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THE

VOYAGE OF H.M.S. CHALLENGER.

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ZOOLOGY.

REPORT on the DEEP-SEA KERATOSA collected by H.M.S. Challenger during the Years 1873–76. By ERNST HAECKEL, M.D., Ph.D., Hon. F.R.S.E., &c., Professor of Zoology in the University of Jena.

PREFACE.

THE remarkable organisms which are described in the following pages were handed over to me by Dr. John Murray partly in 1887, partly several years ago, when I was occupied with the examination of the Radiolaria collected by H.M.S. Challenger. The fact that in the majority of these deep-sea organisms the main mass of the body was composed either of siliceous Radiolarian tests or of calcareous Foraminifera shells, cemented together by an organic substance, was of peculiar interest to me, inasmuch as it had led to the expression of very different opinions by the naturalists who had previously examined them. Several spongiologists (among them some well-known authorities) had denied their sponge-nature, and declared that these peculiar objects were either Rhizopods or other Protozoa. Other naturalists, on the contrary, who were closely acquainted with the Rhizopods, could not acknowledge their Rhizopod nature, neither could they make out the class to which they belonged.

A closer comparative examination of these doubtful organisms of the deep sea has led me to the conviction that they are true sponges, for the most part modified in a peculiar manner by the symbiosis with a commensal organism which is very probably in most cases (if not in all) a Hydropolyp stock. At least the majority of the specimens, I have no doubt, are true Keratose Sponges, although the state of preservation was too imperfect for the recognition of all the finer structures, especially the characteristic

flagellated chambers of the sponges. Perhaps I might not have arrived at that conclusion had I not, ten years before, examined a number of Australian arenaceous sponges, which seem to be closely allied to these deep-sea inhabitants collected by the Challenger in different parts of the world. At that time I was engaged with the Monograph of the Medusæ, and therefore offered the description of those Spongelidæ or Dysideidæ to my friend and pupil, Professor William Marshall of Leipsic. He has given a full description and figures in the Zeitschr. f. wiss. Zool., Band xxxv., 1880.

Dr. John Murray, who, during the cruise of the Challenger, had seen these Deep-sea Keratosa immediately after capture, had at once and rightly recognised their sponge-nature. I find in his handwriting on the labels of the bottles in which all the large forms are preserved the title "Sponges," but afterwards another naturalist crossed this name out and wrote "Large Rhizopods."

Dr. Poléjaeff, of Odessa, commences his Report on the Keratosa collected by H.M.S. Challenger (Zool. Chall. Exp., vol. xi., part xxxi.) with the following words :—"The Keratose Sponges do not belong to the deep-sea fauna." This statement must now be given up in every case. The number of Deep-sea Keratosa described in this Report extends to eleven genera, with twenty-six species, all of which are new, more than half the number (34) distinguished by Poléjaeff among the Keratosa collected by the Challenger in shallow water ; of these twenty-one were new. Whilst all these latter belong to genera previously known, the majority of the new deep-sea species belong to new genera, and some of them exhibit such a peculiar organisation that they may represent some new subfamilies, or even families, among the Keratosa. Twenty-three of the twenty-six species were taken in depths between 2000 and 2900 fathoms ; three only (Psamminidæ) in depths between 1000 and 2000 fathoms. I suppose that some of the gigantic Foraminifera of the deep sea, which Mr. H. B. Brady has described in his Report as Astrorhizidæ (especially *Rhabdammina, Rhizammina, Sagenella,* &c.), may also belong to the arenaceous Keratosa (Ammoconidæ).

The results of my examination of the Deep-sea Keratosa, which are given in the following Report, were communicated to the Medicinisch-Naturwissenschaftliche Gesellschaft in Jena on the 14th December 1888.

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INTRODUCTION.

METHODS OF EXAMINATION.

Considering the peculiar organisation of the Deep-sea Keratosa, and the fact that some distinguished spongiologists had denied their sponge-nature, I was, of course, obliged to employ all possible methods of examination, in order to show their sponge-organisation as clearly as possible. A great number of microtomical sections through the different parts of the sponges were mounted, and stained with carmine, hæmatoxylin, methyl-green, and other colouring matters of modern histology. The sponges were besides examined in the dry and the wet state, in glycerine and Canada-balsam, treated with alkalies, mineral acids, &c. Employing these different methods, it has been possible to show conclusively the presence of a true sponge-skeleton in the majority of the Deep-sea Keratosa, as in the two families of the large-sized Stannomidæ and Spongelidæ (Pls. I.–VI.). The results of this examination were different in two other families, the Psamminidæ (Pl. VII.) and the Ammoconidæ (Pl. VIII.); these produce no sponge-skeleton, and are therefore, strictly speaking, not true Keratosa (in the proper sense of the term), but skeletonless Malthosa (or Myxospongiæ).

The most important part of the sponge-organism—as is well known—is the aquiferous canal-system with its characteristic dermal pores (Porifera). Special care, therefore, was taken to recognise its structure in the Deep-sea Keratosa as fully and exactly as possible. But, unfortunately, I was not able to accomplish this part of my task so satisfactorily as could be desired, for three reasons: first, the insufficient state of preservation; second, the enormous mass of xenophya or of foreign bodies, which makes up the greatest portion of all these sponges, covering and hiding the finer structures; third, the peculiar symbiosis with Hydroids, the reticular hydrorhiza of which traverses the whole body in the majority of the Deep-sea Keratosa.

The state of preservation, as well of the Deep-sea Keratosa themselves as of the symbiotic Hydroids connected with them, was in all the specimens of the Challenger collection very insufficient, though probably they were put in strong alcohol soon after capture. No doubt the principal cause of this is the sudden change of conditions (temperature, pressure, &c.) by which these delicate organisms are injured in the most

violent manner, being brought up from depths between 2000 and 2900 fathoms to the surface within a few hours. Even many deep-sea animals of much stronger texture are so injured by this sudden change that their soft tissues are more or less destroyed. The same must be the case in a much greater degree with such delicate tissues as the epithelia of Sponges and Hydroids.[1] A natural consequence of this circumstance is the fact that in all the Deep-sea Keratosa the epithelia (exodermal as well as entodermal) were more or less destroyed. No trace could be found anywhere of the outer covering pavement-epithelium of the exoderm. The peculiar flagellated epithelium of the entoderm was not distinctly recognisable in most of the specimens, and not fitted for finer examination; in several species, however, its presence could be made out with certainty. The state of preservation was generally better in the structures of the mesoderm and in the skeleton.

FAMILIES OF THE KERATOSA.

The numerous and very different forms of sponges, which are united by modern authors under the name Keratosa or Ceratina (Horny Sponges, Hornschwämme in German), are divided into a great number of genera, and these again collected into a small number of families. The characters and affinities of these families must be discussed here to a certain extent, seeing that only two of the four families in which I have disposed the Deep-sea Keratosa agree with those of shallow water, the other two being perfectly new.

Poléjaeff is the only modern author who holds that "the whole group of Keratosa is nothing more than a single family." He expresses this singular opinion in a very decisive manner, both in his Report on the Keratosa[2] and in his general notes on the Horny Sponges, incorporated in the Narrative of the Cruise.[3] These conceptions of Poléjaeff, as also many of his other systematic views, are quite incompatible with the phylogenetical principles of modern classification; they are, in my opinion, quite unnatural and dogmatical. This will be demonstrated in the remarks on classification, in the Appendix to this Report. Since no other spongiologist will follow the view of the Russian spongiologist, it need not be here refuted.

Two well-known spongiologists, Lendenfeld and Vosmaer, published independently in the year 1887 the Prodromus of a new sponge-system, and since their opinions agree in the most important points, we may here consider together their classification of the Keratosa, passing over all the former attempts, which are critically discussed in the

[1] Compare the remarks on *Monocaulus* by Sir Wyville Thomson, in the Report on the Hydroida by Allman (Zool. Chall. Exp., pt. lxx. p. 6).
[2] Zool. Chall. Exp., pt. xxxi. p. 81.
[3] Narr. Chall. Exp., vol. i. p. 643.

historical introduction given by Vosmaer.[1] Lendenfeld[2] divides the order Keratosa (Bowerbank) into two suborders (called by him tribus[3]), and these into six families, viz.:—

I. Microcameræ, with small spherical ciliated chambers and opaque ground-mass (1. Family Spongidæ (= Euspongidæ), 2. Family Aplysinidæ, 3. Family Hircinidæ).

II. Macrocameræ, with large sac-shaped ciliated chambers and soft transparent ground-mass (4. Family Spongelidæ, 5. Family Aplysillidæ, 6. Family Halisarcidæ).

Vosmaer adopts only four families among his Ceratina, viz.:—1. Spongelidæ, 2. Spongidæ (= Euspongidæ), 3. Aplysinidæ, 4. Darwinellidæ (= Aplysillidæ, Lendenfeld). These latter are distinguished by dendritic spongin-fibres not anastomosing, while the branched spongin-fibres in the three former families anastomose and form a reticular skeleton. Among these the Spongelidæ possess a soft transparent ground-mass (or maltha), not granular, whilst it is granular and opaque in the Euspongidæ and Aplysinidæ. These two families differ again in the structure of the anastomosing spongin-fibres, which are homogeneous, with a thin axial thread in the Euspongidæ, whereas they are heterogeneous, tubular, with an axial pith-substance in the Aplysinidæ.

A single family only of those enumerated is represented among the Deep-sea Keratosa collected by the Challenger. This is the family Spongelidæ (with two new genera, *Cerelasma* and *Psammophyllum*). The sandy Keratosa, *Psammopemma* and *Holopsamma*, hitherto united with the Spongelidæ, must be separated from them, since they produce no spongin at all; they compose (together with the new genus *Psammina*) our family Psamminidæ. A new family is formed by the remarkable Stannomidæ, the largest and most striking among the Deep-sea Keratosa; their spongin-skeleton is never reticular, but formed by bundles of delicate fibrillæ, which never anastomose; the sandy xenophya are not enclosed by the fibres, but lie between them in the maltha. Not less interesting is a fourth new family, that of the Ammoconidæ, distinguished from all the others by the simple structure of their canal-system, formed on the *Ascon*-type.

Respecting this latter most important difference, all the Deep-sea Keratosa collected by the Challenger belong to two main groups of very unequal range, and these correspond perfectly to the two orders or main groups of calcareous sponges which Dr. Poléjaeff, in his Report on the Calcarea[4] dredged by H.M.S. Challenger, has distinguished as Homocœla and Heterocœla. The first order (Cannocœla) is represented by only a few, and small, but most interesting Keratosa, constituting our

[1] Vosmaer, Bronn's Klassen und Ordnungen des Thier-Reichs, ed. 2, Bd. ii. (Porifera), pp. 17–109, 1887.

[2] Lendenfeld, On the Systematic Position and Classification of Sponges, *Proc. Zool. Soc. Lond.*, December 21, 1886; Der gegenwärtige Zustand unserer Kenntniss der Spongien, *Zool. Jahrb.*, 1887, p. 511.

[3] The term *tribus* is generally employed for smaller sections of a family, therefore subordinate to the latter term. Compare my Generelle Morphologie, Bd. ii. p. 400, Berlin, 1866.

[4] Zool. Chall. Exp., pt. xxiv. p. 35.

family Ammoconidæ (Pl. VIII.). They correspond to the Homocœla or Asconidæ among the Calcarea, and are, like these, thin-walled porous tubules, "without separate flagellated chambers, the whole of the inner surface being covered with flagellated cells."[1] The different forms of these Cannocœla, which I could distinguish, may be disposed into three different genera (*Ammolynthus*, *Ammosolenia*, and *Ammoconia*), and these correspond to the three genera which I have described in my Monograph of the Calcisponges as *Olynthus*, *Leucosolenia* (or *Soleniscus*), and *Auloplegma*.

All the other Keratosa of the deep sea are of larger size, and belong to the second order, Domatocœla. They correspond to the calcareous Heterocœla of Poléjaeff, and possess, like these, "separate flagellated chambers lined with flagellated cells, the remaining parts of the inner surface being covered with pavement-epithelium." The Domatocœla of the deep sea may be disposed into three different families: Psamminidæ, Spongelidæ, and Stannomidæ. The Psamminidæ (*Psammina*, *Holopsamma*, *Psammopemma*) produce no spongin-fibres; their pseudo-skeleton is composed of xenophya or of foreign bodies, which are crowded in the ground-mass of the mesoderm. The Spongelidæ (*Cerelasma*, *Psammophyllum*) possess a network of spongin-fibres which enclose foreign bodies. The Stannomidæ, finally, are distinguished by fine bundles of fibrillæ, between which the xenophya are crowded in the maltha (*Stannophyllum*, *Stannarium*, *Stannoma*).

Synopsis on the Four Families of Deep-Sea Keratosa.

I. CANNOCŒLA. Tubular canal-system, on the Asconal-type (similar to the Asconidæ).	No spongin-skeleton.	Pseudo-skeleton composed of xenophya, which are crowded in the maltha, ...	1. AMMOCONIDÆ.
II. DOMATOCŒLA. Vesicular canal-system, on the Leuconal-type, with large flagello chambers (similar to the Spongelidæ).	No spongin-skeleton.	Pseudo-skeleton composed of xenophya, which are crowded in the maltha, ...	2. PSAMMINIDÆ.
	Spongin-skeleton composed of horny fibres, fibrillæ or lamellæ.	Spongin-skeleton reticular, composed of anastomosing fibres, including xenophya, . . .	3. SPONGELIDÆ.
		Spongin-skeleton fibrillar, composed of fibrillæ, not anastomosing, and never including xenophya, .	4. STANNOMIDÆ.

[1] *Loc. cit.*, p. 35.

Bathymetrical Table of the Deep-Sea Keratosa.

Number of Plates and Figures.	Genus.	Species.	Locality.	Challenger Station.	Depth in Fathoms.	Xenophya (or foreign bodies of the pseudo-skeleton).	General Form of the Sponge.	Maximum Size in Millimetres.	Symbiotic Hydroids.
Family I. AMMOCONIDÆ (Pl. VIII).									
VIII, 1.	Ammolynthus	prototypus.	Tropical Pacific.	271	2425	Radiolarian ooze.	Simple tubes.	10	O.
VIII, 2.	„	haliphysema.	„	270	2925	Globigerina ooze.		20	O.
VIII, 3.	Ammosolenia rhizammina.		„	216	2000	„ „	Branched tubes.	12	O.
VIII, 4.	Ammoconia autoplegma.		Tropical Atlantic.	89	2400	„ „	Reticular framework.	16	O.
VIII, 5.	„	sagenella.	North Pacific.	256	2950	Red clay.		20	O.
Family II. PSAMMINIDÆ (Pl. VII).									
VII, 1.	Psammina plakina.		South Atlantic.	331	1715	Globigerina ooze.	Discoidal plate.	12	O.
VII, 2.	„	globigerina.	Tropical Pacific.	220	1100	„ „		30	S.
VII, 3.	„	nummulina.	„	274	2750	Radiolarian ooze.	Massive, tuberose.	15	S.
VII, 7.	Holopsamma cretaceum.		North Atlantic.	70	1675	Globigerina ooze.		50	O.
VII, 6.	„	argillaceum.	South Pacific.	294	2270	Red clay.		22	O.
VII, 4.	Psammopemma radiolarium.		Tropical Pacific.	272	2600	Radiolarian ooze.	Massive, lumpy.	20	O.
VII, 5.	„	calcareum.	Tropical Atlantic.	89	2400	Globigerina ooze.		25	O.
Family III. SPONGELIDÆ (Pls. IV, V, VI).									
VI, 1-5.	Cerelasma gyrosphæra.		Tropical Pacific.	271	2425	Radiolarian ooze.	Reticular framework.	70	S.
VI, 6, 7.	„	lamellosa.	„	216	2000	Sponge-spicules.		20	S.
V, 1-5.	Psammophyllum reticulatum.		„	198	2150	„ „		90	S.
IV, 5-8.	„	flustraceum.	North Pacific.	241	2300	Radiolarian ooze.	Flabelliform leaf.	105	S.
IV, 1-4.	„	annectens.	„	244	2900	„ „		75	S.
Family IV. STANNOMIDÆ (Pls. I, II, III).									
I, 1; II, 1.	Stannophyllum zonarium.		Tropical Pacific.	271	2425	Radiolarian ooze.	Flabelliform.	60	S.
I, 2.	„	radiolarium.	„	„	„	„	„	50	S.
I, 3.	„	pertusum.	„	„	„	Partly Radiolarian ooze, partly Globigerina ooze.	„	120	S.
I, 4.	„	venosum.	„	„	„	„	„	250	S.
I, 5.	„	globigerinum.	„	„	„	Globigerina ooze.	„	90	S.
III, 6-9.	Stannarium alatum.		„	272	2600	Radiolarian ooze.	Composed of branched leafs.	60	S.
III, 10-14.	„	concretum.	„	270	2925	Globigerina ooze.		50	S.
III, 1-4.	Stannoma dendroides.		„	271	2425	Radiolarian ooze.	Arborescent.	50	S.
III, 5.	„	coralloides.	„	272	2600	„ „	Coralliform.	40	S.

Bathymetrical Table.

The bathygraphical distribution of the Keratosa appears very much altered by the results of this Report, as is exhibited by the preceding complete list of the twenty-six Deep-sea Keratosa here described, with notes on the localities and some general qualities. Dr. Poléjaeff, in his Report on the Keratosa,[1] has added a bathymetrical table (also adopted by Vosmaer in Bronn's Klassen und Ordnungen, 1887, p. 455). This table shows that most of the Keratosa are inhabitants of shallow water, and that no single species goes down deeper than 400 fathoms.

Twenty-three among the twenty-six new Deep-sea Keratosa here described are taken from depths between 2000 and 2950 fathoms, three only (Psamminidæ) in depths between 1100 and 2000 fathoms. Twenty-two species are found in the Pacific (eighteen in the Tropical Pacific), and only four in the Atlantic.

[1] *Loc. cit.*, p. 73.

GENERAL REMARKS ON THE ORGANISATION OF THE DEEP-SEA KERATOSA.

