geissel bewegung" in "Amoeboider Bewegung" lies the key to many of the anomalies of the intimate structure of sponges. He draws and describes in *Leucosolenia cavata* "yellow granules," which he more than suggests are symbiotic algæ. I have worked at them—besides in former years—during the last nine months in *Ascetta clathrus* (where, besides the description he quotes from Bowerbank, they were described and figured by Metschnikoff, loc. cit.) and *A. primordialis*. I find Dendy's drawings and descriptions of their behaviour and relations most accurate; in *Asc. clathrus* there is an additional point of interest that the

granules in the (glandular) ectoderm-cells differ from these only in being of smaller size. I have been very slowly and gradually led to the conclusion that the bodies in question, which I propose to call "Metschnikoff cells," are metamorphosed collar-cells; that by their reaching to the exterior and becoming perforated, pores are formed; and that the granules of these and of the ectoderm, and of the glandular ectoderm in general (and possibly the granular cells so frequently described beneath it in *Silicea*), are excretory.

In the nucleus of the ovum Dendy finds in *L. pelliculata* nucleoli and circumferential granules; in *L. depressa*, in addition, a faint reticulum. In *Asc. clathrus* (nitric acid and borax carmine) I find a distinct and typical reticulum with small granules at the nodes. I have found also a large nucleolus with vacuoles, possibly artificial. In the matrix capsule of sponge embryos Dendy has almost established a proprietary interest; in *Leucosolenia Wilsoni* he finds they have no connection with ectodermal cells. In *A. clathrus* ova occur which appear to have such a connection, but when full of yolk they lie in sacs dependent in the gastral cavity, clothed with collared cells, of which some are always metamorphosed, and which are in continuity by the neck of the sac with the general endoderm. It may be worth adding to his instances of specially robust external spicules, besides *Asc. cerebrum*, whose "tripods" are confined to the outer surface, *Ascandra reticulum*, in some varieties of which the acerate ("orceote") spicules are so confined, while in others they disappear. The rod-like bodies he describes on the gastral surface of Sollas's membrane in *L. tripodifera* I do not believe to belong to the sponge; he himself accepts them doubtfully. But it is curious that in the allied *A. cerebrum* and the variety of *A. primordialis* which simulates its form (variety of *A. cerebrum* simulating the spicules of *A. primordialis*? nova species?) the collars and flagella most frequently appear to be replaced by a network of threads. Nothing but its "constancy and peculiar and regular arrangement," to quote Dendy's words, could, however, give any doubt that these are vegetable, which on the whole is at present

my belief. With reference to this membrane, the descriptions of von Lendenfeld, in contradiction to the statements of Sollas and Dendy, are, I have convinced myself, as worthless as those of the unique and quite different form of collar-cell till very recently described and figured by him in all groups of sponges.

Dendy's observations of afferent canals lined with ectoderm perforating the walls of *L. stolonifera* are most interesting, and in my judgment probably of generic importance. Though *A. clathrus* is much more thickly walled than most of the group, the communication is established by a single perforated granular cell as in other *Homocœla*, and strictly homologous with the granular ring round a prosopyle in the *Heterocœla* (cf. Poléjaeff, *Grantia tuberosa*). This description does not refer to other large pores which occur in this lipostomous sponge, whose structure and morphology I have not worked out.

In conclusion, if in this review points of difference rather than of agreement are accented, it is because the former take more words to express. This paper lies throughout in lines parallel to those on which I have been long labouring; and it may so not be impertinent to give it the cordial welcome of a fellow-worker who finds a great stride made forward towards the knowledge of a group that appeared almost insoluble.

GEORGE BIDDER.

NAPLES; August, 1891.