X.—*On the Structure of Suberites domuncula, Olivi (O. S.), together with a Note on peculiar Capsules found on the surface of Spongelia.* By J. ARTHUR THOMSON. (Plates XVI., XVII.)

(Read 7th June 1886.)

PART I.

The sponge *Suberites domuncula* attracted the attention of the Italian naturalist OLIVI* almost a hundred years ago, but was on account of its firm india-rubber like consistency erroneously regarded as an Alcyonium. Beyond the general diagnosis of NARDO† who erected the genus *Suberites*, the structure of the sponge has, I believe, remained virtually unknown. Not for this reason, however, but because the Monaxonia in general, of which *Suberites* is an example, are still for the most part but little known, Prof. F. E. SCHULZE of Berlin was good enough to ask me last winter to investigate the structure of this sponge. To him, therefore—perhaps the greatest living authority on the subject—I may be allowed to express my gratitude for the hospitable reception with which he welcomed a stranger to his laboratory, and for the constant interest and assistance with which he encouraged my work. That I have not succeeded in giving a perfect elucidation of the structure is largely due to the same cause which has kept it for so long almost wholly unknown. The crowded siliceous spicules, the compact consistence, the smallness of the ciliated chambers, make the histological analysis somewhat difficult. Such gaps as exist in my investigation I hope to be able to fill up by the study of related forms, and have with that end begun the study of *Suberites mana*.

Suberites domuncula is found covering the outside of a sea-snail shell, inhabited by a hermit crab. The change of position thus secured for the sponge is an obvious advantage of this commensalism, while the hermit-crab on the other hand is very effectively masked. Numerous polypes are also found embedded in the sponge. In none of the forms which I had the opportunity of examining was the hermit crab present, and in all the limy shell was to a greater or less extent eaten away, leaving in one instance only the apex. How the lime is precisely affected I was not able to discover. The cavity remaining after the shell has gone leaves a wide coiled canal, which will doubtless aid in the irrigation of the compact mass.

My material was obtained from the Berlin Aquarium, and after careful dehydration, was stained (generally with alum carmine or hæmatoxylin), and

* Bronn's *Klassen und Ordnungen*, Vosmaer "Porifera," p. 33.

† *Ibid.*, p. 332.

sectioned in the usual fashion. I found it useful for general survey to make several large sections through the sponge.

The ectoderm of *Suberites* exhibits no marked peculiarities, but consists of a fine layer of small polygonal and apparently unequal cells, the contours of which were readily demonstrable by the silver nitrate or gold chloride method. With a lens the skin can be seen to be covered with fine pores, while numerous larger apertures are irregularly distributed over the surface. I was, however, unable to discover any oscular opening or openings. The larger apertures seemed, on closer examination, to be widened canals occupied by the abundant commensal polypes. Between the pores the points of the monact spicules projected slightly above the surface.

Not a little of the difficulty attending the investigation of *Suberites* is due to the very abundant occurrence of the large free siliceous needles. On a section through the whole sponge a radiate disposition can be recognised. They extend in large crowded brush-like bundles from the centre outwards, though considerable irregularity of arrangement is also observable. The brush-like bundles are best seen towards the surface between adjacent canals. The needles exhibit a simple uniaxial form, running to a point at one end, and knobbed like a pin at the other (Plate XVI. fig. 4). I also observed a diact form, with double median nodes and with both extremities pointed, a modification readily derivable by fusion or doubling.

The Ciliated Chambers (fig. 4).—The disposition of the ciliated chambers, which is of course the principal point, is very difficult to determine owing to the number of spicules, the compactness of the sponge, the minuteness of the chambers themselves, and the adjacent relations of afferent and efferent canal systems. In sections of fortunate thickness and staining, the small chambers can be seen throughout the whole sponge, but more abundantly towards the periphery. They seem to have a somewhat more than hemispherical form, and exhibit on cross section as many as sixteen cells round the margin. These chambers are in direct communication with the finer branches of the ordinary canal system, which exhibits what is usually termed the fourth degree of complexity. An inner flattened nucleated epithelium could be detected as the lining of some of the canals. *The afferent and efferent canals lie side by side*, their parietal pores are adjacent, and beyond the distribution of the chambers and the direction of the increase in the diameter of the branch canals, I could detect no difference between them, and no special oscular or efferent regions.

The Connective Tissue.—The mesodermic connective tissue exhibits great variety of composition in different regions. The cells vary greatly in shape, from round and regular to polygonal and multipolar, or to long drawn out spindle-like forms. Fine connecting threads between adjacent cells could be readily recognised. In some cases, besides nucleus and nucleolus, the intra-

cellular protoplasmic network could be distinctly seen. The great interest of the connective tissue, however, is its frequent modification into what may be termed *muscle-cells*. Disposed in compact strands, specially abundant in certain positions, these extended spindle-shaped cells certainly suggest a contractile function. A thick layer occurs just below the ectoderm; numerous well-defined, occasionally branching, strands run parallel to the surface somewhat further inwards; a similar compactness of disposition is very abundant in the region adjoining the gasteropod shell, and lastly these muscle-strands frequently occur round the larger canalicular passages. While the strands of closely-packed spindle-shaped cells are quite definitely distinguishable, evident transitions exist between the latter and ordinary connective tissue cells (figs. 5-8).