The general organisation of the sponges is widely discussed in the voluminous and most valuable reports on the various main groups of this class, which form such an important part of the Challenger work, viz. :—Sollas on the Tetractinellida (Zool. Chall. Exp., part lxiii. vol. xxv., 1888), F. E. Schulze on the Hexactinellida (Zool. Chall. Exp., part liii. vol. xxi., 1887), Ridley and Dendy on the Monaxonida (Zool. Chall. Exp., part lix. vol. xx., 1887), Poléjaeff on the Keratosa (Zool. Chall. Exp., part xxxi. vol. xi., 1884), and Poléjaeff on the Calcarea (Zool. Chall. Exp., part xxiv. vol. viii., 1883). The greatest part of the general morphological and physiological considerations which are given in this rich series of reports, and mainly in those of Sollas and F. E. Schulze, may be accepted also for the small group of sponges which are described here as Deep-sea Keratosa. To avoid repetitions, therefore, it is sufficient to refer to the last-named reports, and to add here only a few short remarks on those peculiarities which deserve special attention in the organisation of the horny sponges of the deep sea.

INDIVIDUALITY AND EXTERNAL FORM.

The external form of sponges, as is well known, is extremely variable, and is generally of little morphological importance, since often sponges of very different internal structure possess the same external form, and, on the other hand, often two closely allied sponges are quite different in external shape. This is easily explained if we consider as the simplest individual sponge the *Olynthus*, or a Gastræa-like simplest tubular person, and if we assume that the body of most sponges is a corm or stock composed of numerous such persons, viz., the flagellated chambers (or, in the Asconidæ and Ammoconidæ the equivalent branches of the tubular body). The external form of the corms or stocks (in contradiction to that of the component persons) is very variable, and subject to adaptation also in other classes of corm-building lower animals, *e.g.*, in the closely-allied Hydroids and Corals (Hydrozoa and Anthozoa). When we compare the single individuals (persons or zooids) of a massive corm of Hydroids or Corals and the

corresponding individuals of sponges (the flagello-chambers), we find similar relations between the associated persons and their large community. The variable manner in which the persons or zooids are connected and arranged, and in which the common canal-system of the community (the cœnenchyma) is developed, often shows a striking similarity in both cases.

The theory that the true primordial form of all sponges was an *Olynthus*, and that all the other forms were developed from an *Olynthus* stage (*Olynthula*), was first stated in 1872 in my Monograph of the Calcispongiæ (in connection with the Gastræa theory), and has now been accepted by most modern spongiologists, by F. E. Schulze, Sollas, Lendenfeld, Vosmaer, Marshall, Keller, and others. Many of these recent observers have demonstrated the existence of a homologous larval form (*Olynthula*) in the ontogeny of very different sponges. But ripe and fully-developed sponges, which persist in the primitive *Olynthus* form, and produce in this form eggs and sperm, were known hitherto only among the Calcarea (*Calcolynthus*).[1] It is therefore a fact of general interest that among the Deep-sea Keratosa collected by the Challenger, there occurs a small ripe sponge (with eggs) which seems to be a true horny *Olynthus* (or, more strictly speaking, an arenaceous *Olynthus*), the remarkable *Ammolynthus* figured in Pl. VIII. figs. 1, 2. Unfortunately the delicate soft parts of the tissues, in this as well as in all the other Deep-sea Keratosa, were very badly preserved, so that the histological evidence of its true nature could not be demonstrated with all the desirable certainty.

Regarding the *Olynthus* as the simple sponge individual or zooid (Gastræa), and as equivalent or homologous to a single tubular branch in the Homocœla, and to a single flagello-chamber in the Heterocœla, we must regard all other sponge-forms as corms, composed of numerous Olynths. They exhibit the same relation to *Olynthus* as the various Hydroid corms bear to *Hydra*. The external form of these corms or stocks in the Deep-sea Keratosa has the same variability and wide divergence as in the other groups of the class. This is especially the case in the smaller forms, the Ammoconidæ and Psamminidæ, where we find irregular, crusty, and massive corms, flat discs, tuberose lumps, branched and reticular stocks, &c. Among the larger Keratosa of the deep sea the prevailing and most common form is that of a thin flabelliform leaf (*Stannophyllum*, Pl. I.; *Psammophyllum*, Pls. IV., V.). This form (rarely occurring in other sponges) is remarkable for its perfect bilateral symmetry (or, strictly speaking, the amphithect ground form). The regular symmetry is especially striking in those forms in which branched ribs are disposed on both sides (Pl. I. figs. 3, 4; Pl. IV. fig. 5). The two flat sides of the reniform leaf exhibit constantly the same structure; it is therefore probable that these flabelliform sponges arise vertically from the sea-bottom, attached by the slender pedicle, which is inserted in the middle of the basal concave margin.

[1] See pl. i., pl. vi. fig. 1, pl. xi. figs. 6–9, pl. xiii., &c., in my Monograph.

HISTOLOGY.

The tissues of the sponges are now generally regarded as derived from two simple epithelial layers, which I first compared with the two primitive germ layers of the other Metazoa, exoderm (or ectoderm) and entoderm (or endoderm), in my Monograph of the Calcispongiæ (1872). From this comparison, and from the deduced homology of the Gastrula form in all Metazoa, arose my Gastræa theory. At that time I was of the opinion that in all sponges these two primitive cell-layers were metamorphosed in a similar manner, the inner (entoderm) lining as a simple permanent epithelium the cavities of the gastral canal-system, and producing the sexual cells, whilst the blending cells of the outer layer (exoderm) melt together and form a syncytium, or a contractile protoplasmic ground-mass (sarcodine), in which the scattered nuclei of the cells are propagating; in this syncytium, too, the skeleton is formed.

Three years later (in 1875) this conception was corrected by the accurate observations of Franz Eilhard Schulze, the excellent spongiologist, who has advanced in so many important directions the knowledge of this class of Cœlenterata. Employing new methods of histological examination, he discovered on the surface of many sponges a delicate external pavement-epithelium not before observed, and deduced from this observation the following important conclusions :—

The body of the sponges is originally composed not of two, but of three primitive cell-layers, corresponding to those which in the higher organised Metazoa are called exoderm, mesoderm, and entoderm. The exoderm (or outer layer covering the external faces) and the entoderm (or inner layer lining the canal-system internally) are two simple epithelial plates, and between them is enclosed the mesoderm (or the middle layer); this latter is a kind of connective tissue, and produces not only the skeleton, but also the sexual cells (eggs and sperm).

The conception of the sponge-tissues given by F. E. Schulze is now generally accepted, and it is very probable that it has general value, though it was not possible to demonstrate clearly in all sponges the delicate exodermal epithelium. The histological examination of our Deep-sea Keratosa has given no remarkable and positive results in this respect, owing to their insufficient state of preservation. I will not, therefore, further discuss their finer histological structure, but only add a few remarks on the three above-mentioned layers.

Exoderm (Surface-Epithelium).—The delicate simple epithelium, composed of thin pavement-cells, which F. E. Schulze discovered on the surface of many sponges, is now usually regarded as an independent cell-layer, and often compared with the epidermis of the higher Metazoa. This conception may be combated even when we assume its general presence in all sponges (which is not proved). In my opinion this outer exodermal epithelium does not possess the same primary importance and independence as

the inner entodermal epithelium of the canal-system. Comparing the descriptions which are given of the former in many different sponges, I am more inclined to regard it as a superficial epithelial differentiation of the mesoderm, with which it remains in closest connection. The fact that the main mass of the sponge-body (or the so-called mesoderm) belongs histologically to the connective tissue, is not in contradiction with its conception as exoderm. We know that the peculiar mantle of the Ascidiæ is a voluminous and most remarkable product of the exoderm; it is a true connective tissue in histological respect, but a true exodermal (not mesodermal!) production in genetical respect. The cells, which are scattered in the connective ground-mass of the Ascidian tunic, and which are derived from the epidermis (!), are often arranged on the outer surface of the thickened tunic in the form of an outer simple layer of pavement-cells (a quasi-secondary epidermis). This may be compared to the surface-epithelium of the sponges. The histological comparison of the tunic of the Ascidiæ with the so-called mesoderm of the sponges seems to be justified, especially as the further differentiation of both of them is often very similar.

Entoderm (Canal-Epithelium).—In opposition to the exodermal surface-epithelium, which we may regard only as a secondary superficial production of the primary outer cell-layer, the entodermal epithelium of the canal-system is independent from the beginning, a self-subsistent inner group of cells, which is separated already in the Gastrula from the different exodermal group (the fundament of the later mesoderm and the secondary exoderm). This entodermal or gastral epithelium seems to have in the Keratosa—and similarly in the Calcarea—two modes of development. It remains as a single continuous layer of flagellated cells through all the cavities of the canal-system in the Ammoconidæ (Pl. VIII.), closely agreeing with the Asconidæ (Asconal-type). It is differentiated into two very different portions in all the other Keratosa, the canal-system of which is developed on the Leuconal-type (as in the Leuconidæ). The flagellated epithelium remains here restricted to the flagello-chambers, whilst the entoderm in all the other parts of the canal-system is a simple flat pavement-epithelium.

Mesoderm.—The main mass of the sponge-body, which is usually now called the mesoderm, and which we derive from the original primitive exoderm, exhibits in the various sponges, as is well known, an infinite variety of detailed structure, mainly in the production of the skeleton. Regarded histologically, the mesoderm is always a kind of connective tissue or malthar tissue,[1] and exhibits similar manifold differentiations to those of the higher Metazoa. It is a relatively thin lamellar plate in the Ammoconidæ (as also in the Asconidæ), whilst it becomes massive and voluminous in the other Keratosa (as in the majority of sponges). We distinguish in the malthar tissue of the Keratosa (as in the various connectiva of other sponges) the following constituents :—

[1] On the conception of malthar tissue (Maltha) and its distinction from fulcral tissue (Fulcrum), compare the Report on the Deep-sea Medusæ (Zool. Chall. Exp., pt. xii. vol. iv. § 50, p. xxxi).

(I.) The common ground-mass or maltha ; (II.) the cells scattered in the maltha ; and (III.) the various skeletal productions. The cells scattered in the maltha belong in our Keratosa to three different groups, viz., (1) malthocytes or collencytes (usual connective cells) ; (2) amœbocytes (amœboid wandering cells) ; and (3) gonocytes, or sexual cells (eggs and sperm).

Maltha.—The common ground-mass of the connective tissue, which we call shortly maltha, is usually described as ground-mass, matrix, intercellular substance, mesoglœa, collenchyma, &c. It is secreted by the connective cells of the mesoderm, which are derived originally from the primary exoderm cells. Those spongiologists who have especially examined the Keratosa (F. E. Schulze, Lendenfeld, Poléjaeff, and others) distinguish in this group two different main forms of the maltha ; it is clear and transparent in the Macrocameræ (Spongelidæ and Darwinellidæ), and granular and opaque in the Microcameræ (Euspongidæ and Aplysinidæ). All the Keratosa of the deep sea (as far as the maltha is well preserved) seem to agree in this respect with the Spongelidæ ; their mesodermal ground-mass is clear and transparent, in most species soft, scantily developed, and not voluminous.

Malthocytes or Collencytes.—The common cells of the connective tissue, which produce the maltha or matrix of it by secretion, are not very abundant in the Deep-sea Keratosa, and may be easily overlooked in the examination of the scanty maltha, owing to the predominant masses of xenophya filling up the latter. The best objects for their examination (as for that of the maltha in general) are those Keratosa in which the xenophya are calcareous, derived from Globigerina ooze. Having dissolved the calcareous matter by dilute acids, there remains a soft and transparent maltha, in which the small malthocytes are scattered irregularly. Their form is usually stellate or spindle-shaped, with a small granular ovate nucleus, a little protoplasm, and a few short pointed apophyses.

Amœbocytes.—The remarkable amœboid wandering cells, which seem to possess an important physiological function in all sponges, are also found in our Deep-sea Keratosa. They are scattered in the maltha in far less numbers than the malthocytes, and may easily be distinguished from them by the larger size of the protoplasmic cell-body as well as of the clear vesicular nucleus. The more voluminous protoplasm usually encloses a variable mass of dark, highly refracting, and intensely staining granules, and often these enter in the lappet-like processes, or lobopodia of the cell, as in the similar common Amœbæ. The Amœbocytes of the sponges are comparable to the Leucocytes of the higher Metazoa, and are probably derived from the original, not differentiated, exoderm cells. Their functions are probably multifarious, referring mainly to the nutrition of the sponge. They may be vehicles of food and of reserve nutriments. But in the Stannomidæ they may also produce the peculiar spongin-fibrillæ of this family, comparable to odontoblasts which produce dentin fibrillæ.

Gonocytes (Eggs and Sperm).—It was very important to demonstrate that our Deep-sea Keratosa develop eggs in the mesoderm, in order to show that they are true sponges, and not large-sized Rhizopods. At first I vainly searched for them for a long time; but finally I succeeded in finding eggs in single specimens of all four families—in *Ammolynthus prototypus* among the Ammoconidæ (Pl. VIII. fig. 1C, *e*), in *Psammina plakina* among the Psamminidæ (Pl. VII. fig. 1D, *e*), in *Psammophyllum flustraceum* among the Spongelidæ (Pl. V. fig. 5, *e*), and in *Stannophyllum globigerinum* among the Stannomidæ. The eggs were in all these cases of the same indefinite form and size as in the other Keratosa, where they are described so well by F. E. Schulze and others. They lie scattered in the maltha of the mesoderm, and exhibit always the large, clear, subspherical nucleus, with a dark nucleolus, surrounded by the granular protoplasm. The earliest stages of the eggs could not be distinguished from amœbocytes.

It was not possible to distinguish spermatoblasts or ripe sperm in any of the Deep-sea Keratosa, but considering the difficulties in showing their presence even in living and well-preserved sponges, it is easy to conceive that they were not recognisable in our insufficiently preserved spirit-specimens.

CANAL-SYSTEM.

The characteristic gastrocanal-system of the sponges exhibits, as is well known, a great many modifications, which may be disposed in a few main forms or types. In my Monograph of the Calcisponges (1872) I had distinguished three such types, viz.:—1. The Asconal-type (*Ascon, Leucosolenia*); 2. The Syconal-type (*Sycon, Sycandra*); 3. The Leuconal-type (*Leuconia, Leucandra*). Vosmaer, in his recent work on the Sponges (Bronn, 1887), has adopted these three types, and added a fourth type, represented by *Aplysina*, the common sponge, *Euspongia officinalis*, &c. (*loc. cit.*, p. 144); this may be called shortly the Aplysinal-type.

Two of these four principal types are represented among the Keratosa of the deep sea. The canal-system of the new family Ammoconidæ (Pl. VIII.) is constructed on the Asconal-type; that of the three other families (Psamminidæ, Spongelidæ, Stannomidæ) follows the common Leuconal-type. The two peculiar types of canal-system which we call the Syconal-type and the Aplysinal-type, do not occur among the Keratosa here described.

The difference between the simple Asconal-type of the Asconidæ and the complex Leuconal-type of the Leuconidæ (and of the majority of all sponges) is so important that many recent authors have adopted the separation of Poléjaeff, who divides the Calcarea into two orders, Homocœla (Asconidæ) and Heterocœla (all the other Calcispongiæ). Employing the same principle in the Keratosa, we should divide

this legion into two orders, Cannocœla (the Ammoconidæ) and Domatocœla (all the other Keratosa).

The Cannocœla, represented by the Ammoconidæ (Pl. VIII.), retain either the primordial Ascon-type, the *Olynthus*-form (*Ammolynthus*, figs. 1, 2), or they form branched tubular bodies, composed of a few or numerous *Olynthus*-tubules; the branches are either free, each possessing a terminal osculum (*Ammosolenia*, fig. 3), or are connected by anastomoses, and form a reticular framework (*Ammoconia*, figs. 4, 5); the wall of the delicate tubules is in all these Ammoconidæ very thin, supported by a delicate mesoderm-lamella (as in the Asconidæ), and is pierced by small simple pores; the sea-water entering by these pores is propelled by the flagellated collar-epithelium, which lines the whole inside of the tubules, and issues finally either by the distal oscula or by other pores. Each branch of the Ammoconidæ, as well as of the similar Asconidæ, is to be regarded as a secondary *Olynthus*, and at the same time homologous to a single flagellated chamber in the second order, the Domatocœla.

The Domatocœla (corresponding to the Heterocœla in the Calcarea) are represented among the Deep-sea Keratosa by three families, the Psamminidæ (Pl. VII.), the Spongelidæ (Pls. IV.–VI.), and the Stannomidæ (Pls. I.–III.). All the horny sponges hitherto described belong to the Domatocœla. The main mass of their body is formed by a voluminous mesoderm, or a kind of connective tissue, and this is permeated by a complex canal-system. The outer surface of the mesoderm is covered by a delicate pavement-epithelium and pierced by innumerable microscopical pores; the water enters through these pores into ramified canals, and is propelled by the vibratile motion of flagellated entoderm-cells, which line the characteristic " flagellated chambers" disposed in a variable manner along the canals; from these the water issues by canals, which open finally by smaller or larger exhalent openings (oscula). The special structure of this domatocœlous canal-system (as far as it could be recognised in the three families examined) is essentially the same as in the Spongelidæ, with large sac-shaped flagellated chambers (Macrocameræ, Lendenfeld).

Skeleton.

The varied and manifold development of the skeleton, which is the main principle in the classification of the numerous genera and species of sponges, is also in the Deep-sea Keratosa of the greatest importance. It offers, too, here certain remarkable features which are not found in the Keratosa hitherto known, and some peculiarities which are quite new. The causes of this peculiar development may be searched for partly in the peculiar conditions of deep-sea life and the adaptation of the organism to the abyssal bottom, partly in the curious symbiosis, to which the majority of the Deep-sea Keratosa are subject.

Considering as the skeleton—in the usual physiological sense—all those solid parts of the animal body which serve as a supporting frame and as a protecting carapace, we may point out, first of all, that the skeleton of the Deep-sea Keratosa in general is composed of three very different portions, viz., (1) spongin-fibres, produced in the mesoderm of the sponge, and characteristic of all true Keratosa; (2) xenophya, or solid foreign bodies, taken up from the bottom of the deep sea and disposed in the mesoderm; (3) chitinous tubes of Hydroids which live in symbiosis with the majority of our Keratosa. The two latter elements of the skeleton may be better called pseudo-skeleton, since they are foreign bodies not produced by the sponge itself; but they generally possess in our Deep-sea Keratosa a far greater importance than the true skeleton of the sponge itself, composed of its proper spongin-fibres.

