	metre.
Length of anterior palatine foramina	·0035
Length of bony palate from incisors to opening of posterior nares	·008
Length of bony palate behind anterior palatine foramina	·0035
Length of row of upper molars..............	·0035
Distance between anterior molars and incisors.	·005
Breadth of palate between anterior molars....	·003
Length of mandible from condyle to symphysis	·011
Length of row of lower molars..............	·004

The specimen above described agrees fairly with Mr. Blanford's description of *M. sublimis* (loc. cit.); only the tail is nearly an inch longer than in the only example known of that species, the type, a female obtained by the late Dr. Stoliczka at Tankse, west of the Pankong lake in Ladak, at an elevation of 13,000 feet. My specimen, which was obtained miles away from any habitation, is probably a male, and doubtless belongs to the species described by Mr. Blanford. Of the better-known Indian mice this species comes nearest to *Mus urbanus*, but is distinguished by its proportionally longer tail and much longer feet. The habits of the two species are very different.

Lagomys macrotis, Günther.

A specimen obtained near Gilgit, in July, at an elevation of 7500 feet, measures:—

Head and body 7·2 inches, nose to anterior margin of eye 0·92, nose to ear-orifice 1·95, length of ear from orifice 1, hind foot from heel *s. u.* 1·25, fore foot *s. u.* 0·75, hair on middle of back 0·7.

This example agrees fairly with the type of the species; the forehead and crown are rufous. It differs from a specimen obtained in the Gilgit district in October (P. Z. S. 1881, p. 207) in the tips of all the hairs on the back being fulvous, and in not having a rufous gorget.

Lagomys Roylei, Ogilby.

A specimen of *Lagomys* from Deosai (12,000 feet), collected in July, is obviously distinct from the preceding species.

Colour above greyish brown, much mixed with black on middle of back, and rufous on forehead and nape; sides of face and body rufous; lower surface whitish. The fur throughout is dark slate-grey, the tips being rufous on the forehead, nape, and sides of the body, and greyish white on the lower parts; on the back the hairs have fulvous-brown rings near their ends, and black tips. The extremities are clad with pale isabelline hairs above, and ashy-coloured ones below; the feet-pads are black and the claws dusky. The ears are rounded, dusky in colour, and sparsely clad with ash-coloured hairs.

Length of head and body 6·1 inches, nose to eye 0·75, nose to ear-orifice 1·35, length of ear from meatus 0·87, hind foot from heel *s. u.* 1·1, fore foot 0·52, length of hair on middle of back 0·65.

The following are measurements of the skull of this specimen:—

	metre.
Total length	·039
Breadth across zygomatic arches	·021
Length of nasal bones	·013
Width of nasal bones behind	·0045
Width of nasal bones in front	·0053
Width of frontal between orbits	·005
Length of palatine opening	·011
Antero-posterior diameter of bony palate	·002
Width of palate between last pair of molars ..	·007
Length of series of upper molars	·008
Length of lower jaw from angle to symphysis	·025
Height to condyle	·016

This specimen is, I believe, correctly referred to *L. Roylei*, notwithstanding the difference in coloration and size from the typical example. The type seems not to have had any rufous patches on the fur; but the presence or absence of rufous colours in this genus seems to be of no specific importance. The Deosai *Lagomys* agrees well in size, colours, and cranial characters with an example from Sikkim in Mr. W. T. Blanford's collection.

XII.—*Contributions to our Knowledge of the* Spongida. *Order* II. Ceratina. By H. J. CARTER, F.R.S. &c.

[Plate IX.]

Class SPONGIDA.

Order II. CERATINA.

ON reconsideration of the order Ceratina ("Notes Introductory to a Study of the Spongida," 'Annals,' 1875, vol. xvi. pp. 134, 135), which was proposed, among others, after an examination of *all* the specimens of Sponges then in the British Museum, I find, since having gone over, in a similar manner, those of the late Dr. Bowerbank, which by purchase have been added to the Museum, that I have something to alter in and add to, respectively, the characters of the three families into which the Order has been divided.

Family 1. Luffarida.

As regards the general characters of the first family, viz. the Luffarida, I have little to state more than that the digitate, branched forms, which may be hollow or solid, closely resemble those of the digitate Chalinida in having, when solid, the vents in plurality scattered over the branches, and when tubular or hollow, single only, at the ends of the branches respectively; also that, in addition to the other forms mentioned, they may be thick and fan-shaped,—thus pointing out, in both instances, that form in the Spongida is not to be depended on alone in specific description, while as to size, under favourable circumstances, there seems to be no limit; for the specimen of *Luffaria Archeri*, Higgin, vulg. "Neptune's Trumpet" ('Annals,' 1875, vol. xvi. p. 223), found by Dr. Archer at Belize, and presented to the British Museum by Mr. Thomas H. Higgin, F.L.S., of Liverpool, is 5 feet 5 inches long and 4½ inches thick in its greatest diameter, which is about a foot from the mouth, as I am informed by Mr. Stuart O. Ridley, F.L.S., of the British Museum, to whom I am indebted for these measurements.

Geographically the Luffarida, which appear to abound in the seas between the two Americas, *ex. gr.* Caribbean Sea (De Fonbressin et Michelotti), are also to be found on the S.W. coast of Australia (Bowerbank collection, from George Clifton, Esq.) and in the Levant (British Museum, from Admiral Spratt).

Family 2. Aplysinida.

Here the distinction from the Luffarida is chiefly in the relative size of the granular axis to the thickness of the horny fibre, which is the opposite to that in the Luffarida, where the horny element is greatest, and thus the fibre rendered more or less rigid; while that of *Aplysina*, on the contrary, by its thickness, becomes more or less flaccid (Pl. IX. figs. 10, 11), to which may be added, perhaps, a more or less massive lobate form generally, spreading laterally rather than vertically.

Having entered into the history of the Aplysinida preparatorily to describing the species *A. corneostellata*=*Darwinella aurea* ('Annals,' 1872, vol. x. p. 101 &c., pl. vii.), I need not repeat any part of this here; but among the late Dr. Bowerbank's sponges I found some more specimens, from the S.W. coast of Australia and Ceylon (Trincomalee) respectively, which require notice.