Reproductive Elements.—Embedded in the connective tissue matrix, I have observed the occurrence of developing sperms in the form of morula-like balls of minute cells, surrounded by an envelope of flattened connective tissue (fig. 11). These balls of cells correspond with the sperm-morulae described by SCHULZE and POLEJÁEFF. As ova occur in the same specimen, *Suberites* appears to be hermaphrodite. The ova occur, frequently in extraordinary abundance, throughout the whole sponge. In some cases two nuclei were present in the ovum, or a nucleus with a stained aggregate at each pole,—probably the beginnings of division. The chromatic contents of the germinal vesicle exhibited a most varied appearance, which seems to me worthy of special notice. Not one nucleolus, but several apparent nucleoli, were very generally present; a smaller spherule often seemed to arise as a bud from the larger, or to lie adjacent to, though unconnected with it; but more frequently three, four, or five variously disposed nucleolid spheres of perfectly definite contour, and uniformly stained, occurred. They were sometimes of equal size, but oftener with one slightly larger than the others. An idea of the varied disposition can be best obtained by a glance at a few nuclei represented in fig. 10. My friend Dr HEIDER has observed a horse-shoe-shaped nucleolus in sponge-ova, which might of course in cross section explain some of the forms. A more complex form might obviously show several spheres on cross section, and that this is the explanation is suggested by the nuclear sections in fig. 10, several of which were cut through the same nucleus at different levels. It is also possible that we have here to deal with phenomena resulting, not from the complicated shape of the nucleolus, but from the occurrence of that multinucleolar condition which has, of late years, been repeatedly observed.

As *Suberites* is but ill-suited for minute histological study, which could in such a form at most result in the confirmation of what can be better observed in other types, I have contented myself with attempting to elucidate the general

structure, and thus doing something towards increasing our knowledge of the almost unattacked *Monaxonina*.

PART II.

Appended Note on the Capsules found on the surface of Spongelia pallescens. (Plate XVII.)

In the course of some studies on sponges, pursued in the laboratory of the Zoological Institute at Berlin, Professor F. E. SCHULZE directed my attention to certain peculiar club-shaped knobs which were formed on the surface of a *Spongelia*, and entrusted them to me for examination. The death of the *Spongelia* prevented me from tracing their further history, and I can therefore at present only note their interesting structure, in the hope that others who may have observed these or similar structures may be able to explain their import.

The knobs were of the size of a small pin's head, and were raised above the level of the already contracted sponge by stalks formed from projecting peaks of the horny skeletal framework. The shape of the knobs was oval or pear-shaped, and their contour was always perfectly defined.

Treatment with silver nitrate readily revealed the interesting fact that the knobs were surrounded by a well-defined ectoderm composed of cells of varying shape and size (fig. 11).

The contents of a teased-out knob seemed to consist of generally round cells (figs. 3, 6) of very varied size, and with distinct nuclei, while sections of stained knobs exhibited what appeared as a compact and intricate meshwork of fine filaments, the meshes of which were occupied by cells of varied size (figs. 4, 7). Towards the margins, and especially towards the base of the knob, the apparent network was looser, and there especially it could be seen that the structure was that of incipient tissue with undifferentiated cells, or of connective tissue in which the matrix was apparently wrinkled, or in some way modified round the cells, following their contours and producing the appearance of a very intricate filamentous network. The cells round the boundary, directly below the epithelium, were often very regular. Below these and at the base of knob, certain larger round cells (fig. 6) occurred, though by no means confined to these portions. Between these and the irregular cells of the meshwork intermediate forms were obvious. In some knobs the cells were almost all rounded (fig. 10), as if not compressed to the same extent. In others, as was especially well seen at the base, where the cells were less abundant, they exhibited the greatest variability of form (fig. 8).

As these knobs present perfect definiteness of structure, and are only in formal contact with the sponge, it seems possible that they may thus secure the

persistence of the organism in unfavourable environment, which can of course only be verified by following their history. They might therefore be termed regenerative capsules. Somewhat similar aggregations or contractions were observed to occur in *Reniera*, but in these I was not able to make out any definite structure.

As a histological modification in response to a change in the environment, whether it be connected or not with securing the persistence of the endangered organism, the occurrence of these structures is perhaps worthy of record.

Explanation of Plates.

Plate XVI.—*Suberites*.

- FIG. 1. External appearance, showing pores.
 2. Large section, showing spicules, canals, and ova,
 3. Ectodermic epithelium.
 4. System of canals, showing ciliated chambers.
 5-6. Muscle-cells.
 7-8. Connective tissue cells of mesoderm.
 9. Ova.
 10. Germinal vesicles with nucleoli.
 11. Sperm-morulæ.

Plate XVII.—Capsules of *Spongelia*.

- FIG. 1. Capsules on surface of sponge.
 2. Individual capsule on peak of sponge.
 3. Contents of capsule squeezed out.
 4. Longitudinal section.
 5. Border of capsule.
 6. Abundant round cells.
 7. Longitudinal section.
 8. Contained elements.
 9. Cross section.
 10. Longitudinal section with abundant round cells.
 11. Ectoderm outlines.