The first fact that strikes one in the examination of the Deep-sea Keratosa is the circumstance, that in all cases by far the greatest part of the body is composed of various xenophya, and not of the tissues and organs of the sponge itself. The foreign enclosures are everywhere found in such large masses that their total volume is always far greater than that of all the parts of the sponge proper together. The latter form often scarcely one-third or one-fourth of the whole volume, or less; whilst the xenophya occupy two-thirds or three-fourths, or more. Comparing the weight of the two different body-components, their disproportion, of course, appears far greater. The xenophya being much heavier than the delicate soft tissues of the sponge itself, the weight of the former is probably usually more than 90 per cent., the weight of the latter less than 10 per cent.

The xenophyal skeleton is the only essential part of the skeleton in the two first families, Ammoconidæ (Pl. VIII.) and Psamminidæ (Pl. VII.); whilst it is combined with spongin-fibres, and with symbiotic Hydroid tubes in the two other families, Spongelidæ (Pls. IV.–VI.) and Stannomidæ (Pls. I.–III.). But even in these latter the foreign pseudo-skeleton, composed of the chitinous tubes of the symbiotic hydrorhiza, plays a more important part than the true spongin-skeleton of the sponge itself.

The spongin-fibres in our Deep-sea Keratosa are constantly very thin and small, and scantily developed, far less than in the well-known Keratosa of shallow water. In the former are never found the stout and strong horny main fibres, which erect the firm scaffold of the body in the latter. The place of these main fibres is taken by the chitinous tubes of the symbiotic Hydroids, and this remarkable replacement is evidently a most important consequence of that curious symbiosis. The two families which produce spongin-fibrillæ differ essentially in their relation to the xenophya. These foreign skeletal bodies are enclosed within the maltha alone in the Stannomidæ, while in the Spongelidæ a part of them, at least, is enclosed in the spongin-fibres.

Spongin-Skeleton.—The peculiar pure spongin-skeleton, characteristic of the true Keratosa, is found only in two of our deep-sea families, in the Stannomidæ (Pls. I.–III.)

and the Spongelidæ (Pls. IV.–VI.); it is quite absent in the two other families, the Psamminidæ (Pl. VII.) and the Ammoconidæ (Pl. VIII.). These two latter families therefore are, strictly speaking, not Keratosa (or Ceraspongiæ) but Malthosa (or Myxospongiæ). The important question of the natural relations of these different groups will be discussed in the Appendix.

The Spongelidæ of the deep sea are represented in the Challenger collection by two genera, both differing essentially in the structure of the horny skeleton from the common Spongelidæ of shallow water. The stout and strong main fibres of the horny skeleton, which form the solid scaffold of the body in these latter, are wanting in the former; they are replaced by the chitinous tubes of the symbiotic hydrorhiza. The spongin production is restricted in *Psammophyllum* (Pls. IV., V.) to a framework of very thin branched spongin fibres, forming a delicate network, which is expanded within the meshes of the far stouter network produced by the symbiotic Hydroid. *Psammophyllum* seems to be closely related to the similar Spongelid *Phyllospongia papyracea* (Ehlers), but this shallow-water form possesses the same stout main fibres as the common *Spongelia*.

The other genus of deep-sea Spongelidæ, *Cerelasma* (Pl. VI.), is distinguished from all other genera by the peculiar form of the spongin secretion. The spongin here forms peculiar capsular envelopes around the xenophya, and these are connected by branched lamellæ, which form a loose framework. The more solid reticular framework of the symbiotic hydrorhiza branches everywhere between the meshes of the former, and gives them a firm support.

The new family Stannomidæ (Pls. I.–III.), represented by numerous large forms, forming the most stately portion of the collection here described, differ from all other Keratosa in the peculiar development of the spongin-skeleton. This is composed of innumerable fine yellow threads or fibrillæ, which run in all directions through the mesodermal maltha, partly single, partly associated in bundles. They are usually simple and very long, more rarely branched, and never anastomose. They never enclose xenophya, but run everywhere around and between them. A closer examination shows that they cannot be hyphæ of fungi, or other foreign productions (as was supposed by some naturalists), but that they agree perfectly in chemical nature and anatomical structure with the finer horny fibres of the common Spongelidæ.

Xenophya.[1]—The foreign bodies which compose the pseudo-skeleton of the Deep-sea Keratosa, and which we call briefly "xenophya," differ in composition according to the nature of the bottom on which the living sponges grew. The young sponge naturally takes for the building up of its supporting pseudo-skeleton the xenophya making up the bottom at that locality. The three principal kinds of ooze usually found at the bottom of the deep sea compose accordingly the xenophyal skeleton of our Keratosa, viz., (1) Radiolarian ooze, (2) Globigerina ooze, and (3) red clay. Besides, the inorganic

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[1] *Xenophya* = ξενόφυες, foreign bodies.

remains of other organisms which live in the same depths may also be taken up by the growing sponge, as, for instance, the siliceous spicules of Hyalospongiæ, and the calcareous fragments of echinoderms and other lower animals. Among the twenty-six Deep-sea Keratosa here described, ten species possess a siliceous skeleton composed of Radiolarian shells, eight species a calcareous skeleton composed of Foraminifera shells, three species a mineral skeleton, composed of the volcanic particles of red clay, and five species a mixed skeleton, composed of the various elements of the three kinds of ooze and also of various sponge spicules. The disposition of the different skeletal elements in the four families of Deep-sea Keratosa will be seen from the following table :—

Keratosa.	Without spongin-skeleton.		With spongin-skeleton.	
Materials of the pseudo-skeleton taken up from the sea-bottom.	I. Family Ammoconidæ.	II. Family Psamminidæ.	III. Family Spongelidæ.	IV. Family Stannomidæ.
I. Globigerina ooze, ...	3	3	0	2
II. Radiolarian ooze, ...	1	2	2	5
III. Mineral particles of red clay, . .	1	1	1	0
IV. Mixed pseudo-skeleton, with sponge spicules, &c., ...	0	1	2	2

The xenophya fill up the whole maltha in all the Deep-sea Keratosa, and are immediately enclosed by the clear transparent ground-mass of the mesoderm. The family Spongelidæ differs from the other three in having a portion of the xenophya also connected and partly enclosed by the skeletal fibres ; in *Psammophyllum* (Pls. IV., V.) the enclosure by the spongin-fibres is similar to that in the common Spongelidæ (*Spongelia, Dysidea*, &c.), but in *Cerelasma* each single xenophyum is surrounded by a capsular spongin-envelope, and these are connected by branched spongin-lamellæ, which form a reticular scaffold (Pl. VI.). The new family Stannomidæ differs from all other Keratosa in the peculiar fact, that the whole mesoderm is traversed by innumerable bundles of fine spongin-fibrillæ, but these run between the xenophya and never enclose them (Pls. I.–III.).

Chitinous Tubes of Symbiotic Hydroids.

One of the most remarkable features of our Deep-sea Keratosa, characteristic of the majority of them, is their symbiosis with certain Hydroids. The cylindrical, branched, and anastomosing chitinous tubes, which compose the reticular hydrorhiza of the latter,

traverse the body of these Keratosa in all directions, and replace mechanically the absent scaffold of stout spongin main fibres. This peculiar adaptation is found in sixteen species, viz., in all the Stannomidæ (nine species), in all the Spongelidæ of the deep sea (five species), and in two species of Psamminidæ; the symbiotic Hydroids are wanting in most of the smaller forms, in the remaining five species of Psamminidæ, and in all the Ammoconidæ (five species). A full description of the various symbiotic Hydroids is given in the Appendix. Their chitinous tubes are usually filled by a dark brown mass, which former observers supposed to be the phæodium of a large Rhizopod. Closer examination proved it to be the cœnenchyma, which is usually more or less destroyed, and showed also the gonangia and the hydranths.

DESCRIPTION OF GENERA AND SPECIES.

Family I. AMMOCONIDÆ, n. fam. (Pl. VIII.).

Definition.—Keratosa without spongin-fibres. Pseudo-skeleton composed of xenophya (or manifold foreign bodies), which are disposed in the thin malthar plate of the porous tubular body. Canal-system tubular, developed on the Asconal-type (similar to that of the Asconidæ).

The new family Ammoconidæ, represented in the Challenger collection by three different deep-sea genera, is of extraordinary morphological interest, for it is the first example of a simple so-called "homocœlous structure" among the "Non-calcarea," viz., that most remarkable organisation which is represented by the Asconidæ among the Calcarea. In the first genus, *Ammolynthus*, the body is a simple, unbranched tubule, with an oscular opening at the superior end, opposite to the inferior pedicle (Pl. VIII. figs. 1, 2); it corresponds to *Calcolynthus* among the Calcarea. The second genus, *Ammosolenia*, is a branched or arborescent body, composed of several *Ammolynthus* (Pl. VIII. fig. 3), similar to *Soleniscus*. The third genus, *Ammoconia*, forms a loose, roundish framework, composed of anastomosing tubules, without oscula, similar to *Auloplegma* (Pl. VIII. figs. 4, 5). The thin wall of all these tubular sponges is pierced by simple pores, through which the water enters into the simple gastral cavity; it issues either through these or through larger openings (oscula). Remains of the entodermal flagellated epithelium lining the inside of the tubes were visible in two genera examined, but no trace of an exodermal pavement-epithelium was visible on the outside; it was probably lost, as usual in spirit specimens. The main mass of the thin wall is formed by foreign bodies, or manifold xenophya, Radiolaria, Foraminifera, sand-grains, &c. They are connected by a relatively scarce maltha, or a homogeneous ground-mass, in which the small cells of the connective tissue are recognisable between the xenophya.

Xenophya.—The foreign bodies which compose the pseudo-skeleton of the Ammoconidæ, and which are cemented together by the scanty maltha of the mesoderm, are calcareous in three of the five species examined—shells and fragments of *Globigerina* and allied Foraminifera (Pl. VIII. figs. 2–4). They are siliceous in the two remaining species, Radiolarian tests in one (fig. 1), spicules of siliceous sponges and volcanic mineral particles,

such as are found in the red clay, in the other (fig. 5). Thus it appears that the three principal abyssal deposits—Globigerina ooze, Radiolarian ooze, and red clay—supply accidentally the materials of which the pseudo-skeleton in these Ammoconidæ, as well as in the following families of Deep-sea Keratosa, is composed.

Soft Parts.—Whilst the main mass of the tubular body in all the Ammoconidæ is composed of xenophya, or of foreign bodies received from the ooze of the sea-bottom, the true organic tissue of the sponge itself is represented only by the thin delicate membrane which connects and encloses the xenophya. The nature of this membrane is best recognised in those species in which the calcareous matter may be removed by treatment with acids. The delicate residue is formed by a thin, transparent, or somewhat granular membrane, which closer examination proves to be a soft maltha, or mesodermal ground-mass, in which two kinds of cells are enclosed : small, roundish, fusiform or stellate, connective cells, and larger amœboid wandering cells. Besides, in one species (*Ammolynthus prototypus*, Pl. VIII. fig. 1) larger amœboid cells could be recognised, possessing a large clear spherical nucleus with a small dark nucleolus (figs. 1B, 1C, *e*, *v*). These cannot be distinguished from the common naked eggs of sponges ; stages of segmentation, however, and larvæ (Gastrulæ) were not observed in these Ammoconidæ. The same must be said of the (hypothetical) exodermal pavement-epithelium, whereas remnants of the entodermal flagellated epithelium were recognisable on the inside of some tubular Ammoconidæ (Pl. VIII. figs. 1B, 1C, *n*).

Ammoconidæ and Rhabdamminidæ.—The peculiar deep-sea organisms here described as Ammoconidæ exhibit a striking resemblance to certain Rhabdamminidæ, described as Foraminifera Astrorhizida in Henry B. Brady's Report.[1] We find a striking similarity between *Ammolynthus* and *Rhabdammina*, between *Ammosolenia* and *Rhizammina*, between *Ammoconia* and *Sagenella*. Brady thus characterises the family Astrorhizidæ :—"Test invariably composite, usually of large size and monothalamous ; often branched or radiate, sometimes segmented by constriction of the walls, but seldom or never truly septate ; polythalamous forms never symmetrical."[2] The subfamily Rhabdamminidæ is characterised as follows :—"Test composed of firmly cemented sand-grains, often with sponge-spicules intermixed, tubular, straight, radiate, branched or irregular, free or adherent, with one, two, or more apertures, rarely segmented."[3] For further comparison see the careful description of Brady.

Judging as to the nature and affinities of these gigantic deep-sea Rhizopods (the majority of which have been recently described), it must not be forgotten that we know very little more than the external form and the structure of their arenaceous shell. The internal organisation, and even the organic contents, of the shells are almost unknown, except in a few cases. On the other hand, the general form of the numerous

[1] Zool. Chall. Exp., pt. xxii. pp. 63, 227, pls. xix.–xxviii.
[2] *Loc. cit.*, p. 63.　　　[3] *Loc. cit.*, p. 64.

genera is so widely different, and partly so insignificant, that they may belong to very different groups.

Arenaceous shells of cylindrical or urceolate form, with a simple mouth-opening at the distal end, occur in very different classes of the animal kingdom, viz.:—1. Foraminifera (Perforata as well as Imperforata); 2. Physemaria (*Prophysema*, *Gastrophysema*); 3. Spongiæ (Ammoconidæ); 4. Hydroida (*Atractylis*, *Perigonymus*, &c.); 5. Anthozoa (*Cerianthus*, &c.); 6. Rotatoria (*Melicerta*); 7. Gephyrea; 8. Annelida (Oligochæta and Polychæta); 9. Insecta (larvæ of Phryganidæ, &c.). In all these cases the determination of the group is difficult, or even impossible, when only the shell is known, and not the animal producing it. Sometimes the recognition of the shell is possible by comparison, or by means of secondary circumstances. But in other cases it is quite impossible.

The majority of the gigantic deep-sea Foraminifera described by Brady and others are Imperforata, and possess a solid arenaceous shell; these are therefore not sponges. But a number of arenaceous genera are Perforata, and there may be true sponges among them. It is possible (or even probable) that many arenaceous tubes regarded hitherto as Rhabdamminidæ are indeed Ammoconidæ. Brady himself rightly calls many of his Astrorhizidæ doubtful organisms, of which it is difficult to determine the zoological origin and position. Indeed, his *Sagenella* is so similar to our *Ammoconia*, his *Rhizammina* to our *Ammosolenia*, and his *Rhabdammina* to our *Ammolynthus*, that they may be easily confounded. If we assume that, in the well-known calcareous Asconidæ (*Calcolynthus*, *Leucosolenia*, *Auloplegma*), the calcareous spicules are replaced by xenophya (or by foreign skeletal bodies taken from the sea-bottom), we should have the Ammoconidæ figured in Pl. VIII.—*Ammolynthus* (figs. 1, 2), *Ammosolenia* (fig. 3), *Ammoconia* (figs. 4, 5).

Ammoconidæ and Physemaria (*Ammolynthus and Haliphysema*).—A new light is thrown by the Ammoconidæ upon those interesting primitive Metazoa which I described in 1876 as Physemaria (*Haliphysema* and *Gastrophysema*). I had observed two of these organisms in the Mediterranean in the living condition, and bearing eggs (*Haliphysema primordiale* in Corsica, 1875, and *Gastrophysema dithalamium* in Smyrna, 1873). The structures which I found in the walls of these remarkable animals are essentially the same as in the Ammoconidæ collected by the Challenger. The only important difference is that the thin wall of the tubular body is apparently solid and imperforate in the Physemaria, porous and perforate in the Ammoconidæ.

This difference may be explained in two ways. The body-wall of the Physemaria may be indeed imperforate, and in this case they retain the primordial position on the lowermost step of the Metazoa, which I had assigned to them, as " Gastræadæ of the present time." On the other hand, it may be that the body-wall is perforated by numerous microscopical pores, and that these were closed temporarily and accidentally during the

few hours I was examining them ; in this case they are Ammoconidæ. I pointed out in my Monograph that the pores of the Asconidæ are often closed for a long time, and when a single tubular *Calcolynthus* (as that of Pl. I. fig. 1 in my Monograph) is examined in this temporarily closed state, it may be assumed to be a Physemarium (*Haliphysema*).

The genus *Haliphysema* was first described by Bowerbank (1864) as a simple sponge.[1] Carter afterwards expressed the opinion that it was not a sponge but a Foraminifer,[2] and most of the later writers on the subject agree with him. But I think I have sufficiently demonstrated in my Monograph of the Physemaria[3] that this latter opinion cannot be proved. Bowerbank's original description is so incomplete that his *Haliphysema* may have been either a true sponge (*Ammolynthus*), or a Physemarium (*Prophysema*), or a Foraminiferous Monothalamium (*Rhabdammina, Technitella*, &c.). The most careful examination of the original dry specimens (should they still exist) cannot decide this question. It can only be decided by the accurate examination of living or well-preserved specimens from the same locality.

True monothalamous Foraminifera, similar to *Haliphysema*,—and so similar that they appear externally identical,—have been carefully examined in the living state, and described by Möbius[4] in 1874. I myself repeated these observations in 1881 in the coral reefs of Ceylon, where the same forms are very common, and I can completely confirm the correctness of the beautiful figures and accurate descriptions of Möbius. But the striking similarity of the simple tubular organism, described by him as *Haliphysema tumanowiczii*, and of the true Physemaria described by me as *Haliphysema primordiale*, &c.,[5] is merely external. The inner cavity of the first is filled up simply by protoplasma, issuing by the mouth of the tube in the form of numerous branching filaments or pseudopodia. The true gastral cavity of the latter, however, is lined by a flagellated epithelium of the same form as in *Calcolynthus*, and bears amœboid eggs, as in this primordial sponge.

To avoid further confusion, I propose to employ the term *Haliphysema*[6] for that monothalamous Foraminifer in the sense of Möbius, Brady, and most recent authors. For the true Physemaria, however, which I described in 1876 as *Haliphysema primordiale, Haliphysema echinoides, Haliphysema globigerina*, &c., it will be best to adopt the term *Prophysema*. I may add the remark, however, that this *Prophysema* and the closely-allied *Gastrophysema* may be indeed true Physemaria without pores, as I have described them. But it may be, on the other hand, that true pores really exist in their body-wall, and that they were closed only accidentally during my examination. Should

[1] Bowerbank, Monograph of the British Spongiadæ, vol. i. p. 179, pl. xxx. fig. 359 ; vol. ii. p. 76 ; vol. iii. pl. xiii.