Thus, among those from the S.W. coast of Australia is one which, on account of its black colour, nodulated form, and doughy consistence (now hard from dryness), closely resembles the type specimens of *A. aërophoba* from the Adriatic Sea, sent to the British Museum by Prof. Oscar Schmidt; but the "fibre" is different, inasmuch as it is not cylindrical although branched, but scanty and made up of several small incompletely developed fibrils longitudinally fasciculated in an irregularly fluted form (Pl. IX. fig. 1, *h*); so that, in the *transverse* section, it presents a crenulated outline, agate-like, in which the horny laminæ do not entirely surround the axial substance of the different fibrils indicated (fig. 1, *i*), thus constituting a confused composite structure of ill-developed and ill-formed horny material contrasting strongly with the simple, single, perfectly cylindrical fibre of other species (fig. 11). Besides this, it differs from *A. aërophoba* in the presence of dark black-purple pigmental cells (figs. 1, *f*, and 3, *a*), which are so abundant throughout the specimen as greatly to obscure the scantily developed fibre. What the colour when fresh might have been I cannot say; for *A. aërophoba* also, although nearly black in the dried state, is, according to Schmidt's diagnosis, "greenish yellow" when fresh. That the Australian is the same as that which I have noticed under the name of "*Aplysina purpurea*" in my first report on the Manaar specimens ('Annals,' 1880, vol. vi. p. 36), I have no doubt; but having had a very poor supply of the latter for description, this, of course, is correspondingly imperfect. Now, however, I find that not only some of the Australian specimens, but that from Trincomalee, to which I have alluded ('Annals,' *ibid.*), are all of the same species, and among them furnish sufficient for the following amended description.

Aplysina purpurea. (Pl. IX. figs. 1, *a*–*i*, and 2, *a*–*c*.)

Form of specimen pyramidal, somewhat compressed, cactus-like externally, light (Pl. IX. fig. 1, Ceylon), or nodular, compact, and heavy (fig. 2, Australia). Colour black-purple. Surface, in the Ceylon specimen, even minutely reticulated in relief (fig. 1, *c*, and 2, *b*) in the dried state, interrupted irregularly by large puckered monticular or cactiform elevations (fig. 1, *b*) more or less obtuse on the summit, where, in a granular form, still darkened by the pigmental cells of the dermis and on a level with the latter, may be seen the termination of the fasciculated fibre in a truncate-like condition (fig. 1, *d*), or, in the Australian specimens, nodular instead of monticular elevations, &c. (fig. 1, *a*, *b*). Pores not seen. Vents scattered here and there in the dermal sarcode (fig. 1, *a a*). Internal structure cellulo-cavernous in the Ceylon species, more compact in the Australian ones. Dermal sarcode fibrous below, charged abundantly with purple pigment-cells above, which also extend throughout the sarcode, but do not enter into the composition of the horny fibre. Pigmental cells now (in the dried state) compressed and oval, but more inflated and globular, probably, when fresh, consisting of a transparent colourless (?) cell-wall containing several spherical granules which are opaque and purple in colour, together with a nucleus (figs. 1, *f*, and 3, *a*); the whole frequently burst and the purple granules let free into the sarcode, where some at least seem to grow into forms respectively like that of the parent. Horny fibre scanty, not simply cylindrical although branched, but composed of a plurality of more or less imperfectly formed fibrils fasciculated longitudinally so as to present an irregularly fluted surface (fig. 1, *h*), the whole together possessing in the transverse section (fig. 1, *i*) an irregularly crenulated figure, agate-like in the linear outline of the horny laminæ, which therefore do not always completely encircle the granular axis of the fibril to which they belong, although this substance occupies their concavities respectively; also, in the Ceylon or Trincomalee specimen, a great number of amber-coloured "horn-cells," whose composition and gradational growth longitudinally would appear to indicate that from such the fibre originated (fig. 1, *g*). Size of specimen from Trincomalee (which is pyramidal and compressed in shape, with a kind of shoulder in the form of another pyramidal lobe on one side) 5 inches high, with a base 5 inches long and 2 inches thick; that of the largest Australian specimen (for there are two, massive and irregular in form) 4 inches long, $2\frac{1}{2}$ inches broad, and $1\frac{1}{4}$ inch high. (Pl. IX. fig. 1 represents the upper *half* only of the Ceylon specimen, natural size.)

Hab. Sea-bottom on hard surfaces.

Loc. Coast of Ceylon and S.W. Australia.

Obs. As the full-grown specimens of a sponge frequently differ in form, so the Ceylon specimens of the species are cactiform on the surface and cellulo-cavernous in the interior, while the Australian ones are nodular on the surface and more compact internally. How far the doughy compactness of the latter may arise from partial decomposition and drying afterwards, I am unable to state, for the specimens being filled with sand, appear to have been washed about in the waves on the beach some time before they were picked up for preservation.

Pigmental Cells and Origin of the Sponge-Ovule. (Pl. IX. figs. 3–9.)

The so-called "pigmental cells," which are by no means confined to the order Ceratina, are in most species of *Luffaria*, as well as in *Aplysina*, striking objects under the microscope, from their dark opaque carmine-purple colour, sharply defined outline, and compressed elliptical or globular form, averaging about 1-2000th inch in diameter (fig. 3, *a*); but in a dried specimen of a digitate branched species of *Luffaria* from the West Indies, in the British Museum (which is of a pinkish-brown tint), as, indeed, in the well-preserved specimen in spirit from the Levant, presented to the British Museum by Admiral Spratt, they are not so deeply coloured, although in other respects they present the same appearance (fig. 3, *b*); while in the European species of *Aplysina*, viz. *A. carnosa* and *A. corneostellata*, they are not only still lighter, but much less defined in their outline, possessing an elongate irregularly stellate form, in which the ray-like processes of the cells, more or less prolonged into thread-like forms, seem to be connected with each other. This is well seen in a large globular well-preserved specimen in spirit of the "fine Turkey sponge" of commerce (*Spongia officinalis*) from the Black Sea, where, on the upper surface, they are dark purple in colour, becoming *colourless* towards the base; and in another, but dry specimen, of the same kind of sponge from the West Indies, on which the dermal sarcode is *absolutely black*, the colour fades off gradually where extended into the sarcodic lining of the larger excretory canals, until, beyond a certain distance inwards, it disappears altogether, thus apparently indicating that, as in plants, the colour is deepest where the cells are most exposed to the light, and *vice versâ*: yet this can hardly be the case always; for the dark-purple pigmental cells are almost as abundant in the flesh of *Aplysina purpurea* and *Ianthella* (which will presently be described) internally as in the dermal sarcode.

In no instance have I found the pigmental cells so large or so defined as in *Stelletta aspera* and *Dercitus niger* (fig. 8), where they are elliptical or globular, and average 1-170th inch in diameter, contain a large colourless nucleus (fig. 8, *a*), and are otherwise filled with a great number of brown spherical granules (fig. 8, *b*), each of which is also nucleated and averages 1-6000th inch in diameter ('Annals,' 1871, vol. vii. pp. 7 and 4 respectively, pl. iv. figs. 14 and 6). The "granules" are just as brown and large in *Chondrilla sacciformis*, but in this, as well as in *C. nucula* (where they are smaller), have no definite arrangement, being grouped together irregularly in small parcels of four to twelve granules, each without any appearance of *cell-wall* whatever (fig. 9). Similarly composed are the pigment-cells of the Ceratina, to which I have alluded as "so-called," because in no instance have I been able to demonstrate a *cell-wall* by chemical reagents, any more than in *Amœba*; hence all that can be stated in this respect is that the nucleus and granules appear to be suspended in a sarcodic substance which, in some of the Ceratina, and in *Stelletta aspera* &c., has a definite elliptical or globular form *like* that of a "cell;" while the "parcels" of granules in the two *Chondrillæ* just mentioned have no defined form at all, and but for their being thus congregated might be generally distributed throughout the filamentous trama (fig. 6), of which the substance of these sponges is chiefly composed, for the colouring effect which they produce.