[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. v. pp. 309 *et seq.*, pls. iv., v., May 1870.

[3] *Jenaische Zeitschr.*, Bd. xi. p. 1, Aug. 1876.

[4] Möbius, Meeresfauna der Insel Mauritius, &c., I. Foraminifera, p. 72, Taf. i.

[5] *Loc. cit.*, Taf. i.–iii.

[6] Norman, The Genus Haliphysema, *Ann. and Mag. Nat. Hist.*, ser. 5, vol. i. pp. 26 *et seq.*, pl. xvi., April 1878.

further observations prove the existence of such pores, then these Physemaria must be united with our *Ammolynthus*, as the simplest forms of Ammoconidæ.

Genus 1. *Ammolynthus*,[1] n. gen.

Definition.—Ammoconidæ with simple, tubular or urceolate, unbranched body. Distal end of the tubule with a simple opening (osculum).

The genus *Ammolynthus* is of special interest, as the simplest of all Keratose sponges, and as a prototype corresponding perfectly to *Calcolynthus* among the calcareous sponges. I propose to retain the term *Olynthus* (first employed in my Monograph of the Calcispongiæ, 1872) for the simplest tubular sponge-type without skeleton, and to use the term *Calcolynthus* for those forms of *Olynthus* which produce calcareous spicules in the mesodermal outer wall of the utricle, and *Ammolynthus* for those forms, the pseudo-skeleton of which is composed of xenophya. The important embryonic stage of many sponges, which corresponds to these mature *Olynthus*-forms, may be called *Olynthula*, and the corresponding hypothetical phylogenetic form—the probable common ancestral form of all sponges—*Archolynthus* (= *Archispongia*).

Two interesting species of *Ammolynthus* were found in the Challenger collection, both representing a simple utricle of the typical *Olynthus*-form. The pseudo-skeleton of the smaller form (*Ammolynthus prototypus*, Pl. VIII. fig. 1) is siliceous, composed of Radiolarian ooze ; that of the larger form (*Ammolynthus haliphysema*) is calcareous, composed of Globigerina ooze. The former was better preserved, and exhibited not only remnants of the flagellated entodermal epithelium, but also distinct eggs.

Ammolynthus prototypus, n. sp. (Pl. VIII. figs. 1A–1C).

Habitat.—Central Pacific, Station 271 ; September 6, 1875 ; lat. 0° 33′ S., long. 151° 34′ W. ; depth, 2425 fathoms ; bottom, Globigerina ooze, containing many Radiolarians.

Sponge urn-shaped or urceolate, representing a simple ovate utricle, which is fixed by a slender cylindrical pedicle at the proximal end, and opens by a cylindrical proboscis at the distal end. Pseudo-skeleton composed of siliceous shells of Radiolaria.

Ammolynthus prototypus may be regarded as the simplest architype of a Keratose sponge, corresponding to *Calcolynthus* among the Calcarea.[2] The utricular body has a length of 6 to 10 mm., and in its middle widest portion a breadth of 1 to 1·2 mm. The inferior or proximal half of the body is formed by a cylindrical pedicle 0·3 mm. in diameter, which is fixed to the bottom by a broadened basal plate. The superior or

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[1] *Ammolynthus*=Sandy fruit, ἄμμος, ὄλνος.　　[2] Compare my Monograph, 1872, pl. i., vol. i., pp. 339, 342, etc.

distal half is ovate, and opens above by a short cylindrical proboscis (caminus). The terminal mouth of the latter, or the osculum (o), is simple, circular, and has a diameter of 0·5 mm.

Longitudinal and transverse sections through the utricular sponge (figs. 1A, 1B) show that the internal cavity (or the gastral cavity) is perfectly simple, enclosed by a thin wall of nearly equal thickness (about 0·1 mm.). This cavity opens above by the distal ostium, and in the middle dilated portion by numerous small circular pores, 0·03 to 0·04 mm. in diameter (p). The pores seem to be absent in the basal pedicle as well as in the distal proboscis. Probably the sea-water enters into the gastral cavity by these dermal pores and issues by the distal osculum (o).

The thin and rather firm wall of the utricle is mainly composed of siliceous Radiolarian tests of those wonderful and most elegant forms making up the Radiolarian ooze of Station 271. They are connected by a granular maltha, or the ground-mass of the connective tissue, which constitutes the outer wall of the sponge. Through this maltha are scattered numerous very small stellate cells, and a few larger amœboid wandering cells (a); these are more distinct in the thinner walled proboscis, which is free from xenophya. In some transverse sections (fig. 1B), through the inferior part of the gastral cavity, close to the pedicle, there appear between the xenophya and within the maltha (m) single eggs (e), naked amœboid cells, 0·1 to 0·2 mm. in diameter. Their nucleus or germinal vesicle (v) includes a distinct nucleolus. Further, in some of these sections are visible, on the inside of the wall, small thin bands composed of small granular cells (n); these are probably the remnants of the flagellated entodermal epithelium. Fig. 1C shows a small portion of the wall, seen from the inside, in which the above-mentioned structures are more or less distinct.

Ammolynthus haliphysema, n. sp. (Pl. VIII. fig. 2).

Habitat.—Central Pacific, Station 270; September 4, 1875; lat. 2° 34′ N., long. 149° 9′ W.; depth, 2925 fathoms; bottom, Globigerina ooze.

Sponge ovate, with a simple osculum at the distal end, arising from a slender cylindrical pedicle, which is fixed by a broad basal plate. Pseudo-skeleton composed of calcareous shells of Foraminifera.

Ammolynthus haliphysema is closely allied to the preceding species, but differs from it in the simple, not proboscidial, opening of the osculum (o), and principally in the composition of the pseudo-skeleton, which is built up of calcareous shells from the Globigerina ooze. The ovate body of the sponge is much larger, 5 to 8 mm. in diameter, and arises from a slender, cylindrical, slightly curved pedicle, which is 10 to 12 mm. long and 1 to 1·2 mm. broad. This is broadened below and attached to the bottom on the proximal

end by an irregular broad basal plate. The mouth-opening—or the osculum (*o*)—on the opposite distal end is circular, 2 mm. in diameter. The total length of the sponge is 15 to 20 mm.

The opaque white body of this species is composed almost entirely of calcareous shells of Foraminifera and their fragments. After being dissolved in dilute hydrochloric acid, there remains a thin membranous wall, pierced by numerous small pores (*p*). These dermal pores are shown in fig. 2 in the complete body, although they are not distinct until the removal of the calcareous matter. On the inside of the thin wall were visible fragments of delicate epithelium, composed of small granular cells; these were, however, not so distinct as in the closely-allied *Ammoconia auloplegma* (Pl. VIII. fig. 4, *n*).

Genus 2. *Ammosolenia*,[1] n. gen.

Definition.—Ammoconidæ with arborescent body, forming tubular branches, which are not connected by anastomoses. Each branch with a terminal opening (osculum).

The genus *Ammosolenia* is derived from the preceding *Ammolynthus* by branching, and therefore bears the same relation to it as among the Calcarea *Leucosolenia* (or, more strictly speaking, *Soleniscus*) does to *Calcolynthus*. The branched or arborescent body of the tubular sponge bears a number of thin-walled porous branches, and each of these has on the distal end a wide simple mouth-opening. Branched tubes like these are not rare in many deep-sea soundings of the Challenger collection, and are described by Brady in his Report on the Foraminifera (p. 274, pl. xxviii.) under the name of *Rhizammina algæformis*. Their arenaceous pseudo-skeleton is usually composed of Globigerina ooze, as also in our *Ammosolenia rhizammina*. But two important differences separate the latter from the former. The thin wall of the arenaceous sponge (*Ammosolenia*) is pierced by numerous small pores or inhalent openings (fig. 4, *p*), whilst the solid wall of the similar arenaceous Rhizopod (*Rhizammina*) is not perforate. The cavity of the branched tubes is lined in the former by a flagellated epithelium, filled up in the latter by simple sarcode or protoplasm. It must be recorded, however, that this sarcode, as the most important part, in *Rhizammina* as well as in many other large arenaceous Foraminifera, has not been demonstrated by observation, but only assumed theoretically. It may be, therefore, that many of these latter belong to our *Ammoconia* or similar Ammoconidæ.

Ammosolenia rhizammina, n. sp. (Pl. VIII. fig. 3).

Habitat.—Tropical Pacific, Station 216A; February 16, 1875; lat. 2° 56′ N., long. 134° 11′ E.; depth, 2000 fathoms; bottom, Globigerina ooze.

[1] *Ammosolenia* = Arenaceous tubes, ἄμμα, σωλήνιον.

Sponge branched, with free cylindrical branches of equal thickness, each provided at the distal end with an osculum. Pseudo-skeleton composed of Globigerina ooze.

Ammosolenia rhizammina forms dendritic or branched tufts, composed of a variable number of cylindrical, not anastomosing, branches. The small trees have a diameter of 8 to 12 mm., and are either erect or creeping on the bottom of the sea. The diameter of the tubules is between 0·8 and 1·2 mm., the length between 10 and 16 mm. Usually they are of nearly equal thickness, and open at the distal end by a circular mouth. The thin wall of the tubes seems to be solid, and to consist only of *Globigerina* shells cemented together by a scanty maltha. But after removal of the calcareous matter by hydrochloric acid, and staining the residuum by carmine, there remains a thin membrane pierced by numerous small pores. These are disposed in the same manner as in *Ammolynthus haliphysema* (Pl. VIII. fig. 2) and in *Ammoconia auloplegma* (fig. 4). Between the pores are visible here and there small cellular flakes, composed of minute granular cells, perhaps the remnants of the flagello-epithelium. A careful examination of living and well-preserved specimens is, however, required to confirm the sponge-nature of this as well as of the other Ammoconidæ with certainty.

Genus 3. *Ammoconia*,[1] n. gen.

Definition.—Ammoconidæ of reticular shape, forming a network of anastomosing porous tubules, without oscula.

The genus *Ammoconia* among the Keratosa represents the same characteristic form, which is very common among the calcareous Asconidæ, described in my Monograph (1872) as *Auloplegma*. The sponge consists of a network, composed of numerous thin-walled (usually cylindrical) anastomosing tubes. The thin walls are pierced by numerous small round pores, but there is no larger opening or osculum. Whilst the thin outer wall of the tubes in *Auloplegma* is supported by calcareous spicules formed by the sponge itself, in *Ammoconia* it is built up of xenophya, or foreign bodies taken from the sea-bottom. There are two similar species of this genus found on the sea-bottom; in the first (*Ammoconia auloplegma*) the pseudo-skeleton is formed by calcareous Globigerina ooze (Pl. VIII. fig. 4); in the second (*Ammoconia sagenella*) it is sandy and siliceous, composed of sponge spicules and the volcanic debris of the red clay. Very similar to this latter, or even identical with it, may be that form which Brady has figured as *Sagenella frondescens*.[2]

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[1] *Ammoconia* = Sandy cement, ἀμμοκονία.
[2] Zool. Chall. Exp., pt. xxii. p. 278, pl. xxviii. figs. 14, 15.

Ammoconia auloplegma, n. sp. (Pl. VIII. fig. 4).

Habitat.—Tropical Atlantic (between the Canary and Cape Verde Islands), Station 89; July 23, 1873; lat. 22° 18′ N., long. 22° 2′ W.; depth, 2400 fathoms; bottom, Globigerina ooze.

Sponge reticular, composed of anastomosing cylindrical branches, the porous wall of which is calcareous, composed of agglutinated *Globigerina* shells.

Ammoconia auloplegma forms a loose roundish network, 12 to 16 mm. in diameter, of the same form as that of the following species, figured in Pl. VIII. fig. 5. The cylindrical branches composing it are, however, only half the size of those of the latter, viz., 0·5 mm. in diameter. They present the same aspect as the free cylindrical tubes of *Ammosolenia rhizammina,* so that the former sponge may be derived from the latter simply by the anastomosing of the branches. The structure of the canal-walls, too, is the same in both. After the removal of the opaque calcareous matter by hydrochloric acid, there remains a delicate membrane, pierced by numerous circular pores (*p*). The membrane contains small stellate cells scattered in a granular maltha (*m*), and a few larger dark granular cells, which may be amœboid wandering cells. Seen from the inside, the porous wall is covered here and there by small irregular flakes of epithelium, composed of minute granular cells, probably the remnants of the flagellated entodermal epithelium (*n*). Fig. 4 on Pl. VIII. is semi-diagrammatic, exhibiting these different elements united as they would appear in a transverse section of the living sponge.

Ammoconia sagenella, n. sp. (Pl. VIII. figs. 5A, 5B).

Habitat.—North Pacific, Station 256; July 21, 1875; lat. 30° 22′ N., long. 154° 56′ W.; depth, 2950 fathoms; bottom, red clay.

Sponge reticular, composed of anastomosing cylindrical branches, the porous wall of which is siliceous, composed of sponge spicules and volcanic debris.

Ammoconia sagenella (in Pl. VIII. fig. 5A magnified four times) forms a loose network, composed of short, cylindrical, anastomosing branches. The diameter of the reticular sponge is 12 to 20 mm., that of the branches 1 to 2 mm., that of the meshes of the network 2 to 4 mm. The thin wall of the tubes is rather hard and firm, pierced by numerous very small circular pores (fig. 5B, *p*). The xenophya composing the wall are siliceous, partly fragments of various sponge spicules, partly small polyhedral or more rounded sand-grains, the characteristic constituents of the red clay (*x*). Some fragments of the tubes, treated with carmine, and seen from the inside, exhibited here and there between the pores small epithelial flakes, composed of small granular cells; they are probably the remnants of the flagellated entodermal epithelium.

Family II. PSAMMINIDÆ, Lendenfeld (Pl. VII.).

Definition.—Keratosa without spongin-fibres. Pseudo-skeleton composed of xenophya (or manifold foreign bodies), which are cemented together and enclosed by the transparent maltha. Canal-system vesicular, developed on the Leuconal-type (similar to that of the Spongelidæ).

The family Psamminidæ comprises those Keratosa (or rather " Pseudo-Keratosa ") in which no trace of spongin-fibres is developed, the skeleton being composed only of manifold foreign bodies, which are enclosed in the maltha or the mesodermal ground-mass of the connective tissue. Lendenfeld, who founded this family in 1886 (as Psamminæ, a subfamily of the Spongelidæ), gives the following definition of it :—" The skeleton consists of foreign bodies cemented by spongin, which, however, is not distinctly visible ; without flesh spicules."[1] Three genera are distinguished by him, *Psammopemma*, *Psammella*, and *Holopsamma*. *Psammella* (Lendenfeld) has not yet been described. The first genus, *Psammopemma*, described by Marshall in 1880, was placed by him in the family Spongelidæ or Dysideidæ. I think, however, that the complete absence of a horny spongin-skeleton is quite sufficient to separate the Psamminidæ from the Spongelidæ. No trace of true spongin or horny substance is to be found either in those species described by Marshall as *Psammopemma* in 1880, nor in those described by Carter as *Holopsamma* in 1885. Both these genera are represented by several new deep-sea forms in the Challenger collection, and it contains besides three new species of a new interesting genus, *Psammina*, the discoidal body of which is remarkable for its simple structure.

The Psamminidæ must be separated from the true Spongelidæ for the same reason as the Halisarcidæ and Chondrosidæ. They are indeed—regarded critically—skeletonless, like the two latter families ; for the impregnation of the mesoderm with manifold xenophya, or hard foreign bodies, produces only a pseudo-skeleton,—a solid supporting mass in a physiological sense,—but not to be compared with a true internal skeleton produced by the mesodermal connective tissue itself, as is the case in the Keratosa proper. It would, therefore, perhaps be better to separate the Psamminidæ as " Myxo-spongiæ arenosæ," or Psammospongiæ, from the true Keratosa, and to unite them with the skeletonless Myxospongiæ (Halisarcidæ and Chondrosidæ).

Dr. N. Poléjaeff, in his Report on the Keratosa,[2] describes two species of *Psammopemma* collected by the Challenger in shallow water. The first is the form illustrated by Marshall (*Psammopemma densum*), dredged at Station 49, in 85 fathoms ; the second is a new form (*Psammopemma porosum*)[3] found at Bahia in shallow water. Dr. Poléjaeff gives the following definition of *Psammopemma* :—" Spongelidæ without any

[1] Lendenfeld, Classification of Sponges, *Proc. Zool. Soc. Lond.*, p. 589, Dec. 21, 1886.
[2] Zool. Chall. Exp., pt. xxxi.   [3] *Loc. cit.*, pp. 45–50, pl. iii. figs. 3, 4.

differentiated skeletal fibres, the supporting skeleton being represented by foreign enclosures lying separately in the parenchyma, and the secretion of the horny substance having been reduced to the formation of only a thin envelope around the enclosed foreign bodies." In contradiction to this description, the figure of *Psammopemma*, given by Poléjaeff, exhibits no trace of a horny envelope, but the xenophya are imbedded immediately in the maltha or the so-called parenchyma of the mesoderm, in the same way as the flagellated chambers. The same is the case in the original specimens of *Psammopemma densum*, upon which Marshall founded the genus, and which he received from my museum at Jena. A re-examination of them has convinced me that Marshall's description is quite correct, and that there is no trace of spongin in the body, as Poléjaeff supposes. The "horny envelopes" described by the latter are the usual sheaths of xenophya, or the condensed parts of the maltha, which envelop all the foreign bodies in the ground-mass of the connective tissue. But if his *Psammopemma porosum* really possesses "fully-developed horny envelopes around the foreign enclosures, occasionally with very conspicuous outgrowths," then probably this species should be transferred to *Cerelasma* (p. 45), or to an allied genus of Spongelidæ.

The Psamminidæ often seem to inhabit the deep sea, and during the ten years in which I made my investigations on the Challenger Radiolaria, I found in many soundings from the Challenger collection irregularly formed lumps or crusts, which a closer examination proved to be fragments of arenaceous Keratosa without horny fibres. But only seven of these Psamminidæ were preserved in a manner sufficient for their description as new species. In two of these seven deep-sea Psamminidæ the pseudo-skeleton is composed of Radiolarian ooze; in four others of Globigerina ooze; in another it is built up of red clay. It therefore seems probable that all the different kinds of deep-sea bottom are accidentally employed by several Myxospongiæ for the construction of a pseudo-skeleton.

The external appearance of all these Psamminidæ is generally simple and insignificant, the general form being an irregular lump or crust; at first sight one is inclined to regard them as porous lumps of inorganic deposit. But anatomical examination, especially by means of sections through different planes, shows that the sandy body is traversed by branched canals, which are in connection with flagellated chambers, the characteristic organs of sponges.

Canal-System.—The state of preservation of the deep-sea Psamminidæ which I found in the Challenger collection was usually not sufficient to enable one to recognise its true structure with precision; besides, their examination is very difficult, owing to the dense sand masses which fill up the whole mesoderm. In four cases, however, I succeeded in recognising the main parts of the canal-system, and convinced myself that it is constructed on the Leuconal-type. This was recognisable in those four species of Psamminidæ in which the pseudo-skeleton is composed of agglutinated *Globigerina*

shells. Having dissolved the calcareous matter by cautious application of dilute hydro-chloric acid, I was able to examine in a rather satisfactory manner the delicate remains, consisting of a scarce, clear maltha, and of the branched canals traversing the latter. The canals have often a distinct *membrana propria*, the wall of which is supported by small xenophya (fig. 7C). Numerous rather large flagellated chambers, of an ovate or oblong form, were visible between the smaller branches of the canal-system, and partly connected with them; here and there, too, the small inhalent canals could be recognised coming from the small dermal pores. The choanocytes were exceedingly small, on an average 0·001 mm. in diameter; the same was observed by Poléjaeff in *Psammopemma porosum*. The best preparation of the canal-system was obtained by vertical sections through the discoidal *Psammina plakina* (Pl. VII. figs. 1C, 1D). In this remarkable preparation were also found single eggs, some in segmentation (figs. 1C, 1D, *e*). Their structure and disposition are similar to those in *Plakina monolopha*.

The excurrent part of the canal-system exhibits in the deep-sea Psamminidæ three different types. The discoidal *Psammina* possesses a girdle of oscula, or of large exhalent openings (usually between ten and twenty) on the peripheral margin of the medal-shaped body (Pl. VII. fig. 2B). The tuberose *Holopsamma* bears either a single osculum on the top of each prominent lobe (fig. 6B, *o*), or a series of oscula (or several series) on the projecting crests of the massive body, between the conical depressions which bear the dermal pores (fig. 7A). The true *Psammopemma* has no distinct oscula at all (figs. 4, 5).

Symbiontes.—The majority of the deep-sea Psamminidæ are not associated with a symbiotic Spongoxenia. Two species only of *Psammina* exhibit this symbiosis, viz., *Psammina globigerina* (Pl. VII. fig. 2C) and *Psammina nummulina* (fig. 3). Between the two parallel hard dermal plates of these discoidal sponges (which in the former are composed of Globigerina ooze, in the latter of Radiolarian ooze) is placed a soft medullar mass, with the canal-system of the sponge, and within this is expanded a network of anastomosing chitinous tubes, filled with dark brown cells (figs. 2C, 3). This is probably the hydrorhiza of a symbiotic Hydroid (*Stylactis?*); its hydranths and gonophores, however, could not be seen.

Genus 4. *Psammina*,[1] n. gen.

Definition.—Psamminidæ with a discoidal body, forming a thin and flat crust or plate, the margin of which is provided with a series of oscula. The canal-system is expanded horizontally in a soft medullar mass, which is enclosed between two hard cortical plates (upper and lower plate), both full of xenophya.

The genus *Psammina*, represented in the Challenger collection by three new and

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[1] *Psammina* = Sandy, ψάμμινα.

very interesting species, is characterised by the flat crusty form, representing a roundish or subcircular disc, the peripheral margin of which bears a series of oscula or exhalent openings, whilst the inhalent dermal pores are disposed on the flat upper face of the disc. *Psammina*, therefore, closely approaches in structure those interesting Tetractinellidæ described by F. E. Schulze as Plakinidæ, of which *Plakina monolopha* is a typical form, because of its simple organisation. One of the three new deep-sea forms collected by the Challenger is so similar to it, that it may be regarded as a *Plakina monolopha*, in which the Tetractinellid spicules are lost and replaced by xenophya (calcareous shells of the Globigerina ooze). This species (*Psammina plakina*) contains no symbiotic Hydroid. The two other species are connected with a symbiotic *Spongoxenia* (probably *Stylactis* or an allied genus); its reticular hydrorhiza, composed of brown anastomosing chitinous tubes, is expanded horizontally in the medullar substance of the sponge, between the two solid parallel skeleton plates of the cortical substance (upper and lower face). The pseudo-skeleton in *Psammina globigerina* is composed of Globigerina shells; in *Psammina nummulina* of Radiolarian tests. The canals of the sponge are branched between the meshes of the Hydroid tubes (*h*), and open together with these on the peripheral margin of the disc. The isolated canals exhibit a distinct *membrana propria* (fig. 2D, *c*).

Psammina plakina, n. sp. (Pl. VII. figs. 1A–1D).

Habitat.—South Atlantic, Station 331; March 9, 1876; lat. 37° 47′ S., long. 30° 20′ W.; depth, 1715 fathoms; bottom, Globigerina ooze.

Sponge discoidal, subcircular, composed of two parallel hard cortical plates, with a soft medullar substance between them, the former being composed of *Globigerina* shells, the latter of maltha and a simple gastral cavity, covered by a single layer of flagellated chambers. No symbiotic Spongoxeniæ. Several oscula on the peripheral elevated margin.

Psammina plakina is a very remarkable form, which differs from the following typical species of the genus in such essential points, that it may perhaps be better described as the representative of a new genus, *Psammoplakina discoidea*. Two small specimens were observed forming white subcircular plates, the smaller 5 to 6 mm. in diameter, the larger 10 to 12, and 1·5 to 2·5 mm. in thickness. The internal structure is very similar to that of *Plakina monolopha*, accurately described by Franz Eilhard Schulze. If we were to suppose that the characteristic siliceous spicules of the Tetractinellid *Plakina monolopha* were lost or dissolved and replaced by Globigerina ooze taken from the bottom of the sea, then we should have the structure of *Psammina plakina*.

The consistence of *Psammina plakina* is very hard and solid, not so rigid, however, as in the similar following species. The subcircular disc is slightly convex on the lower,

concave on the upper, side, the peripheral margin being curved somewhat upwards. The convex basal (inferior) face as well as the concave free (superior) face are two parallel thin white plates, composed of small *Globigerina* shells cemented together by a scarce maltha. The medullar or intermediate plate enclosed between these two parallel dermal or cortical plates is somewhat thicker than these, but much softer; it is composed of numerous small shells and fragments of *Globigerina* imbedded in a clear maltha, and of a very remarkable canal-system. The structure of this latter became evident, after having dissolved the calcareous mass of the pseudo-skeleton by hydrochloric acid. Then appeared a flat saccular or pouch-shaped central cavity, divided into irregular chambers by mesodermal septa (figs. 1C, 1D, *g*). From the upper face of this central sac arise numerous lobate diverticles, which are beset with groups of flagello-chambers (*k*). These open by small pores into inhalent canals (*i*), which descend vertically from the upper face. From the periphery of the sac arise numerous excurrent canals, which open into a few peripheral exhalent main canals, and these open free on the peripheral elevated margin by oscula (*o*). About ten or twelve such peripheral oscula could be recognised as larger openings, probably prolonged in the living sponge into prominent oscular tubes or chimneys.

The circulation of the water in *Psammina plakina* is evidently the same as in the similar *Plakina monolopha*, the water entering by the inhalent pores of the concave upper face of the disc, issuing by the exhalent oscula of the margin. Very remarkable is the large simple gastral cavity, or the paragaster (fig. 1C, *g*). This is divided in the following species into numerous chambers, probably due to the development of the symbiotic Spongoxenia (absent in *Psammina plakina*).

In the middle portion of the discoidal body, in that portion of the mesodermal maltha surrounding the basal flagello-chambers, are visible single scattered eggs, some of which are in segmentation (Pl. VII. figs. 1C, 1D, *e*). Although badly preserved, the egg-cells and their large clear nuclei were distinct. Their disposition is also similar to that in *Plakina monolopha*.

Psammina globigerina, n. sp. (Pl. VII. figs. 2A–2D).

Habitat.—Tropical Pacific, Station 220; March 11, 1875; lat. 0° 42′ S., long. 147° 0′ E.; depth, 1100 fathoms; bottom, Globigerina ooze.

Sponge discoidal, subcircular, composed of two parallel hard cortical plates and a soft medullar substance between them, the former being composed almost entirely of *Globigerina* shells, the latter of maltha, with the canal-system and a network of symbiotic Spongoxeniæ. Exhalent oscula on the peripheral margin. Gastral cavity chambered.

Psammina globigerina is very similar to the preceding *Psammina plakina*, and may be perhaps identical with it, but it differs in the more complicated form of the canal-system and the chambered gastral cavity. Perhaps these differences are caused by the development of a reticular symbiont in its interior medullar plate. The irregular roundish or subcircular disc is white, hard, and rigid, between 20 and 30 mm. in diameter, 1·5 to 2·5 mm. in thickness, and is composed of two parallel hard cortical plates, and a soft medullar plate enclosed between them. The two white cortical or dermal plates are composed almost entirely of larger and smaller *Globigerina* shells, cemented together by a scanty clear maltha; the superior plate is pierced by very small pores. The soft medullar mass between the two plates consists of the mesoderm of the sponge with its canal-system, and of the network of a symbiotic Spongoxenia disposed between the branches of the latter. The maltha is filled up with xenophya, fragments of *Globigerina* shells and small complete shells.

Having dissolved the calcareous mass of the pseudo-skeleton by hydrochloric acid, and stained the remains of the body by carmine (Pl. VII. fig. 2D), I could distinguish clearly in the scanty maltha of the mesoderm two branched canal-systems, the dark reticular network of a brown Spongoxenia (probably the hydrorhiza of *Stylactella, h*), and the delicate red tree-like tubes of the sponge itself (*c*). The latter are branched, not anastomosing, canals, with a distinct *membrana propria*, and in the course of these the remnants of numerous flagello-chambers. The dark network of the Spongoxenia (or the hydrorhiza), expanded horizontally between the two dermal plates, is composed of anastomosing cylindrical horny tubes, of variable diameter, filled up by greenish brown epithelia. The thickest tubes radiate from the centre of the disc (fig. 2C, *h*).

Psammina nummulina, n. sp. (Pl. VII. fig. 3).

Habitat.—Tropical Pacific, Station 274; September 11, 1875; lat. 7° 25′ S., long. 152° 15′ W.; depth, 2750 fathoms; bottom, Radiolarian ooze.

Sponge discoidal, subcircular, composed of two parallel hard cortical plates and a soft medullar substance between them, the former being composed of Radiolarian tests, the latter of maltha with the canal-system, and the network of a symbiotic Spongoxenia. Gastral cavity chambered. A corona of oscula on the peripheral margin.

Psammina nummulina is, like the two preceding species, a thin and hard subcircular disc (Pl. VII. figs. 1A, 1B), but while the two parallel hard dermal plates of the disc in the two latter are coarsely sandy and calcareous, composed of *Globigerina* shells, they are in *Psammina nummulina* more finely sandy and siliceous, composed of Radiolarian tests. These are cemented together by a rather conspicuous maltha. The upper face of the disc is traversed by numerous small inhalent pores, which are not visible on the lower face.

The exhalent oscula, ten to fifteen in number, are larger, and form a corona on the elevated peripheral margin of the disc (as shown in Pl. VII. fig. 2B). The diameter of the disc is 12 to 15 mm., the thickness 1·12 to 1·18 mm.

The two hard parallel dermal plates of the disc are easily detached from each other, and then is seen between them a softer medullar plate, composed of the branched canal-system of the sponge, and of the network of the symbiotic Spongoxenia (Pl. VII. fig. 3). The structure of the canal-system is difficult to make out, but seems to be similar to that of *Psammina globigerina* (fig. 2D). The inhalent pores on the upper face of the disc open into small canals, and the main tubes of the canal-system open on the elevated margin of the disc by exhalent oscula.

The symbiotic Spongoxenia (fig. 3, *h*) (probably the reticular hydrorhiza of *Stylactis* or an allied tubularian Hydroid) forms an elegant network with polygonal meshes, expanded horizontally in the equatorial plane of the disc between the branches of the canal-system. The anastomosing chitinous tubes of the network are filled by a dark green-brown cellular detritus, sharply defined from the whitish tissue of the sponge.

Genus 5. *Holopsamma*,[1] Carter (1885).

Definition.—Psamminidæ with a massive tuberose or lumpy body, which bears groups of distinct oscula either on prominent ridges or on the top of projecting lobes.

The genus *Holopsamma* was founded in 1885 by Carter with the following definition :—" Arenaceous sponges without fibres, whose composition consists of foreign microscopic objects (sand, fragments of sponge-spicules, &c.) diffused in the flakes of the parenchymatous sarcode, traversed by the canals of the excretory system."[2] Carter points out that "there is absolutely no fibre, but the foreign material is diffused, and so far held together by being imbedded in the delicate flakes of the parenchymatous sarcode" (*i.e.*, the maltha, or the ground-mass of the mesoderm). Carter describes five different species of *Holopsamma;* the three first of these are characterised by a massive lumpy or tuberose body, in which numerous distinct oscula are visible, usually placed on the most projecting parts, either on the margin of crests or the top of lobes. These three typical species of *Holopsamma* are *Holopsamma crassa, Holopsamma lævis,* and *Holopsamma laminæfavosa.* To these are closely allied two new deep-sea species obtained by the Challenger, and described in the following pages (*Holopsamma cretaceum* and *Holopsamma argillaceum*). The two remaining species of Carter might be better placed in the genus *Psammopemma* of Marshall.

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[1] *Holopsamma* = Whole sand, ὅλος, ψάμμα.
[2] *Loc. cit.*, p. 211.

Holopsamma cretaceum, n. sp. (Pl. VII. figs. 7A–7C).

Habitat.—North Atlantic, Station 70; June 26, 1873; lat. 38° 25′ N., long. 35° 50′ W.; depth, 1675 fathoms; bottom, Globigerina ooze.

Sponge massive, lumpy, forming irregular roundish or bulbous chalk-like masses, composed almost entirely of *Globigerina* shells, cemented together by a scarce maltha. The porous surface exhibits conical depressions; the prominent ridges between them bear series of oscula.

Holopsamma cretaceum is represented in the Challenger collection by a single dry specimen, an irregular tuberose white lump, the diameter of which varies between 20 and 50 mm. The dry sponge is like a piece of common rough chalk, white and very friable. Nearly the whole body is composed of Globigerina ooze, the shells of which are cemented together by a small quantity of maltha. No symbiotic Spongoxenia inhabits this species.

The single specimen of the Challenger collection is figured by Miss Traill from two sides on Pl. VII. figs. 7A, 7B. It is very friable, like chalk, represents an irregular, tuberose, roundish lump, compressed from two sides, and exhibits about a dozen unequal funnel-shaped depressions of the surface. These funnels are 8 to 12 mm. in diameter and are twice as broad as the prominent ridges between them (4 to 6 mm. in diameter). The ridges bear series of black points, which seem to be the oscula of the exhalent canals; they are absent in the white surface of the funnels, in which only the smaller pores of the inhalent canals are to be seen.

After having dissolved the calcareous matter of the skeleton by hydrochloric acid, there remains a very small residuum, composed of the scarce maltha connecting the shells of the Globigerina ooze and groups of branched canals (fig. 7C). These canals have thin structureless walls, and their diameter varies greatly; the smallest branches seem to proceed from the porous thin dermal membrane and are colourless; the canals of medium size bear sand in their walls and exhibit roundish dilatations, which seem to be the remnants of the flagellated chambers. The large canals, which open on the surface by the oscula above mentioned, are easily visible, since their thin wall is impregnated with black pigment-spots; the black oscula have a diameter of 0·4 to 0·6 mm.

Holopsamma argillaceum, n. sp. (Pl. VII. figs. 6A, 6B).

Habitat.—South Pacific, Station 294; November 3, 1875; lat. 39° 22′ S., long. 98° 46′ W.; depth, 2270 fathoms; bottom, red clay.

Sponge massive, lumpy, forming irregular roundish or bulbous masses, composed almost entirely of mineral particles characteristic of the red clay, and cemented

together by a scarce maltha. The porous surface bears conical elevations, and on the top of each cone opens a large osculum.

Holopsamma argillaceum is represented in the Challenger collection by a single small specimen, in the form of an irregular, roundish, tuberose lump, the diameter of which is between 12 and 22 mm. The dry sponge is like a piece of red clay, quite hard and solid, of a reddish grey or light red colour, but it is porous, and transverse sections show the branched canals, proving its sponge-nature (fig. 6B). The smallest inhalent canals open everywhere on the surface by the usual dermal pores; the larger confluent canals open into a few main branches, and each of these opens on the top of a conical protuberance by a large osculum (fig. 6B, *o*). Attempting to isolate the canals from the massive pseudo-skeleton, I was able to discover a few roundish sacs in the course of the smaller canals, apparently the remnants of flagellated chambers. A closer examination of the canal-system, however, was not possible. The fine argillaceous matter, which forms the main-mass of the sponge, is composed of the numerous mineral particles characteristic of the red clay, such as would be produced by the decomposition of felspathic minerals, pumice, and other volcanic products; intermingled are siliceous spicules of different sponges, and their fragments; all these xenophya are cemented together by a small quantity of clear maltha. No Spongo-xeniæ were found in this species.

Genus 6. *Psammopemma*,[1] Marshall (1880).

Definition.—Psamminidæ with an irregular massive or lumpy body, the surface of which is pierced everywhere by small dermal pores, but showing no larger openings or oscula.

The genus *Psammopemma* was founded by Marshall in 1880 upon some Australian sponges preserved in the Museum of Jena. He characterised it by the complete absence of spongin-fibres, the crusty, lumpy, or cake-shaped body being supported by sand or other foreign bodies, connected only by a small quantity of protoplasm. The sandy body is traversed by very narrow branched canals, which exhibit no distinct oscula or larger exhalent openings. This latter character mainly distinguishes *Psammopemma* from *Psammina* and from *Holopsamma*; both these genera possess distinct oscula, as the opening of wide exhalent main canals. The two species of *Psammopemma*, which Poléjaeff describes in his Report on the Keratosa,[2] and which were collected by the Challenger in shallow water, seem to belong to *Cerelasma* (*cf.* below). The author says that "the secretion of the horny substance has been reduced to the formation of

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[1] *Psammopemma* = Sandy cake, ψάμμα, πέμμα.
[2] *Loc. cit.*, p. 45.

only a thin envelope around the enclosed foreign bodies." I was not able to discover any trace of true spongin in the different species of *Psammopemma* now described.