Again, if we return to the pigmental or coloured cells of *Aplysina carnosa* &c. and *Spongia officinalis*, they will be found to possess the irregularly stellate form mentioned, in which the ray-like processes are prolonged into pseudopodial appendages that unite with each other. This is particularly well seen in fresh specimens and those which have been preserved in spirit of *Dysidea* (*Spongelia*) *fragilis* (fig. 4), where, although colourless, or nearly so, on the surface as well as in the interior, these cells are the centres of a network of pseudopodial reticulation which spreads throughout the sponge, and is so soft and delicate that, on drying, the whole structure is irretrievably lost in the gum-like consistence which it then assumes.

Thus the well-defined pigmental cell with its deeply coloured purple granules, as well as the stellate form with its lighter ones, may be fairly assumed to have been produced by evolution from a pseudomorphous *uncoloured* condition; while, on the other hand, the dermal cell, when more elongated, might lead not only to the elliptical form (fig. 5), but to the fusiform filamentous element (fig. 6), of which the general structure of *Chondrilla* &c. is chiefly composed, whereby, still possessing its contractile or polymorphic power, the whole mass might, in combination, be subjected generally or partially to this motive influence; for change of form cannot be effected without motion.

Here it should be remembered that all the soft parts of a sponge are polymorphic, and that, as they are all evolved from a single cell at the commencement, they are only parts of the

same unit modified to meet their respective requirements (figs. 5, 6). Hence it has appeared to me that while the cells (spongozoa) of the ampullaceous sacs (Geisselkammer) are uniciliate and take in food, there may be others scattered through the parenchyma which have no cilium and are more particularly *ova-bearing*, whereby the presence of the ova in the midst of the parenchyma, and not in the ampullaceous sacs, might be explained. That there are sponge-cells there under an amœboid form (that is, without cilium), but with pseudopodia, which are interunited and capable of taking in food (carmine, fig. 7), has been pointed out by Metschnikoff in *Halisarca Dujardinii* (Zeitschrift f. wiss. Zoologie, Bd. xxxii. p. 372, Taf. xxi. fig. 4), after which my illustration is taken.

The presence or absence of the cilium in the sponge-cell (spongozoon) is of no account; for, although provided with one when first liberated under water from the ampullaceous sac, the cilium may be seen to soon shrink back into the cell itself, which in its turn supplies the locomotive power by polymorphism, creeping about like an *Amœba*. This power of being able to put forth or retract the cilium I have long since pointed out in *Acineta tuberosa*, Ehr. ('Annals,' 1865, vol. xv. p. 287, pl. xii. figs. 9–11), as being worth remembering in a physiological point of view generally.

Returning once more to the "pigmental cells," it is remarkable that, although chiefly confined to the surface and outer part of the large excretory canals, they are not always so; for in *Ianthella*, as will be seen hereafter, they are not only present in the sarcode generally, but also enter largely into the composition of the horny fibre, both the dermal sarcode and the fibre being analogous in their skeletal uses according to the requirements of the case—thus affording an external skeleton in *Geodia* (the petrous crust), and an internal one in the fibrous sponges (viz. the "fibre").

Moreover the colouring-matter, which appears to be born on the surface of the granules, often becomes separated from them and diffused throughout the sponge, leaving the granules themselves more or less colourless (in fact, just as they might be if not exposed to the light); or the diffusion might be confined to the sarcode of the pigmental body suspending the granules, and thus the former present a defined outline similar to a cell-wall, especially when dry.

Aplysina fusca. (Pl. IX. fig. 11, *a–f*.)

There is another species of *Aplysina* in the Gulf of Manaar, of which I could only give a short description on account of the limited supply; but it also appears to grow on the south-west coast of Australia, as a specimen among the late Dr. Bowerbank's sponges indicates. In size this specimen does not exceed 2 inches in diameter; thus, although sufficient for identification, it adds very little to my description of *A. fusca* in the first Report of the Manaar specimens (*loc. cit.* p. 36). The dried sarcode, too, presents the appearance of dry thick glue, and contains *no* purple pigmental cells, although an equal number of such cells without pigment (that is, nearly colourless) are especially congregated towards the surface, together with large cylindrical fibre (fig. 11), whose branches, intertympanized by the sarcode, give rise to a cavernous internal structure much coarser and larger than that of the Manaar specimen. On account of the large size of the fibre, averaging in its greatest thickness 1-24th inch in diameter, wherein the horny laminæ (fig. 11, *b*) are comparatively loosely united to each other and the granular axis very large (fig. 11, *a*), it affords a convenient object for microscopical dissection and examination of these elements, of which the former (that is, the horny laminæ), when viewed edgewise in a transverse section, appear to be composed of cells (especially the outer ones), like those of *Ianthella* (fig. 14), but of course without colour, and therefore very faintly foreshadowed. To this fact I shall have to allude again in the next article.

Aplysina inflata, n. sp.

Cylindrical, somewhat curved, hollow, closed at each end, rendered more or less irregular by the presence of mammiform bud-like projections here and there. Colour dark brown tinged with purple, becoming greenish black-grey after much exposure. Surface ciliated or fringed by the projection of the filamentous ends of the fibre beyond the reticulation of the interior. Vents large, scattered here and there over the surface, and terminating singly at the summit of each of the mammiform projections. Pores not seen. *Internally* hollow, bladder-like; wall very thin, composed of a single layer of reticulated fibre, whose interstices are tympanized by the sarcode, which, in the dried state, are translucent. Fibre round, aplysinoid (that is, more or less flaccid from the large size of the granular core or tube compared with the thickness of the kerasine wall); kerasine fibrillous in structure longitudinally, especially after much exposure and, perhaps, drying in the sun. Size $4\frac{1}{2}$ inches long by $1\frac{1}{2}$ inch in diameter.

Hab. Marine. Attached to a bivalve shell.

Loc. Coast of S.W. Australia, Freemantle.

Obs. The chief character of this species is its inflated bladder-like structure and consequently thin wall, together with its filamentous surface and the fibrillous composition of the fibre after exposure.