This genus seems to be widely distributed in the deep sea, but has been overlooked hitherto, owing to its insignificant shape and usually small size. I have found small fragments belonging to *Psammopemma* in several soundings; they are like irregular lumps or crusts, composed of the sediment covering the sea-bottom. But a closer examination informs us that the apparent sandy concrement is traversed by a branched canal-system, in the course of which are interpolated numerous flagellated chambers.

Psammopemma radiolarium, n. sp. (Pl. VII. figs. 4A, 4B).

Habitat.—Tropical Pacific, Station 272; September 8, 1875; lat. 3° 48′ S., long. 152° 56′ W.; depth, 2600 fathoms; bottom, Radiolarian ooze.

Sponge lumpy, forming irregular, roundish, clavate or turbinate masses, which are composed almost entirely of siliceous Radiolarian tests, cemented together by a scarce maltha. No symbiotic Spongoxenia.

Psammopemma radiolarium, in the characteristic turbinate form, which is represented in Pl. VII. fig. 4A from the side, fig. 4B from below, was found at Station 272; similar specimens occur also in the soundings of Stations 270, 271, and 274, usually in the form of irregular, roundish or cake-shaped, massive lumps, which at first sight were regarded as mere inorganic concrements of Radiolarian ooze. A closer examination, however, principally by means of different sections stained by carmine, informed me that the whole sandy mass of these apparently homogeneous lumps is traversed by an irregularly branched canal-system, opening on the surface by innumerable fine pores. No flagello-chambers nor oscula were visible, but comparison with the similar lumps of the following species makes it very probable that it belongs to this genus. The porous lumps had partly the form of a flat cake or a subglobose mass, partly of a pedunculate club or an inverted cone, sometimes like a peg-top. The diameter of the dry lumps is from 5 to 20 mm. The consistence is that of a soft sandstone or of a friable marl, the colour light grey or whitish. The xenophya of this species are exclusively Radiolarian tests, cemented together by a very scanty maltha; sometimes a few fragments of siliceous sponge spicules are intermingled.

Psammopemma calcareum, n. sp. (Pl. VII. fig. 5).

Habitat.—Tropical Atlantic, between the Canary and Cape Verde Islands, Station 89; July 23, 1873; lat. 22° 18′ N., long. 22° 2′ W.; depth, 2400 fathoms; bottom, Globigerina ooze.

Sponge massive, lumpy, forming irregular, roundish, club-shaped or turbinate masses, which are composed almost entirely of calcareous *Globigerina* shells, cemented together by a scarce maltha. No symbiotic Spongoxenia.

Psammopemma calcareum sometimes assumes, like the preceding species, the characteristic subregular turbinate form, which is figured in Pl. VII. fig. 5, taken from Station 89 ; the same form has been described in *Holopsamma turbo* by Carter in 1885,[1] but the central depression of the summit of the funnel-shaped body has not the large vent or osculum in its centre, as described in the latter species. The whole surface is coarsely porous, pierced by innumerable smaller and larger pores, but no distinct oscula are visible ; they are absent also in the typical species of the genus first described by Marshall. The dry body of our *Psammopemma calcareum* is white, hard, chalk-like, friable, composed almost entirely of smaller and larger *Globigerina* shells, which are cemented together by a scanty clear maltha. After dissolving the calcareous matter in hydro-chloric acid, there remains a small residuum, composed mainly of branched canals, similar to those of *Holopsamma cretaceum* (Pl. VII. fig. 7C). The *membrana propria* of the canal-wall is reinforced by small xenophya (sand-grains). The diameter of the specimen figured is between 20 and 25 mm.

Similar pieces of a chalk-like *Psammina* of the same composition occur also at other Challenger stations, where the bottom of the sea is covered with Globigerina ooze, but they have not that regular turbinate form, seen only in the single specimen figured from Station 89. The pieces, which were occasionally observed in the Globigerina ooze of Stations 220, 270, &c., were for the most part roundish or club-shaped, 2 to 8 mm., rarely 12 to 20 mm., in diameter.

<div align="center">

Family III. SPONGELIDÆ, Lendenfeld (Pls. IV.–VI.).

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Definition.—Keratosa with a reticular horny skeleton, composed of anastomosing spongin-fibres, which enclose xenophya (or manifold foreign bodies). Maltha transparent, not granular, also often supported by xenophya. Canal-system vesicular, developed on the Leuconal-type (similar to *Spongelia*).

The family Spongelidæ (Lendenfeld) or Dysideidæ (Marshall) comprises those Keratosa which produce a network of anastomosing homogenous spongin-fibres and possess a clear maltha, or a transparent, not granular, ground-mass of the mesoderm. They differ in this latter character from the closely-allied Euspongidæ (the Spongidæ of Vosmaer), which all possess a granular maltha (like the Aplysinidæ). Most of the Spongelidæ—especially all the deep-sea forms—are arenaceous sponges or " Psammo-spongiæ," and possess a pseudo-skeleton composed of manifold xenophya or foreign bodies (sand-grains, calcareous shells of Foraminifera, siliceous shells of Radiolaria and Diatoms,

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[1] *Loc. cit.*, p. 213.

spicules of various sponges, &c.). These are disposed in the horny fibres of the skeleton, but sometimes also in the clear maltha or the ground-mass of the mesoderm. Sometimes the spongin is developed very scantily, and forms only thin sheaths, partially covering the xenophya connected by it, or saccular envelopes around them.

The external form in the Spongelidæ is very variable, as also in the Euspongidæ. The canal-system is formed on the Leuconal-type (the third type of Vosmaer), with roundish or oblongish flagellated chambers of variable size, usually rather large, but sometimes very small. It is impossible to retain the relative size of the flagello-chambers as the essential difference between the Spongelidæ and Euspongidæ. Among the Deep-sea Keratosa collected by the Challenger, there are five distinct species belonging to the Spongelidæ. They represent two different new genera, both of special interest. Their peculiar organisation is probably due (to a certain extent at least) to the symbiosis with a Hydroid, the reticular hydrorhiza of which traverses the whole body of these sponges.

The first genus, *Cerelasma* (Pl. VI.), is distinguished from all other Spongelidæ (and probably from all other Keratosa hitherto described) by the peculiar mode of the spongin-secretion. The yellow horny substance of the skeleton forms in the two species of this genus not a framework of anastomosing cylindrical fibres, as usual, but saccular envelopes around the innumerable xenophya which compose the pseudo-skeleton ; these are connected by irregular branched lamellæ, which are expanded in the meshes between the branches of the symbiotic hydrorhiza. The sponge itself represents in the two species of *Cerelasma* a globular or tuberose body composed of numerous anastomosing branches, which are either lamellar or cylindrical.

The second genus, *Psammophyllum* (Pls. IV., V.), is represented by three species, which are very similar in external shape to the Stannomid genus *Stannophyllum* (Pls. I., II.). The body is invariably a pedunculated flabelliform leaf. Its spongy substance is supported by the reticular hydrorhiza of a symbiotic Hydroid, and overladen with xenophya. But the essential difference between the two similar genera is, that the simple (rarely branched) spongin-fibrillæ of *Stannophyllum* do not anastomose, form no network, and do not include the xenophya. In *Psammophyllum*, however, as in all true Spongelidæ, the anastomosing spongin-fibres form a network, and include (partially or totally) the foreign bodies of the pseudo-skeleton.

Psammophyllum is closely allied to that remarkable Spongelid described by Esper as *Spongia papyracea*,[1] by Ehlers[2] and Hyatt[3] as *Phyllospongia papyracea*. But if the description of this latter be correct, it differs from *Psammophyllum* in two essential points. The two sides of the flabelliform leaf are the same in *Psammophyllum*, whereas in *Phyllospongia* the upper and lower sides have a very different structure. In the

[1] Esper, Spongien, Forts., Bd. ii. p. 38, Taf. lxv.
[2] Ehlers, Die Esperschen Spongien, pp. 22, 30, 1870.
[3] Hyatt, Revision North Amer. Porif., part ii. p. 73, pl. xvii. fig. 31, 1876.

horny skeleton of the former there is not that distinction between stout primary and delicate secondary fibres as in that of the latter. But one may suppose that the stout spongin-fibres of *Phyllospongia* forming its supporting scaffold have been lost in *Psammophyllum* and replaced by the chitinous tubes of the symbiotic hydrorhiza.

Skeleton.—The marked peculiarity of the five deep-sea Spongelidæ here described, and the principal distinction between them and the well-known Spongelidæ of shallow water, is the complete absence of stout spongin-fibres, forming the firm scaffold of the spongin-skeleton. As already mentioned, these seem to be replaced by the chitinous tubes of the reticular hydrorhiza, produced by the symbiotic Hydroids which traverse the whole body of these curious sponges. The production of the spongin-skeleton, however, is reduced to the scanty and thin fibrillæ or lamellæ which partly enclose the xenophya, partly connect them.

Xenophya.—The foreign enclosures, which fill up the scanty transparent maltha of *Cerelasma* (Pl. VI.) and of *Psammophyllum* (Pls. IV., V.), and which are partly enclosed by the lamellar or fibrous spongin productions, are in three of the five species observed Radiolarian tests, in the other two siliceous sponge spicules intermingled with volcanic mineral particles. The calcareous Globigerina ooze, which composes the pseudo-skeleton in most of the Psamminidæ and Stannomidæ, is rare or entirely absent in these deep-sea Spongelidæ, though the bottom at one Station (216) is true Globigerina ooze. The manner in which the xenophya are collected and disposed seems to prove that in these Spongelidæ (as in the Stannomidæ) there is a power of selection of materials for the construction of the pseudo-skeleton. The scarce transparent maltha, or the ground-mass of the mesoderm, which surrounds and connects the xenophya, contains two kinds of cells: small stellate, fusiform or roundish connective cells, and amœboid wandering cells; the latter probably produce the spongin-skeleton.

Symbiontes.—The firm scaffold of the body in all the deep-sea Spongelidæ is formed not by a network of stout spongin-fibres, as in all the shallow-water inhabitants of this family, but instead by a network of chitinous tubes, which belong to the hydrorhiza of a symbiotic Hydroid. This foreign network traverses all parts of the sponges so densely and continuously (as well in *Cerelasma*, Pl. VI. figs. 2–4, as in *Psammophyllum*, Pls. IV., V.), that in the preliminary examination I was inclined to regard it as an organ-system of the sponge itself, comparing it with the skeletal network of the Aplysinidæ, the branches of which are thin-walled spongin-tubules filled up with a dark medullar mass or pith-substance. But this first supposition was afterwards refuted by the discovery of hydranths, and in some places even of gonangia, being in direct continuity with the chitinous tubes of the network, and filled by the same dark (brown, greenish, or blackish) cellular mass. This mass is evidently the decomposed cœnosarc, the cells of which (entodermal and exodermal) could not be well preserved within the containing dense and decomposing sponge-tissue. The symbiotic

Hydroids belong partly to the Campanulariæ (*Halisiphonia*, Pl. IV. fig. 9), partly to the Tubulariæ (*Stylactella*, Pl. II. figs. 6, 7), partly to a larger Hydroid with annulated tubes, the true position of which I could not make out (*Eudendrium?*, Pl. IV. fig. 4).

Eggs and Larvæ.—Amœboid eggs, with a large clear germinal vesicle and a dark germinal spot (Pl. V. fig. 5, *e*), partly in segmentation, were found scattered in the mesoderm of *Psammophyllum flustraceum* (Pl. IV. fig. 5). The same specimen contained larger dark ovate bodies composed of granular cells, which probably were decomposed or badly-preserved gastrula larvæ, similar in size and form to those of other Spongelidæ.

<p style="text-align:center">Genus 7. Cerelasma, n. gen.[1]</p>

Definition.—Spongelidæ with reticular spherical or tuberose body, composed of numerous anastomosing branches, each branch supported by a peculiar reticular framework of thin spongin-lamellæ. These, as well as the maltha, enclose numerous xenophya, which are usually enveloped by a spongin-sac.

The genus *Cerelasma* differs from all the Keratosa hitherto described in the peculiar shape of the Keratose skeleton, which is not composed of cylindrical or roundish fibres, but of flat and thin horny lamellæ. These are branched, and the branches unite and form a framework in the most irregular manner. The xenophya possess usually also a saccular envelope of spongin, and are partly enclosed in the maltha, partly in the lamellæ of the framework. This is expanded between the tubular branches of a reticular dark coloured symbion, probably in all cases the hydrorhiza of a symbiotic Hydroid (*Stylactis* or another Spongoxenia).

The peculiar structure of *Cerelasma* may be best understood anatomically, if we compare it with that of a human liver. The reticular system of the hepatic blood-vessels corresponds to that of the symbiotic Spongoxenia, the system of the biliferous canals to that of the canal-system proper of the sponge, the reticular framework of the hepatic glandular cells to that of the maltha full of xenophya, and the supporting framework of the hepatic connective tissue is comparable to that of the Keratose skeletal lamellæ. As in the case of the complex liver structure, the knowledge of the structure of *Cerelasma* is only possible by means of sections through different planes. But the great mass of foreign mineral bodies and siliceous particles crowded in the maltha makes it very difficult to recognise the true structure of this remarkable Spongelid.

The main mass of the body in *Cerelasma* is not formed by the horny framework of the true skeleton, but by the xenophya, which are surrounded by thin horny envelopes, and partly enclosed by the lamellæ. These xenophya or foreign enclosures, which compose the pseudo-skeleton, are in *Cerelasma gyrosphæra* (from Station 271) almost

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[1] *Cerelasma*=Horny plate, κέρα, ἔλασμα.

exclusively Radiolarian tests ; in *Cerelasma lamellosa* (from Station 216A) partly *Globigerina* shells and their fragments, partly siliceous spicules of sponges and mineral particles. The majority of the xenophya have a peculiar horny envelope, a thin-walled yellow or brown sacculus of spongin. Some of the xenophya (probably those which were most recently incorporated) lie immediately in the transparent maltha, and possess no spongin-envelope. It seems as though the thickness of the sacculi increased with age. The spongin-sacculi are so connected with the branched lamellæ of the skeleton that these latter may be regarded as connecting bands between the former.

The canal-system of *Cerelasma* seems to be similar to that of *Spongelia*, with large flagello-chambers ; in the two deep-sea species, however, which I have examined, it was not sufficiently well preserved. In the preliminary examination I was inclined to regard as peculiar canals of the sponge the reticulated canal-system, filled with dark phæodia-like masses, which I afterwards recognised as the hydrorhiza of a symbiotic Hydroid (*Stylactis* or a similar Spongoxenia). The strong chitinous tubes of this latter in *Cerelasma* seem to replace the main spongin-fibres of *Spongelia*.

Probably to this genus belongs also the Keratose sponge which Poléjaeff has described as *Psammopemma porosum* in his Report on the Keratosa (p. 48). He says that the foreign enclosures of this species possess a thick envelope of horny substance, " occasionally with very conspicuous outgrowths" (p. 49). The true *Psammopemma* forms no spongin at all.

Cerelasma gyrosphæra, n. sp. (Pl. VI. figs. 1–5).

Habitat.—Tropical Pacific, Station 271 ; September 6, 1875 ; lat. 0° 33′ S., long. 151° 34′ W.; depth, 2425 fathoms ; bottom, Globigerina ooze, containing a good many well-preserved Radiolarian shells.

Sponge a globular framework, with mæandric surface, composed of numerous cylindrical, anastomosing, convoluted branches. No distinct dermal membrane. Pseudo-skeleton composed almost exclusively of Radiolarian tests.

Exterior.—The body of the single well-preserved specimen is nearly spherical, slightly flattened on the basal side, where it has been attached. The diameter of the globe is between 60 and 70 mm., 66 on an average. The whole surface is similar to that of a gyrencephalon mammalian cerebrum, numerous curved gyri, and between them deep sulci, being turned in all directions. Closer examination shows that this aspect is produced by numerous cylindrical branches, which form a reticular framework by frequent anastomoses. The length of most of the branches is between 6 and 9 mm., the thickness 3 to 4 mm. The sponge, as preserved in spirit, is rather soft and fragile ; when dry it is rather hard. The colour is dark brown. The surface of the sponge is rough

and coarsely porous. No distinct dermal membrane is present, whereas in the following species this is easily detached from the softer medulla.

Interior.—The structure seems to be the same in all parts of the sponge. Its main mass is composed of foreign enclosures, viz., the hydrorhiza of a symbiotic Hydroid, and innumerable siliceous shells of Radiolaria, which are embedded as well in the transparent maltha as in the Keratose lamellæ. The latter are expanded in the most irregular manner between the chitinous tubes of the symbiotic Spongoxenia. Between the latter and the former are visible remnants of the canal-system of the sponge, apparently with irregularly-disposed, large, flagellated chambers. The bad state of preservation of the soft tissues, however, did not allow me to form a decided opinion on this difficult subject. (Compare figs. 2–5 and their explanation.)

Spongin-Skeleton.—The true horny skeleton secreted by the sponge itself is composed of two different portions, viz., firstly, the saccular spongin-envelopes which surround the single xenophya, and secondly, the branched lamellæ which connect the former and are expanded in the meshes between the chitinous tubes of the symbiotic hydrorhiza. The thickness of the yellow spongin-plate in the sacculi, as well as in the lamellæ, is very variable, and often much stronger in the nodal points of the network. In those places where the yellow spongin-lamellæ (fig. 3, f) are inserted into the outer wall of the similar yellow chitinous tubes of the hydrorhiza (fig. 3, h), there is often an appearance as if both these substances might pass directly one into the other; closer examination, however, proves that there is a distinct limit between them (fig. 4).

Xenophya.—The foreign bodies which compose the pseudo-skeleton of *Cerelasma gyrosphæra* are almost exclusively Radiolarian shells, in the astonishing variety and richness which characterises the Radiolarian ooze of Station 271. The majority of these siliceous shells are enclosed by a thinner or thicker envelope of yellow spongin-substance, either an isolated sacculus, or an inflated portion of a lamella (fig. 5, f); but there are other xenophya (probably taken up recently) which lie immediately in the clear maltha, without a spongin-envelope.

Symbiontes.—The network of anastomosing cylindrical chitinous tubes, filled by a dark brown cellular mass (figs. 2, 3, h), everywhere traverses the body of this sponge so densely, that it occupies perhaps one-third or one-fourth of its volume. In the preliminary examination I was inclined to regard these tubes either as hollow spongin-tubes (similar to those in *Aplysina*) or as peculiar canals of the sponge, but afterwards I was convinced that they belonged to the hydrorhiza of a symbiotic Hydroid, probably *Stylactella*. In some places their epithelium was preserved (fig. 4, h).

Cerelasma lamellosa, n. sp. (Pl. VI. figs. 6, 7).

Habitat.—Tropical Pacific, Station 216A; February 16, 1875; lat. 2° 56′ N., long. 134° 11′ E.; depth, 2000 fathoms; bottom, Globigerina ooze.

Sponge an irregular tuberose on subglobose framework, composed of anastomosing lamellar branches. These are covered by a silvery dermal membrane, easily detached from the spongy medullar mass. Pseudo-skeleton composed of different xenophya, principally sponge spicules, *Globigerina* shells, and mineral particles.

Cerelasma lamellosa is represented in the Challenger collection by two tolerably well-preserved specimens, the smaller subglobose, 7 to 9 mm. in diameter, the larger more irregular, tuberose, 16 to 20 mm. in diameter. The coarser and finer structures are the same in both. The body appears to the naked eye as a rather massive framework, composed of irregular lamellar branches, the thickness of which is 1 mm. on an average (the thickest branches 1·5 to 2 mm., the thinner only 0·6 to 0·8 mm.). The lamellar branches are so united as to form an irregular network of inter-canals or of anastomosing tubes, which are invested by the silvery dermal membrane. These curved inter-canals are for the most part cylindrical, with a diameter of 1 to 2 mm., rarely more.

The dry sponge is not elastic, rather firm, but friable. The whole surface and all the inter-canals are silvery, covered by the whitish cortex or dermal membrane, whilst the transverse section of the medullar mass of the lamellar branches is brown, partly yellowish, partly blackish, densely porous (fig. 6). After treatment with carmine the cortex becomes rose, the medulla blackish purple.

Dermal Membrane.—The thin silvery dermal membrane, which covers the whole surface of the anastomosing branches, and also lines all the cavities between them, may be easily detached from the soft brown medullar mass. Its white opaque appearance is produced partly by *Globigerina* shells and their fragments, partly by other xenophya taken from the surrounding ooze, partly by very small roundish mineral particles, which are not soluble in mineral acids. The whole dermal membrane is densely pierced by circular pores, which are very distinct in this species. Between the pores of the sponge are visible larger scattered openings, the external mouths of the tubes of the symbiotic Hydroid.

Medullar Substance.—The brown main mass of the sponge or the porous medullar substance, which remains after the detachment of the white cortex, is composed of the transparent maltha and of a dense network or framework of anastomosing horny lamellæ, both overladen with xenophya, and further of a loose network of the symbiotic Spongoxenia. The structure of the narrow irregular canal-system, and especially the shape of the flagellated chambers, could not be made out in a satisfactory manner, but it seems to be similar to that of *Spongelia*.

Spongin-Skeleton.—The horny lamellæ of the true skeleton are in general thin and broad, of a yellow colour, very irregularly branched, varying greatly in thickness and breadth. They pass over immediately into the horny substance of the saccular envelopes which surround many xenophya. The lamellar branches are everywhere connected by anastomoses, and form a dense framework, the meshes of which are filled up partly by

the canal-system and the maltha, partly by the network of the symbiotic Spongoxenia. The horny lamellæ are partly tubular, partly expanded in the form of thin Keratose membranes. They are overladen with xenophya, in the same way as the granular maltha (fig. 7). There are besides a great number of roundish black-brown pigment-cells scattered in the maltha, so that its structure is difficult to make out.

Xenophya.—The majority of the foreign bodies in the maltha as well as in the Keratose lamellæ are broken siliceous spicules of different sponges; between them are scattered many fragments of *Globigerina* shells and mineral particles, more rarely single tests of Radiolaria. Many xenophya possess peculiar yellow envelopes of spongin, whilst others lie immediately in the transparent maltha (fig. 7).

Symbiontes.—The tubular network of Spongoxenia is very differently developed in the two specimens examined, in one very rich, in the other rather scarce. The anastomosing chitinous tubes are of the same shape as in *Stannophyllum*, and belong probably to *Stylactella;* they are filled with dark cellular detritus.

Genus 8. *Psammophyllum*,[1] n. gen.

Definition.—Spongelidæ with foliaceous or flabellate body, supported by a network of homogeneous spongin-fibres of nearly equal thickness, which enclose manifold xenophya. Maltha clear, also often filled by xenophya.

The genus *Psammophyllum*, represented in the Challenger collection by three deep-sea species, is in the external foliaceous form very similar to the Stannomid *Stannophyllum;* in internal structure it is closely allied to the typical *Spongelia* or *Dysidea.* It differs from this latter in the flat leaf-like form of the body, which seems to be partly produced by the flabelliform growth of the symbiotic Hydroids (*Stylactella, Halisiphonia,* &c.) (*cf.* below). On the other hand, *Psammophyllum* seems to be nearly allied to *Phyllospongia papyracea,* Ehlers; from this, however, it differs essentially in the absence of main-fibres and the structure of the skeleton (*cf.* above, p. 43).

The three species of *Psammophyllum*, which are described in the following pages, were taken in the Tropical and Northern Pacific (from depths between 2100 and 2900 fathoms), and are of special importance ; they are very similar in external shape, but rather different in internal structure. *Psammophyllum annectens* (Pl. IV. figs. 1–4) is very similar to *Stannophyllum zonarium,* and has similar thin spongin-fibrillæ, but they exhibit frequent ramifications and anastomoses, and begin to enclose xenophya. *Psammophyllum flustraceum* (Pl. IV. figs. 5–9) is distinguished by much coarser spongin-fibres, of very unequal thickness, many enclosing xenophya, as in *Spongelia.* It approaches more to *Psammophyllum reticulatum,* in which the horny network is composed of scanty fine

[1] *Psammophyllum* = Sandy leaf, ψάμμα, φύλλον.

fibres, which partly connect, partly include, the xenophya. These foreign bodies are in the latter species principally siliceous spicules of different sponges; in the first species principally Radiolarian tests, and in the second species both these forms of xenophya are found. The chitinous tubes of the hydrorhiza of the symbiotic Hydroids replace in all the three species the stout main fibres which are characteristic of *Spongelia*.

Psammophyllum reticulatum, n. sp. (Pl. V. figs. 1–4).

Habitat.—Tropical Pacific, Station 198; October 20, 1874; lat. 2° 55′ N., long. 124° 53′ E.; depth, 2150 fathoms; bottom, blue mud.

Sponge foliaceous, reniform, pedunculate, very thin, felty, with undulate distal margin. Surface reticulate, without concentric zones. Framework of the spongin-fibres very scanty and loose, mainly composed of very thin and solid anastomosing fibres, which connect siliceous spicules of different sponges and other xenophya. The same foreign spicules also fill up the maltha.

Psammophyllum reticulatum has the shape of a broad reniform leaf, which attains, in the largest specimen preserved, a height of 50 to 60 mm. and a breadth of 80 to 90 mm. or more. The majority of the specimens preserved are about half that size or less; there are a few small leaves in the collection, which are only 3 to 4 mm. in height and 5 to 6 mm. in breadth, but the form and structure is the same as in the largest leaves. The thickness of the leaf is between 1 and 5 mm., usually 2 or 3 mm., and nearly equal throughout the whole extent, but several leaves are thinner in the middle part (only 0·4 to 0·5 mm.) and thicker on the club-shaped base of the pedicle (7 or 8 mm.). The pedicle is cylindrical, usually about half as long as the leaf itself, gradually broadening toward both ends; the basal end is thickened and expanded into an irregular foot-plate for attachment.

The colour of the leaves is brown, the consistence very soft and fragile, little elastic. The entire surface is felty or woolly, and the aspect of the body at first sight is that of a thin felt-sole or hair-sole. It is very loose in texture and easily torn to pieces. The woolly aspect and the felty consistence of the surface is produced by the numerous large spicules of siliceous sponges everywhere prominent and matted together.

Symbiontes.—The characteristic reniform leaf-shape of the sponge is evidently produced by the dense network of the symbiotic Hydropolyp (Spongoxenia), which is growing in a vertical plane, like a *Rhipidogorgia*. The sponge itself is only a thin woolly mantle, which covers both sides of the foliaceous polyp-corm and fills up the meshes of its loose network. The chitinous tubes of this latter are cylindrical, often varicose, 0·1 to 0·2 mm. broad; the meshes between them are 1 to 3 mm. in diameter. The tubes are irregularly curved, broadened on the nodal points of the network, and

contain the usual brown phæodia-like contents, which fill up the hydrorhiza of the symbiotic Tubularian (probably *Stylactis* or *Stylactella*, figs. 2, 3, *h*). I was, however, not able to observe anywhere the hydranths or the gonophores of the Hydroid, which might be due to the bad state of preservation.

Xenophya.—The foreign bodies which compose the pseudo-skeleton of this species are almost exclusively various siliceous spicules of sponges, belonging to very different genera of Hexactinellida, Tetractinellida, and Monaxonida; the quality and quantity of different forms is very variable, according to the accidental composition of the ground on which the sponge grows. The majority of the xenophya, and especially the larger spicules, are not completely enclosed by the horny fibres, but only partially on the ends.

Horny Skeleton (figs. 2–4, *f*).—The entire body of the foliaceous sponge is supported and traversed by a very fine framework, composed of anastomosing horny fibres produced by the sponge itself. Examined by a weak lens, this delicate network fills up all the meshes of the coarser network of the polyp-corm (fig. 1). The yellow horny fibres are of the usual Keratose structure, the broader with a distinct axial filament. The majority of the fibres are 0·004 to 0·006 mm. broad, many finer, only 0·001 mm. or less; rarely there are larger fibres, 0·01 to 0·012 mm. in diameter, or even more. The stellate nodal points of the Keratose network are 0·02 to 0·04 in diameter.

Psammophyllum flustraceum, n. sp. (Pl. IV. figs. 5–8; Pl. V. fig. 5).

Habitat.—North Pacific, Station 241; June 23, 1875; lat. 35° 41′ N., long. 157° 42′ E.; depth, 2300 fathoms; bottom, red clay.

Sponge foliaceous, reniform, pedunculate, rather thick and soft, with lobulate distal margin. Surface with branched ribs in the proximal part, with concentric zones in the distal part. Framework of the spongin-fibres very dense and irregular, composed of branched and anastomosing fibres of unequal thickness; these include numerous siliceous spicules of sponges, Radiolarian tests and other xenophya, which also fill up the maltha.

Psammophyllum flustraceum is of special interest as a connecting link between the preceding and the following species. The single specimen observed (figured in Pl. IV. fig. 5, natural size) is a broad flabelliform leaf, similar to *Stannophyllum venosum* (Pl. I. fig. 4). Its breadth is 105 mm., its height (without pedicle) 70 mm.; the slender pedicle, which arises from the centre of the concave proximal margin, is inversely conical, 33 mm. long, 16 mm. broad at the distal insertion. The convex distal margin of the leaf is lobulate, with twelve to fifteen large lobes, each of which is again divided into two to four smaller lobules.

The surface of the reniform leaf is felty, of a brown colour. The proximal part is traversed by branched radiating ribs, which diverge from the attachment of the pedicle,

similarly as in *Stannophyllum venosum* (Pl. I. fig. 4). The ribs are lighter in colour, grey or whitish; they disappear in the distal part of the leaf, which exhibits distinct concentric zones of nearly equal breadth (3 to 4 mm.). The zones are more prominent than in the following species, and more thickened in the proximal part, so that the vertical section is cuneiform (Pl. IV. figs. 7, 8). Each zone therefore covers with its thickened proximal edge the thinner distal part of the neighbouring proximal zone; the thickened edge exhibits an irregular row of large openings, probably the oscula (fig. 7, *o*), whilst the felty dermal membrane of the surface is pierced by the smaller dermal pores (fig. 7, *p*). The outermost distal zones exhibit oscula also on the two faces (fig. 8, *o*). Scattered in some parts of the mesoderm were found amœboid egg-cells, similar to those of other Keratosa (Pl. V. fig. 5, *e*).

Symbiontes.—The spongy parenchyma between the two parallel dermal plates is traversed by numerous anastomosing cylindrical tubes, which form a rather dense network. These chitinous tubes belong to the hydrorhiza of a symbiotic Hydroid, *Halisiphonia spongicola* (Pl. IV. fig. 9). After long continued researches, I was successful in finding in some portions of the sponge the club-shaped gonangia (fig. 9, *g*) as well as the urn-shaped hydrothecæ (fig. 9, *p*) of the symbiotic Spongoxenia. The cellular contents of the chitinous tubes were rarely distinct (Pl. V., fig. 5, *h*); usually they were destroyed, their remains forming a dark granular mass of an olive or brown colour.

Xenophya.—The foreign bodies which compose the pseudo-skeleton in this species are more varied than in the preceding and following species. Siliceous spicules of sponges, tests of Radiolaria, and various mineral particles characteristic of the red clay, occur intermingled. They are partly crowded in the clear maltha, partly enclosed by the meshes of the network of the spongin-fibrillæ (Pl. IV. fig. 6, *r*), and the smaller xenophya are enclosed in the horny fibres, as in *Spongelia*.

Horny Skeleton.—The spongin-fibres in this species are more developed than in any other Deep-sea Keratosa here described. They form a dense irregular network, exhibit numerous ramifications and anastomoses, and are of very unequal thickness (Pl. IV. fig. 6, *f*). The thinner fibrillæ (0·001 to 0·01 mm. in diameter) are equal to those of *Stannophyllum*, whilst the thickest fibres (0·02 to 0·06 mm.) approach those of *Spongelia*. The axial thread is very distinct.

Psammophyllum annectens, n. sp. (Pl. IV. figs. 1–4).

Habitat.—North Pacific, Station 244; June 28, 1875; lat. 35° 22′ N., long. 169° 53′ E.; depth, 2900 fathoms; bottom, red clay.

Sponge foliaceous, reniform, pedunculate, rather compact and elastic. Surface with concentric zones of equal breadth. Framework of spongin-fibres very irregular,

rather dense, composed of branched fibres of nearly equal thickness; the majority of
the fibres without xenophya; the thickest fibres enclose remains of Radiolaria, which also
fill up the maltha.

Psammophyllum annectens has the same external appearance as *Stannophyllum
zonarium* (Pl. I. fig. 1); it is a broad reniform leaf, soft and thin, of a brown colour
with concentric zones on the surface. The height of the leaf (without pedicle) is usually
25 to 30 mm., breadth 35 to 40 mm., thickness 1 to 3 mm. The largest specimen,
however (figured in Pl. IV. fig. 1), is 75 mm. broad, 55 mm. high, without the pedicle
(10 mm.). The concentric zones or bands of both surfaces, which run parallel to the
semicircular margin, have the same breadth as in the similar *Stannophyllum zonarium*,
3 to 4 mm.; they are separated by superficial furrows, somewhat thicker on the proximal
than on the distal margin. The dried body is very soft and flexible, of felty appearance.
The inferior edge of the kidney-shaped leaf is more or less concave (in a smaller specimen
scarcely emarginated), and from its centre starts a short conical pedicle, with a small
basal plate for attachment.

Canal-System.—The entire surface of the sponge on both sides of the leaf is covered
by a rather firm dermal membrane, and this is pierced by small inhalent pores; between
them are scattered at irregular distances larger openings (two or three times the diameter
of the inhalent pores), probably the exhalent oscula; these occur mainly on the proximal
margin of the concentric zones, which is somewhat thickened. The large subdermal
cavities, which occur in the similar *Stannophyllum*, are absent in this species.

Symbiontes.—The whole spongy parenchyma of the leaf between the two dermal
plates is traversed by a network of cylindrical anastomosing tubes, the hydrorhiza of a
symbiotic Hydroid (Spongoxenia). Perhaps this is the same, *Stylactella abyssicola*, as
occurs in the similar *Stannophyllum*. I was able to find in one specimen the
hydranths and gonophores, which were not distinct in the latter (*cf.* Pl. II. fig. 7).

Xenophya.—The foreign bodies which compose the pseudo-skeleton in this species are
almost exclusively siliceous shells of numerous Radiolaria and their fragments, as in the
closely-allied species of *Stannophyllum* (*radiolarium* and *zonarium*). They fill up the
clear maltha of the mesoderm, and are connected, and partly enclosed, by the spongin-
fibrillæ (Pl. IV. figs. 2, 3, *f*).

Horny Skeleton.—The spongin-fibrillæ in this species are more like those of
Stannophyllum and those of the Stannomidæ in general than in any other Spongelidæ
hitherto known. They are very thin and of nearly equal breadth (0·003 to 0·006 mm.
on an average), but they differ from the simple fibrillæ of the Stannomidæ in the numer-
ous ramifications and anastomoses. The network thus formed includes the xenophya,
and the larger Radiolarian shells are surrounded by its meshes. Smaller shells and
fragments are also enclosed in the fibres, and they fill up the maltha between them
(Pl. IV. fig. 2, *r*). *Psammophyllum annectens*, therefore, is a true intermediate form

between *Stannophyllum* and the other species of *Psammophyllum*, which in structure approach more to *Spongelia*.

Family IV. STANNOMIDÆ, n. fam. (Pls. I.-III.).

Definition.—Keratosa with a fibrillar spongin-skeleton composed of thin, simple or branched, spongin-fibrillæ, never anastomosing or reticulated. Pseudo-skeleton composed of xenophya (or diverse foreign bodies), which are crowded in the transparent maltha, never in the homogeneous fibrillæ. Canal-system vesicular, developed on the Leuconal-type (similar to that of the Spongelidæ).