Aplysina compacta, n. sp

There is still another specimen from the south-west coast of Australia in the Bowerbank collection, which, although much worn and only $2\frac{1}{2}$ inches in diameter each way, bears evidence of an altogether different species. The mass in form is irregularly lobed; black in colour, with an irregular although smooth surface; the sarcode charged throughout with intensely black-purple pigmental cells, and the fibre small, short-meshed, reticulated, and abundant, so that the internal structure is more compact than cavernous. On account of its massive amorphous state and the granular core of the fibre prevailing greatly in size over the thickness of its horny investment, I have named it "*Aplysina*;" but otherwise the fibre, from its uniformity in size and short uniform reticulation, yellow colour when denuded of the black sarcode, and great abundance, simulates that of *Luffaria*; so slightly do some of the species of these families differ from each other!

Family 3. **Pseudoceratida.**

Here I must at once correct an error which partly led me to propose the formation of this "family," viz. the impression that an Aplysian fibre internally might be combined with a spiculiferous one on the surface; hence I named the supposed species "*Aplysina chalinoides*," gave this as part of the character of the "family" ('Notes' &c., *loc. cit.* p. 132 &c.), and placed it among the typical illustrations (*ibid.* p. 192); but on examining it more particularly I found out that it was a tubular digitate *Chalina*, in which the acerate spicules of the fibre *internally* had become absorbed, leaving a granular axial tube or core with horny exterior, of a dark amber-colour, exactly like that of *Aplysina*, while the small fibre of the surface still retained its spicules. Hence "*Aplysina chalinoides*" must be expunged, as well as that part of the character relating to it, in the diagnosis of the Pseudoceratida (*loc. cit.*), viz. "or passing into a dermal layer of proper spicules like that of the Rhaphidonemata,"—a misleading change, which is not confined to one species of *Chalina* only, but may occur in others of a similar kind, and has thus been mentioned to prepare the student for dealing with it accordingly.

Aplysina capensis, n. sp.

This is the species to which I have alluded in my "Key to the Classification of the Spongida" (*loc. cit.* p. 192) as one of those illustrating the Pseudoceratida, whose description having been promised in the third part of my "Notes," is for convenience here given, as follows:—

Form massive, lettuce-like, foliate; leaves, fronds, or laminæ continuous, plicate, thin, erect, proliferous; sessile. Colour pink or mulberry-purple. Surface uniformly papillated by a thick incrustation in the form of a reticulated structure in relief, wherein the interstices correspond to depressions and the knots to papillæ, from the summits of which respectively the attenuated terminal end of a fibre for the most part projects. Incrustation composed of foreign bodies—*ex. gr.* quartz-grains, fragmentary sponge-spicules, frustules of Diatomaceæ, &c. Pores and vents respectively situated in the "depressions" of the incrustation, which are tympanized at the bottom by the dermal sarcode *alone*. Internal structure cellular; cellular cavities formed by the sarcode intertympanizing the intervals between the branches of the fibre. Sarcode dark purple when dry, pink by transmitted light, charged more or less with pink but not opaque dark purple cells: colour diffused, not confined to the cells; many foreign bodies in the sarcode, viz. quartz-grains &c. Fibre amber-coloured, branching, reticulated longitudinally by intertransverse portions, more or less flaccid when dry, from the small amount of horny element and the large size of the axial tube or core, which here and there also contains foreign bodies, *ex. gr.* quartz-grains &c. Size variable, that of the specimen about 2½ inches in diameter all ways; a little broader than high, and somewhat expanded towards the top.

Hab. Marine, on hard objects.

Loc. Port Elizabeth, Cape of Good Hope.

Obs. This species, which is placed among the Pseudoceratida on account of the presence of foreign bodies here and there in the fibre, seems to be allied to *Aplysina carnosa* and *A. corneostellata*, as well as the British species *A. nævus*, dredged on board H.M.S. 'Porcupine' between the north of Scotland and the Färöe Islands ('Annals,' 1876, vol. xviii. p. 229, pl. xii. figs. 1 *c* and 2). *Aplysina capensis* is remarkable for the great variety of sponge-spicules and Diatomacean frustules in its incrustation, indicating the great variety also of Sponges and Diatomaceans that must exist in the locality where it grew; while the pink colour which characterizes it, being due to the presence of the dermal sarcode more or less among the white foreign bodies, becomes much darker in the dried sarcode internally where it is without them (No. 1, reg. no. 71. 5. 12. 1, Brit. Mus.).

IANTHELLA, Gray.

This sponge is placed among the Pseudoceratida for having, like the foregoing, foreign bodies here and there in its fibre. The genus was first established by the late Dr. J. E. Gray (Proc. Zool. Soc. Lond., Jan. 14th, 1869, p. 49), although long before specialized by Pallas, followed by later authors under the names respectively of *Spongia basta* ("Vox basta pannum grossius significat") and *S. flabelliformis* (see Gray *l. c.*). There are three thin specimens in the British Museum under a glass case, bearing my "running no." 529. The central one, which is the largest, viz. *Ianthella flabelliformis*, Pall., registered "42. 6. 16. 5," is fan-shaped, 11 × 9 inches; and on either side are two others, one of which, bearing the name *Ianthella basta*, Pall., has no number, and the other, called by Dr. Gray "*I. Homei*," is registered 57. 11. 18. 200. The former of these two is vase-shaped, 8 inches high and 5 inches in diameter at the mouth, with a hole at the bottom, indicating that it also was fan-shaped first, and then, as usual, became converted into a vase-shape by approximation and union of the opposite borders, except at the bottom, where the "hole" or incompleted union now exists; the latter is but a flat, thin, fan-like fragment about 5 × 6 inches in diameter.

For this genus, as before stated, the late Dr. Gray proposed the name of "*Ianthella*;" and the three specimens to which I have alluded, which are noticed in his paper under the names respectively of *I. flabelliformis*, *I. basta*, and *I. Homei*, are generically and specifically described; but there is nothing stated of their histological character, which character renders the genus as remarkable as it is unique among the Spongida. I allude chiefly to the composition of the fibre, in which the dark purple pigmental cells of the sarcode generally are so numerous in each horny lamina, that the latter not only appear to have been produced by them, but the fibre throughout, when viewed under the microscope by transmitted light, presents in colour one of the most beautiful objects that can be conceived, on account of the contrast between the clear, transparent, amber-looking horny laminæ and the purple pigmental cells in them, rendered bright carmine by transmitted light (Pl. IX. figs. 12–14).

All the specimens come from the Indian Ocean; and they do not appear to be uncommon, although the unique histological structure to which I have alluded has not, to my knowledge, been heretofore pointed out by any one but myself.

I found one small, rugged specimen without label among the late Dr. Bowerbank's collection of sponges; but it appears to have come from the south-west coast of Australia or the Indian Ocean; and although only a fragment (consisting of the remains of two thin fronds united at their base) altogether measuring about 5 × 3 inches, the fibre and dry black-purple sarcode filling up the interstices of the thin lattice-like structure are quite sufficient for identification, while the former, from its large size, here 1-12th inch in diameter at the base of the specimen, seems to ally it to *I. Homei*, Gray; yet, as Dr. Gray states (*l. c.*) that the latter "chiefly differs from *I. basta* in the network appearing to be thicker and stronger," and "is only a young and partly-developed specimen," while *I. basta* has received its designation also from the *coarseness* of its fibre, being like "bast," it may be that future observation will identify the two, which thus differ from the more finely-fibred latticed one, viz. *I. flabelliformis*. The fibre, however, of Dr. Bowerbank's specimen not only appears to be coarser but more oblique in the interstices of its reticulation than that of *I. flabelliformis*, which, on the other hand, is more quadrate. As its histological character will be more particularly mentioned in the "Development of the Fibre in the Spongida" generally, which I propose to consider in the next article, there is no occasion for entering into it more at length here.

The generic description given by Dr. Gray (*loc. cit.* p. 50) may, however, be rendered more complete by adding to it the following histological characters, viz.:—"Sarcode charged with dark purple pigmental cells, especially numerous on the surface and in the horny laminæ of the fibre, which appear to be secreted by them (fig. 12). Core of the fibre granular, grey or colourless, often enclosing foreign bodies, but no pigmental cells."

XIII.—*On the Development of the Fibre in the* Spongida. By H. J. Carter, F.R.S. &c.

[Plate IX.]

For a familiar example of the fibrous structure in the Spongida the sponge of commerce may be instanced, as consisting of

nothing else, all the soft parts having been abstracted, leaving only a resilient mass composed of what will henceforth be called "fibre," while the horny material of which the fibre is chiefly composed will be termed "kerasine" (κέρας), "resembling horn, horny, corneous."

To all who are acquainted with this fibre, it must appear no less true than inexplicable how it can be so formed as in most cases to become axiated or cored with foreign bodies, or by spicules formed by the sponge itself.

Tracing, then, the development of the fibre through the different orders of my proposed classification of the Spongida ("Notes" &c. *loc. cit.*), we find that there is none in the Carnosa (ex. gr. *Halisarca*); that it makes its appearance in the Ceratina (*Luffaria*), where it is composed of horny laminæ axiated by a granular core; that foreign bodies appear within this core in the Psammonemata (*Hircinia*), and in the Rhaphidonemata (ex. gr. *Chalina*) spicules formed by the sponge itself, which are equivalent to the "foreign bodies" in this respect; and so on throughout the other orders, where the spicules are held together by more or less kerasine.

With reference to the presence within the fibre of foreign bodies or spicules developed in the sponge itself, it might at once be assumed that this *must* have preceded the formation of the laminæ of horny material which enclose them, and that these bodies *must* have been placed there by that developmental intelligent power whose existence in every organized product is only known to us by its manifestations.

Our object, however, is not to endeavour to find out what this power is, which may be said to be able to do any thing with every thing and every thing with any thing so far as we can see, but to observe the nature of the material and the sequence of its adaptation in the formation of the fibre.

With this view it is first necessary to briefly define the elementary composition of the material of which the fibrous sponges are composed; and this may be divided into the soft and hard parts—the "soft parts" consisting of a transparent granuliferous substance (polymorphic when alive), in which are suspended nucleated granuliferous cells more or less alike but of different functions, the ampullaceous sacs, the sperm-sacs, and the ova when developed, all together usually called the "sarcode" or "parenchyma" ("syncytium," Häckel*). But of these, the part of most conse-

* How far the whole of this may not be composed of a congeries of polymorphic cells or bodies, and the transparent granuliferous substance itself ('Annals,' 1849, vol. iv. p. 91, pl. xiv. fig. 2, *d d*) a united mass of them, in which their individualization can be no more distinguished than

quence to remember here is the "transparent granuliferous substance" ("sarcodine" and "granula," Häckel), as this is the primordial element of the single ovicell or ovum from which by evolution all the rest is developed; whilst the "hard parts" consist of the grey or colourless granular core (fig. 10, *a*), which may also contain foreign bodies or spicules developed by the sponge itself, according to the species, and of the horny laminæ or kerasine (fig. 10, *b*), which together form the fibre.

Now, if we examine microscopically the fibre of *Luffaria*, the axial structure will be found to consist of the granuliferous core just mentioned, which, being comparatively soft and colourless or of a light *grey* colour, contrasts strongly with the external part, which is horny, concentrically lamellated, and of a transparent brown or *amber* colour. Both these structures are sharply differentiated; and in thin transverse sections the axial one becomes so separated from the horny cylinder that it may be picked out and easily examined under a high magnifying-power (say 450 diameters), when the granuliferous substance of which it is composed closely resembles the "granuliferous transparent substance" of the sarcode, while the granules, which are yellowish and opaque, appear to be spherical (? *cellulæ in embryo*), and become, when dyed with red aniline, much deeper in colour than the rest (Pl. IX. fig. 11, *f*).

Thus the question arises whether the horny layers of the fibre are formed by successive additions to its interior through the granuliferous substance, or whether they are supplied by the sarcode or parenchyma externally.

If we follow the axial substance of the interior, say in the Psammonemata, where the fibre for the most part is cored with foreign bodies, it will be found that the axial substance encloses these bodies, which, indeed, are incorporated with it, and the same with spicules in the Rhaphidonemata &c., so that the granuliferous core might be inferred to exist *before* the horny part of the fibre was supplied; while if we examine the purple sponge (viz. *Ianthella*) to which I have alluded in the concluding part of the preceding article—wherein the nucleated cells of the sarcode, taking on a pigmental action, become strikingly defined by their opaque deep purple colour rendered carmine and translucent by transmitted light under the microscope—the horny laminæ may be seen to be almost wholly composed of them in a more or less flattened state, corresponding with the thinness of the lamina in which they are imbedded (figs. 12, *b*, and 14, *b*); while in one specimen, viz. that from Dr. Bowerbank's collection before mentioned, where the cells and their coloured contents have so disappeared as to leave *nothing but their empty cavities*, the horny laminæ present nothing but a reticulated structure of kerasine (tinged with carmine from the escape and diffusion of the colouring-matter), and the axis consists of the colourless or grey granuliferous substance already described. Again, if by taking a very early development of this fibre, in which it is very thin, we lessen the number of the horny laminæ one after another down to the axial granuliferous substance, the *last horny layer* (fig. 13, *b*) will be found to possess comparatively very few pigment-cells, where it rests immediately on the granular core, which, on the other hand, contains none (fig. 13, *a*).

So that, in fact, we are reduced to the conclusion that the horny laminæ were not only deposited on the grey granuliferous axis, but the horny material itself was formed by the *pigmental cells*, which would become substantiated if the horny laminæ generally (that is, in all other sponges) presented this cellular structure in an equally evident degree; but they do not; on the contrary, the higher the magnifying-power that is put upon them in most other sponges but *Ianthella*, the more homogeneous their composition appears to be. Even in the Luffarida and Aplysinida, where the pigment-cells are as purple and as defined as in *Ianthella* itself, there is not a vestige of them to be seen in the horny laminæ.

Thus we are compelled, so far as the *purple* pigmental cells are concerned, to attribute the formation of the horny laminæ either to the grey granuliferous substance of the *axis* on the one side, or to the granuliferous transparent sarcode of the general parenchyma on the other—either to the addition of the laminæ internally from the axis, or externally by some other agency.

Studying the early development of the axial substance, which, being so like the granuliferous transparent portion of the sarcode or parenchyma, can hardly be distinguished from it, in the absence of the horny laminæ, it is not uncommon to find in the Aplysinida *separate* globular horn-cells more or less elongated and branched, arrested on their way to the formation of fibre, and thus rendered abnormal products, in all of which the grey granuliferous material occupies the axis (fig. 1, *g*); so that I have long since termed such bodies

that of two *Amœbæ* under similar circumstances, future observation must determine. I have already pointed out that the "investing membrane," or dermal sarcode, of *Spongilla*, in which the *pores* are situated, is thus composed ('Annals,' 1857, vol. xx. p. 24, pl. i. figs. 1, *bbb*, 6 & 7).

"horn-cells" ('Annals,' 1873, vol. ii. p. 6, pl. i. fig. 7, *d d*). Moreover the fibre may present interiorly towards its termination a number of conical lines indicative of a succession of layers arranged after the manner of a bud (*ibid.* 1872, vol. x. p. 107, pl. vii. figs. 5–7), but added to the surface and not produced, as in the vegetable bud, from the axial substance. Hence the horny laminæ would appear to be deposited on the granuliferous axis by the sarcode or parenchyma, although by what element of it in particular there is no evidence to show.

So far, then, we may infer that the axial substance is polymorphic and can enclose extraneous bodies, foreign or formed by the sponge itself, as the case may be, thus supplying the mould or core, and determining, in the first place, the position and extent of the kerasine fibre, which is afterwards deposited on it by the sarcode or parenchyma to complete the formation of the fibre.

However acceptable this view may be in the main, it should be remembered that the axial substance under the microscope is very like the "transparent granuliferous sarcode" of the sponge generally, and therefore that it may possess the means of covering itself with a layer of kerasine in the first instance, although the sarcode of the sponge generally may supply the subsequent ones, since in many of the Hydroida the horny sheath *must* be formed by the *core*, for there is no other soft substance externally, although where there is a fleshy layer externally, as in *Hydractinia*, the horny structure produced by the "horn-cells" in the first instance may be subsequently thickened by it ('Annals,' 1880, vol. v. p. 455).

I have stated that the horny laminæ of sponge-fibre *generally* do not present a vestige of cell-structure; and in no instance, except *Ianthella*, are they composed of *coloured* pigmental cells; but I have also noticed in my description of *Aplysina fusca* (antè) that, when viewed on their edges in a transverse section, the horny laminæ *here do* present a faint *colourless* appearance of cellular structure, especially in the outer layers, which seem to lose it and become more homogeneous as they become older or more internal, evidencing, as in the specimen of *Ianthella* from Dr. Bowerbank's collection, that it is formed by cells which in the fully-formed laminæ are obliterated; while if this be the case generally, then it may be inferred that the horny laminæ are produced from horn-secreting cells in the parenchyma. Where the pigmental cells of *Ianthella* are empty, as in the instance to which I have just alluded, the cellular structure of the fibre is manifest; but it is still, as before stated, tinged of a carmine colour by the

pigment having passed into the kerasine. The faint lineation of the colourless cellular structure in the fibre of *Aplysina fusca* (fig. 11, *b*, *c*), although too indistinct for representation, nevertheless presents somewhat of the appearance in form of that of *Ianthella* in the transverse section (fig. 14, *b*). I should also mention that in the abortive (?) horn-cells of *Aplysina purpurea* many of the granules of the axial substance often present a dark purple colour like those of the pigmental cell, and that, in size, the smallest horn-cell hardly exceeds the dark pigmental cell itself (fig. 1, *f*), in which, too, the dark purple granules are most distinct; so that it seems as though the horn-cell originated in the pigmental one; and yet there are no *dark-purple* pigmental cells to be seen in the horny fibre of *A. purpurea* as in *Ianthella*, although the sarcode of the former is equally charged with them (see a description of the pigmental cell, *antè*, p. 104).

As the spicules formed by the sponge itself have been mentioned among the "hard parts" of which the skeletal structure is composed, it may not be without interest to add here that they appear to be developed in a similar way, although certainly, in some instances at least, first originated in nucleated cells and then ejected into the sarcode or parenchyma for completion ('Annals,' 1874, vol. xiv. p. 100, pl. x. figs. 3–15, and pl. xxi. figs. 26, 27); also that, occasionally, arrested spherical, elliptical, and elongated forms of the spicule are present analogous to the "horn-cells" above mentioned (fig. 15). This is particularly the case in a specimen of *Dictyocylindrus laciniatus* from the Mauritius, to which I have before alluded ('Annals,' 1879, vol. iii. p. 297), as it is with the "horn-cells" in the specimen of *Aplysina purpurea* from Trincomalee. Further, it may be observed that the *ornamental* parts of the spicule are the last parts added to its structure (*ex. gr.* the small spines on the anchoring-spicule of *Hyalonema*, 'Annals,' 1873, vol. xii. p. 371, pl. xiv. fig. 9, *f*, &c.), and that the horny fibre is frequently accompanied by a foreign body attached to its surface by an extension over it of the last formed horny lamina, indicating in either instance that the sarcode or parenchyma, at least, has the power of producing both substances ('Annals,' 1872, vol. x. pl. vii. fig. 4, *f*).

Analogous, however, as the sequential growth of the fibre and the spicule in the sponges may be, they are not homologous, any more than the bones and ligaments in the higher animals; and but for a single instance, viz. that published in 1865 by Fritz Müller in *Darwinella aurea* (Archiv f. mikroskop. Anatomie, Bd. i. p. 344, Taf. xxi.), wherein some of the fibre has a stellate or rayed form, there is not another recorded instance in which there is the slightest resemblance of the horny fibre to the thousand and one known forms of spicules which exist among the sponges. And even here Fritz Müller's "favourite" hypothesis (*loc. cit.* p. 351), viz. that in evolutionary development a horny form of the sponge-spicule precedes the siliceous and calcareous ones, is not borne out by the facts that in the first order, viz. the Carnosa (according to my classification), the first family, viz. the Halisarcida, possesses neither fibre nor spicules, that the second family, viz. the Gumminida, possesses spicules but no fibre, and that it is not until we reach the Ceratina and other orders that the *fibre* is developed. So with the development of the sponge from the ovule, the spicules of the species are already seen in the embryo, while the fibre does not appear until the embryo has become fully developed into the young sponge ('Annals,' 1874, vol. xiv. pls. xxi. and xxii. fig. 34, respectively).

Again, if I am right as to the sequential way in which the fibre and the spicule are formed, the core or axis receives in the one as well as in the other its respective coverings *at once*, and not by transition; that is, the kerasine alone is deposited in the former and kerasine suspending silex in the latter. Thus Schmidt's statement, in 1866, that the siliceous spicule, when deprived of its silex by fluoric acid, leaves a horny form ("Hornnadel," Spong. Adriatisch. Meeres, 2nd Suppl. p. 21), by no means confirms Fritz Müller's hypothesis, as was intended, which, in an evolutionary point of view, as before shown, is not substantiated by either phylogenetic or ontogenetic development.

Moreover I have studied *Darwinella aurea* myself independently, as my naming a specimen *Aplysina corneostellata*, which came from the N.W. coast of Spain, will show, and find that to identify the stellate development of the fibre with the spicules ("Nadeln") of a sponge requires a stretch of imagination which the anatomical facts, forms, and measurements that I have long since published ('Annals,' 1872, vol. x. p. 101, pl. vii.) do not justify, any more than the phylogenetic and ontogenetic development to which I have just alluded. Hence I do not think that the term "Hornnadeln" should be applied to this fibro-stellate structure.

I can see no more analogy between the fibre and the spicule than that above mentioned. They are as distinct from each other as the ligamentous structures and bones of the human subject, where, under normal conditions, the former never become the latter nor the latter the former.

Thus, then, my study of the development of the fibre leads me to the inference that the granular core is able to produce a kerasine layer at first, but that subsequent ones are added by some other agent of the sarcode or general parenchyma; while the kerasine is supplied by the pigment-cells in *Ianthella* simulated by faint cell-structure in *Aplysina purpurea*, but in no other instance that has come under my observation have I been able to see this.

Other facts bearing upon the fibre and the spicule respectively might be mentioned here with advantage, viz. that the interior of a Rhaphidonematous fibre may have the whole of its spicules removed by absorption, and the core so transformed into a simple granuliferous tube, while the horny part still remains unaffected, that it becomes almost identical with the fibre of *Aplysina*, and that, too, while the acerate spicules in the circumferential fibre remain intact, as I have before mentioned (p. 109)—which led to my calling the specimen "*Aplysina chalinoides*."

Again, it is not uncommon to find the core-spicules in both the Rhaphidonemata and Echinonemata only *partly* absorbed, although the horny fibre in this case also remains perfectly intact. Here the spicule is often obliterated, all but the central canal and a single fragment of its entire calibre in the centre, whereby it presents the form of a spindle—which at first appears to be a new form, but is subsequently proved, by the presence of others in different degrees of absorption, to be otherwise, and the true form of the spicule thus found out.

Nor is it uncommon to find the central cores of spicules themselves so enlarged that the siliceous portion is more or less reduced to a mere continuous film while its extremities are still *closed*.

All this points out that the spicules within the fibre and the internal part of the spicule itself may undergo absorption without any evident contact with the element by which they may be surrounded.

I have said nothing of the glassy fibre of the vitreous Hexactinellida, because it, *mutatis mutandis*, is the same as the horny fibre; and, of course, in the Lithistina there is no fibre at all, where its office is supplied by the interlocking of the filigreed extremities of the branches of the spicules.

EXPLANATION OF PLATE IX.

Fig. 1. *Aplysina purpurea*, from Trincomalee. Upper half of the specimen, natural size. *a a*, vents; *b*, monticular elevation, magnified 2 diameters; *c*, reticular subdermal structure; *d*, dermal termination of fibre; *e*, group of pigmental and horn-cells; *f*, pigmental cells; *g*, horn-cells (scale 1-48th to 1-6000th inch);

h, fragment of the fibre, lateral view; *i*, the same, transverse section (diagrams).

Fig. 2. The same, from S.W. Australia. Fragment, natural size. *a*, lobule, magnified; *b*, subdermal reticulation; *c*, dermal termination of fibre.

Fig. 3. Pigmental cells of the Ceratina. *a*, dark opaque purple; *b*, light-coloured pinkish brown.

N.B. The opaque purple pigmental cells in this illustration are made *generally* dark for contrast, or as they appear under a low magnifying-power; otherwise their elementary composition is similar to that of the light-coloured pinkish-brown ones, with the exception of the pigment.

Fig. 4. Pigmental cells of *Dysidea fragilis*=*Spongelia*.

Fig. 5. The same, elongated, ? muscular.

Fig. 6. Filaments of the trama in *Chondrilla nucula* and *sacciformis*; ? filiform cells.

Fig. 7. *Spongilla*. Sponge-cells of the parenchyma containing fragments of carmine. *a*, carmine, after Metschnikoff (Zeitschrift f. wiss. Zoologie, Bd. xxxii. Taf. xxi. fig. 4).

Fig. 8. *Stelletta aspera* and *Dercitus niger*, pigmental cells of. *a*, nucleus; *b*, granules.

Fig. 9. *Chondrilla sacciformis*. Pigmental granules, in irregular groups as they occur, viz. without cell-definition.

N.B. Figs. 3–9 inclusive are on the scale of 1-24th to 1-6000th inch.

Fig. 10. *Luffaria*. Fragment of the fibre, to show the relative size of its component elements. *a*, granular axis; *b*, horny laminæ.

Fig. 11. *Aplysina fusca*. Fragment of the fibre, to show the relative size of its component elements. *a*, granular axis, tubular, membranous; *b*, horny laminæ; *c*, transverse section; *d*, granular axis; *e*, horny laminæ; *f*, fragment of granular axis, greatly magnified; *g*, transparent sarcode; *h*, granules.

Fig. 12. *Ianthella*. Fragment of the fibre, lateral view. *a*, granular axis; *b*, horny laminæ, chiefly composed of pigmental cells.

Fig. 13. The same. Fragment of small fibre, lateral view. *a*, granular axis; *b*, first horny lamina bearing a few pigmental cells.

Fig. 14. The same. Transverse section of the fibre, showing the horny laminæ and their pigmental cells edgewise. *a*, granular axis; *b*, horny laminæ.

N.B. Figs. 10–14 inclusively are all diagrams.

Fig. 15. *Dictyocylindrus laciniatus*, Mauritius. *a*, abortive development of the spicule; *b*, cells of the parenchyma. (Scale the same as that of fig. 1, *e*, for analogical contrast.)

XIV.—*On an Organism which Penetrates and Excavates Siliceous Sponge-spicula* (Spongiophagus Carteri). By Prof. P. Martin Duncan, F.R.S., Pres. Royal Microscop. Soc., &c.

In a communication which I made to the Royal Microscopical Society on June 8, 1881, the presence of green-coloured cells on siliceous sponge-spicula, in relation to minute penetrations into their axial canals, was asserted. The occurrence of a

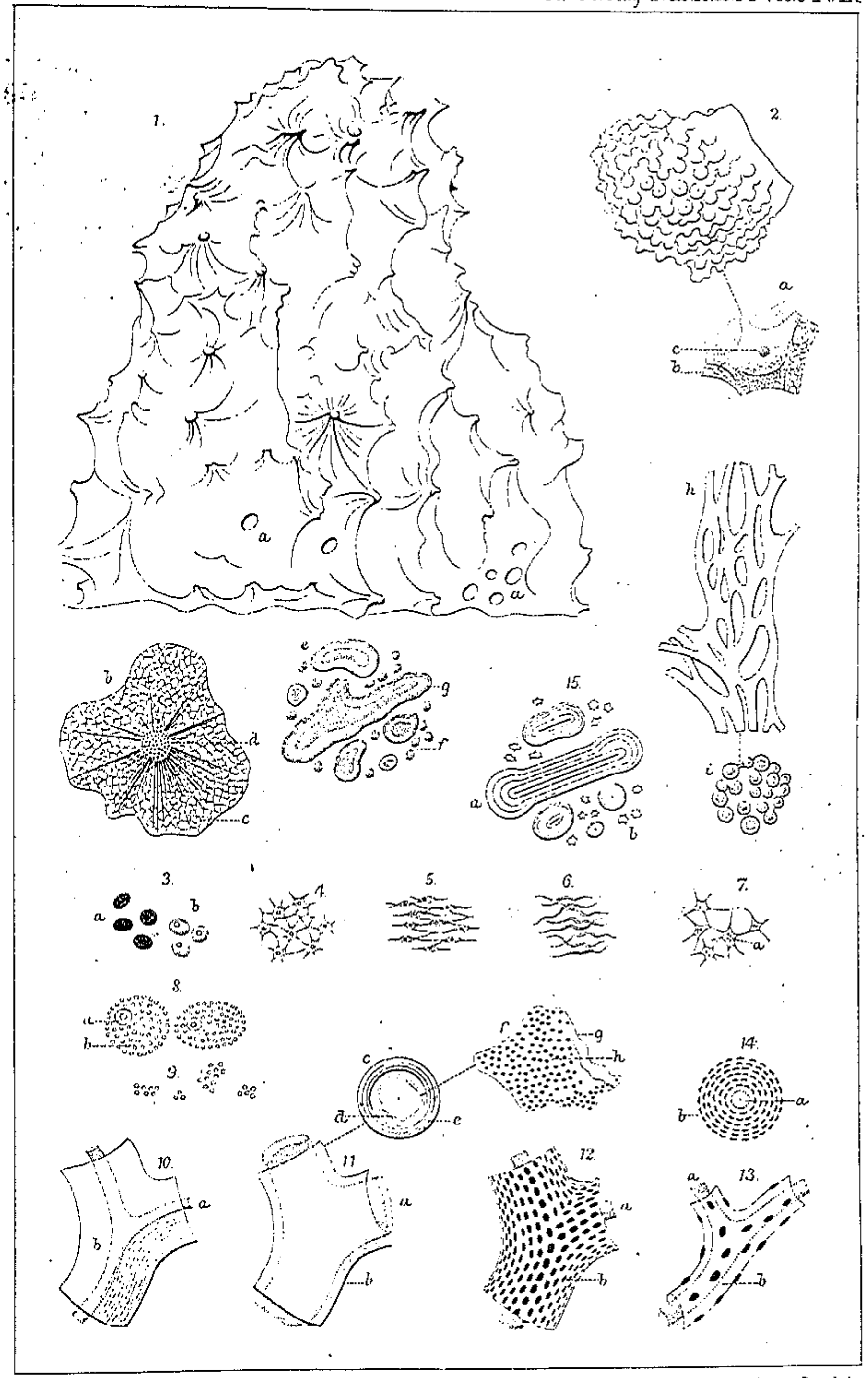
granular plasma of the same tint within enlargements of the axial canals was noticed; and the penetration and erosion were stated to be due to the organism. The cells which were observed within hollows on the surface of spicula, and also on perfect spicula in positions where erosion from without inwards could readily occur, were very small,—not more than $\frac{1}{7000}$ inch in length, and very much less in height. Their dimensions, however, corresponded to those of certain circular patches with hollowed-out bases, which are the first stages of the penetration through the spicule down to the axial canal. The penetration of the spicule down to the central canal is followed by the growth of the organism, which appears to erode the silica and enlarges the canal in a most remarkable manner.

After a while the spicule suffers solution of its continuity by the thinning from within, and the thinnest flakes present a granulated appearance.

Since writing that communication I have observed siliceous sponge-spicula, obtained from great depths, which are affected by an organism whose cells are much larger and whose penetrations therefore are wider and much more visible. On the head of a large spinulate spicule I found many circular pits, each containing an organic mass without definite cell-wall, and yet granular and green in colour by transmitted light. These pits are shallow and are $\frac{1}{2000}$ inch in diameter. Similar pits and of the same dimensions are seen on other spicula; but they are deep and resemble cylindrical tubes with hollowed-out bottoms. Some reach the axial canal, which has become enlarged. The penetrations contain granular organic substance; and so do the enlarged axial canals. The walls of the enlarged axial canals are frequently very irregularly eroded and look "worm-eaten;" the hollows are, moreover, green with the very visible granular matter.

Thus there are two dimensions of the penetrations. The first kind of cell found on the spicula resembles somewhat the simple zoospores of *Achlya penetrans*, nobis (Proc. Royal Soc. vol. xxv. pl. vi.); the second is larger; and in both there is a decided green tint. No ramifications of the penetrating cylindrical tube occur; and it pierces perpendicularly to the surface of the spicule, or, it may be, slightly aslant.

The presence of pits on the surface of sponge-spicula was noticed by Kölliker as a peculiar degeneration of the structure. Dr. Carter described and figured pits in the outer part of a spicule, and distinctly referred them to the action of a vegetable cell, in the Ann. & Mag. Nat. Hist. ser. 4, vol. xii. p. 457, pl. xvi. figs. 8, 9. None of the pits seen by my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