The new and most remarkable family Stannomidæ comprises those Keratosa hitherto unknown, which produce true horny fibrillæ in the mesoderm, and besides possess a pseudo-skeleton composed of various xenophya; but these foreign bodies are enclosed in the clear maltha or the ground-mass of the connective tissue, not in the spongin-fibres (as in the Spongelidæ). All Stannomidæ are inhabitants of the deep sea; they are very dissimilar in external form, while they all agree in internal structure. Three different types of external form may be distinguished, viz.—(1) *Stannophyllum*, with foliaceous or laminar flabellate body (Pls. I., II.); (2) *Stannarium*, with a branched body, composed of several free or coalescent foliaceous wings (Pl. III. figs. 6–14); and (3) *Stannoma*, with a branched arborescent or coralliform body, the branches of which are cylindrical, either free or connected by anastomoses (Pl. III. figs. 1–5). The size of these two latter Stannomidæ is usually between 30 and 60 mm., while the large flabelliform leafs of *Stannophyllum* reach a diameter of 100 to 200 mm. and more.

The Stannomidæ discovered by the Challenger have all been found in the central part of the Tropical Pacific, in depths between 2425 and 2925 fathoms. The majority of the specimens collected were taken at Station 271, in the equatorial central Pacific (depth, 2425 fathoms); some other forms were captured in the neighbouring Stations 270 and 272. The Stannomidæ are the most important and most interesting of all the Keratosa collected by the Challenger. Their structure is so strange and so peculiar that several distinguished spongiologists, to whom they were submitted for investigation, said they were not sponges. Some naturalists declared that they were gigantic Rhizopods. Nevertheless I am now quite convinced that they are true horny sponges; some new forms of *Psammophyllum* (Pls. IV., V.), which form an uninterrupted continuous series of modifications and connecting links between *Stannophyllum* and *Spongelia* (*Phyllospongia*), leave no room for doubt.

Unfortunately, the state of preservation of all the Stannomidæ collected, as well as of the peculiar Hydroida living in symbiosis with them, was very imperfect, and not sufficient for the examination of the finer structures. It is natural that " these delicate things, drawn up rapidly through the water from a depth of nearly four statute miles,

and transported into such totally different conditions of temperature, pressure, &c., suffer greatly from this violent change. They are, in fact, almost knocked to pieces, and their fine tissues are in a nearly deliquescent state." This is what Sir Wyville Thomson says, when speaking of the gigantic Hydroid *Monocaulus*, and the same may be said of the Stannomidæ and their delicate symbiotic Hydroids.[1]

Indeed it was quite impossible, in spite of all possible precautions and different methods of examination, to make out the anatomical structure of the canal-system of the Stannomidæ, and especially of the flagello-chambers. The dermal membrane, too, was more or less destroyed. It is very probable that they agree in these particulars with the closely-allied Spongelidæ, with which they are closely connected by intermediate forms (*Psammophyllum*). Nevertheless the composition of the well-preserved skeleton, and the relations with the symbiotic Hydroids, are so peculiar, that they are sufficient for the erection of a new family.

Skeleton.—Accepting the term "skeleton" in the usual physiological sense as the combination of all the solid parts of the body which serve as supporting and protecting organs, due to their hard and firm consistence, we may say that the skeleton of the Stannomidæ consists of three different parts, viz.—(1) the delicate spongin-fibrillæ produced by the sponge itself; (2) the xenophya, or the foreign enclosures (siliceous shells of Radiolaria, calcareous shells of Foraminifera, &c.), all received from the ooze of the sea-bottom; (3) the chitinous tubes of the hydrorhiza of the symbiotic Hydroids, which replace the absent stout spongin-fibres. The two latter elements, of course, represent a pseudo-skeleton composed of foreign enclosures, whilst the first alone is the true skeleton proper of the sponge. But the most curious fact is, that in all these Stannomidæ the main mass of the body consists of the pseudo-skeleton, and that the fibres of the spongin-skeleton form only a delicate connective tissue between the constituents of the pseudo-skeleton. The spongin-fibrillæ appear as a framework of fine elastic threads (f) strengthening the scanty maltha, which holds together all the different parts of the sponge. (Pl. II. figs. 1–3, m).

Maltha.—The ground-mass of the mesoderm, which we briefly call maltha (the mesoglœa, mesenchyma, collenchyma, intercellular substance, common ground-mass, &c., of other authors), is in all the Stannomidæ scanty, and appears as a soft (clear and transparent) structureless mass, cementing all the heterogeneous parts of the sponge and its foreign enclosures together. The maltha has the same characters as in the closely-allied Spongelidæ; it is clear and transparent, not granular, and contains two different kinds of connective cells—(1) malthar cells, the usual small cells of the connective tissue, roundish, spindle-shaped or stellate, with scanty protoplasm around the small nucleus; and (2) amœboid wandering cells, probably migrating slowly through the whole body and producing the fibrillæ (similar to the odontoblasts which produce the dentin-fibrillæ).

[1] Compare Zool. Chall. Exp., part lxx. p. 6.

Spongin-Fibrillæ.—The fibrillæ characteristic of the Stannomidæ are imbedded in the clear hyaline maltha or the connective ground-mass, and exhibit the same physical and chemical peculiarities as the well-known corneous fibres of the common Keratosa; they consist, therefore, of spongin (or spongiolin). Usually they are simple cylindrical filaments, rarely a little branched, never anastomosing or reticular. Their colour is yellow, sometimes light brownish (Pl. II. figs. 1–3, *f*; Pl. III. fig. 9).

Size of the Fibrillæ.—The fibrillæ are in general very long, but difficult to determine, since it is usually impossible to isolate them for their whole length; in some macerated specimens, however, I was able to separate fibrillæ 2 to 5 mm. in length, and in one case even a thread 11 mm. in length. I suppose that they often really attain a length of some centimetres or more; perhaps often (or even constantly?) a great part of the fibrillæ run uninterruptedly from the base of the sponge to its periphery. Their thickness is usually equal throughout their whole length, viz., 0·001 to 0·004 mm. on an average, but sometimes the thicker fibrillæ attain a diameter of 0·01 to 0·02 mm., whilst the thinnest threads are only 0·0001 to 0·0005, or even less. In the majority of the Stannomidæ the thickness of the fibrillæ varies very little, and is nearly constant in one and the same specimen.

Arrangement of the Fibrillæ.—The arrangement of the spongin-fibrillæ in the body of the Stannomidæ is rather variable, and seems to depend often upon the mode of growth and the development of the pseudo-skeleton and of the symbiotic Hydroids. Often all the fibrillæ run isolated, irregularly interwoven in all directions. But usually the fibrillæ are aggregated densely in bundles, connected by a minimum quantity of maltha. The smaller bundles are composed of four to eight, the larger of ten to twenty or more parallel fibrillæ. When the bundles branch, a part of the unbranched fibrillæ separates from the rest and passes into the branch, similar to the nervous primitive fibres in a branching nerve. The fibrillæ themselves do not usually branch, but in some of the Stannomidæ, and especially in those in which the pseudo-skeleton is composed of Globigerina ooze, the thicker fibrillæ branch frequently. The branches are sometimes of equal, at other times of unequal, thickness; they never anastomose in the true Stannomidæ. As soon as the neighbouring branched fibrillæ anastomose and form a network, the Stannomidæ pass over into Spongelidæ. So *Stannophyllum* (from Station 271) passes over into *Psammophyllum* (Stations 241 and 244).

Structure of the Fibrillæ.—The thinnest fibrillæ appear under the microscope, even with the highest powers, perfectly structureless; but in the thicker threads, mainly the thickest forms (0·01 to 0·02 mm. in diameter), may be clearly distinguished a central medullary substance or an axial thread and a peripheral cortical substance; the latter is usually also in the thickest threads much broader than the former, but in some of the Stannomidæ distinguished by rather thick fibrillæ the axial thread is twice as broad as the surrounding cortical tube. In some macerated specimens the axial canal

of the dry fibrillæ was filled with air. The difference between the thin axial thread and its thick spongin-envelope is the same as in the thinner forms of the so-called homogeneous horny fibres of the Euspongidæ, Spongelidæ, &c. On the other hand, they recall also the peculiar so-called "filaments" of the Hircinidæ, and this leads us to the question of the true nature of the fibrillæ.

Nature of the Fibrillæ.—The first question arising out of the examination of the peculiar fibrillæ of Stannomidæ, and also of the similar "filaments" of the Hircinidæ, is this: Are they produced by the sponge itself? or are they foreign organisms which live in the sponge as parasites or symbiontes? As is well known, this question is not yet decided in the case of the Hircinidæ. Poléjaeff, in his Report on the Keratosa,[1] discusses the nature and the systematic value of the filaments of the Hircinidæ, and the majority of modern spongiologists agree with him when he says that "their nature as independent organisms is clearly established." But of what nature are these "independent organisms?" No zoologist will accept them as animals, no protistologist can regard them as neutral protists, no botanist will acknowledge their vegetable nature! All botanists who have thoroughly examined the filaments of the Hircinidæ, and among these are some great authorities, mainly fungologists, declare decidedly that they are not fungi, and not plants at all. Indeed, neither their chemical nature nor their anatomical structure is that of any fungus or alga, and, although many observers have examined them for a long time and in all possible directions, no one has been able to discover their fructification and development.

Poléjaeff's principal argument in favour of the parasitical nature of the filaments found in the Hircinidæ is as follows :—" F. E. Schulze made out the structure of sponges characterised by the presence of filaments, and found that anatomically and histologically they do not differ from sponges which, like *Euspongia*, have never been found with filaments."[2] This argument, in my opinion, has no decisive value. If we apply it to the Chondrosidæ, we might arrive at the following conclusion :—" *Chondrilla*, characterised by the presence of sphero-stellate siliceous spicules, does not differ anatomically and histologically from *Chondrosia*, which has never been found with these spicules. Therefore these spicules are not produced by the sponge itself, but are independent organisms." On the other hand, the fact that the fibrillæ of the Hircinidæ are not in direct connection with the reticulate horny skeleton of these Keratosa has also no decisive value. For *Darwinella* possesses numerous radiate horny spicules imbedded in the mesoderm, without connection with the ramified tree of the Keratose skeleton ; so also have many Halichondrinæ siliceous "flesh-spicules" imbedded in the connective tissue, without connection with the main skeleton.

I am therefore inclined to regard the filaments of the Hircinidæ, and also the similar fibrillæ of the Stannomidæ, as true skeletal fibres, comparable to the elastic fibres in the

[1] Zool. Chall. Exp., part xxxi. pp. 11–16.　　[2] *Loc. cit.*, p. 13.

connective tissue of many animals. They may be developed to strengthen the soft ground-mass of the mesoderm, independently from the primary Keratose skeleton. The fibrillæ of the Hircinidæ, ending at the two free ends with a club or knob, may be regarded as monaxial Keratose spicules, similar to the siliceous " biclavated cylindrical spicula" of Bowerbank. They strengthen the tissue of the Hircinidæ in the same manner as the elastic fibrillæ in many kinds of connective tissue.

The fibrillæ of the Stannomidæ seem to be more nearly related, physically as well as chemically, to the common horny fibres of the Keratosa than to the similar filaments of the Hircinidæ. No single fact in their structure, arrangement, and development makes it probable that they are independent organisms. Several botanists who have examined them, and among them two fungological authorities, declared decisively that they are neither fungi nor algæ. I am therefore fully convinced that they are produced by the sponge itself.

Xenophya.—The solid foreign bodies which form the pseudo-skeleton and make up the greatest portion of the body of the Stannomidæ are either siliceous Radiolarian shells, or calcareous *Globigerina* shells, or a combination of both materials. The pseudo-skeleton is composed of pure Radiolarian ooze in five among the nine species, of pure Globigerina ooze in two, and of a mixture of both in the other two species. The two latter species (*Stannophyllum pertusum* and *venosum*) are most remarkable, since several parts of the body (the strong ribs of the leaf) are mainly composed of the coarser Globigerina ooze, whereas other parts (the intercostal plates) are composed of the finer Radiolarian ooze. This fact, as well as others observed in the Psamminidæ and Spongelidæ, seem to uphold my opinion (stated in my description of the Physemaria) that these animals possess a faculty of selection of materials in the construction of their pseudo-skeleton. This opinion is supported, too, by Lendenfeld and Carter (1885), but it is attacked by F. E. Schulze, Marshall, Poléjaeff, and others.

The xenophya are placed so densely and close together in all the Stannomidæ that the connecting maltha appears only as a scarce cement between them. They are never enclosed in the spongin-fibrillæ, but these run everywhere between the foreign enclosures, either single or associated in bundles (Pl. III. figs. 2–4, &c.). When the dermal plate of the sponge is well developed, the crossed bundles of fibrillæ form subregular meshes, in which groups of xenophya are placed, and the dermal pores are scattered at varying distances (Pl. II. figs. 1–4, &c.).

Symbiontes.—Whilst the protecting sandy carapace of the Stannomidæ is formed by the agglutinated xenophya, the supporting scaffold, which gives stiffness and solidity to the body when erect, is formed by a dense network of anastomosing chitinous tubes, filled with a dark brown or blackish cellular mass. In the preliminary examination I supposed that this constant network might be a constituent portion of the sponge itself, a tubular skeleton similar to that of the Aplysinidæ, composed of thin-walled heterogeneous fibres,

which contain a soft medullar or pith-substance. But a closer examination of the different Stannomidæ, and a comparison with the Spongelidæ and Psamminidæ, have convinced me that the network is the hydrorhiza of a symbiotic Hydroid; this conjecture was finally proved by the discovery of the hydranths and gonangia (figured in Pl. II. figs. 6, 7, &c.; see their description in the Appendix). I suppose that these strong chitinous tubes of *Stylactis*, &c., replace the absent stout spongin-fibres of the skeleton in the Stannomidæ, and that the want of these latter may be supplied by the development of this curious symbiosis. The same remarkable condition is found among the Spongelidæ, in *Psammophyllum* (Pls. IV., V.), which connects this family with the Stannomidæ.

Canal-System.—The Stannomidæ seem to agree in the essential structure of the canal-system with the closely-allied Spongelidæ, with which they are immediately connected by the transitional genus *Psammophyllum* (Pls. IV., V.). Below the porous dermal membrane, which is very distinct in *Stannophyllum* and *Stannarium*, there are usually large subdermal cavities. These communicate with the internal canal-system, which is expanded, together with the symbiotic hydrorhiza, between the two parallel dermal plates of these foliaceous sponges. In *Stannoma*, where no distinct dermal membrane was preserved, the canals in the cylindrical branches form a closer network, with smaller meshes. The form, size, and disposition of the flagellated chambers seem to be similar to those of the Spongelidæ, but only traces of them could be found; their epithelia were destroyed in the same way as the exodermal epithelium of the outer surface.

Eggs and Gastrulæ.—Having convinced myself that the Stannomidæ are true sponges (and not "gigantic Rhizopods," as was supposed by the first observers), it was, of course, very important to confirm that opinion by the authentic demonstration of eggs, and if possible gastrulæ. For a long time I looked in vain for them, but at last I was fortunate enough to find them in a single specimen of *Stannophyllum globigerinum*, apparently better preserved than the others. After having stained it with carmine and dissolved the calcareous pseudo-skeleton in hydrochloric acid, I found scattered here and there in the maltha single amœboid cells with a large vesicular transparent nucleus and a dark nucleolus. The largest were so similar to the usual naked sponge eggs (especially to those of *Psammophyllum*, Pl. V. fig. 5, *e*, and of *Spongelia*), that I had no doubt as to their egg nature, the more so as a few eggs were found in segmentation. Finally, some larger dark ovate bodies, composed of granular cells which were found in the same specimen, may be its gastrula larvæ; they were, however, not sufficiently well preserved to allow of a detailed description and drawings.

Genus 9. *Stannophyllum*, n. gen.[1]

Definition.—Stannomidæ with a thin foliaceous or flabelliform body, arising vertically from a simple short pedicle.

The genus *Stannophyllum* is the largest and the most remarkable of all the Deep-sea Keratosa. It comprises by far the greatest part of the Challenger collection of Keratosa, and is represented by very numerous (more than a hundred) specimens, of which more than half are well developed and tolerably well preserved. All these specimens were brought up from a depth of 2425 fathoms, at that most interesting equatorial Station (271) in the Central Pacific, the bottom of which is covered by a deposit of Globigerina ooze containing many Radiolarian remains, and which supplied the richest treasures in the form of numerous Radiolarian species of all the Challenger stations.

The careful examination of this rich material (regarded by previous observers as "large-sized Rhizopods") has yielded most interesting results, especially from a systematic and phylogenetic point of view. The numerous forms in this important collection may be disposed at least into five different species. These are so widely divergent in external form and shape, as well as in internal structure and composition, that every systematic zoologist would accept them as so-called "good species," provided that they were collected at widely-distant localities, and not connected together by intermediate forms. But they were all taken at the same place (Station 271), and there are so many intermediate forms or connecting links, that the zoologists of the pre-Darwinian epoch would have regarded all these forms as mere varieties of one and the same species, *Stannophyllum flabellum* (compare the Synoptical Table on p. 64).

The body in all the specimens of *Stannophyllum* (Pl. I.) is a thin and flat flabelliform leaf, attached at the bottom of the sea by a small basal pedicle. Probably it stands vertically erect, since the two parallel faces of the leaf are identical in structure. The size of the smaller species (diameter of the roundish leaf) is 4 to 8 cm., that of the larger 12 to 24 cm. The general form of the leaf (without pedicle) is sometimes subcircular or subovate, at other times reniform or palmate. The middle part of the proximal margin is attached by the basal pedicle, which is sometimes short and stout, sometimes long and slender. The distal margin is usually integral and semicircular, but sometimes lobulate or undulate. The surface is usually even and integral, but often coarsely arenaceous, and in one species reticular, pierced by numerous holes.

The striking differences which the five species of *Stannophyllum* show in external shape and internal structure are evidently due in the first instance to the composition of the skeleton and the selection of the various xenophya or foreign bodies which compose it. *Stannophyllum zonarium* (Pl. I. fig. 1) is distinguished by the predominant develop-

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[1] *Stannophyllum* = Cement leaf ; στέγνος = *Stannum*, cement, solder ; φύλλον = leaf.

ment of spongin-fibrillæ and the relatively smaller quantity of xenophya (for the most part Radiolarian shells) which are disposed in the maltha between them. The fibrillæ are very much alike, and regularly arranged in thick crossed bundles (Pl. II. fig. 2). The leaf, therefore, is coriaceous, more elastic and coherent than in the four other species. Its surface is soft and velvet-like, and marked by a number of distinct concentric zones, which run parallel to the semicircular distal margin.

The second species, *Stannophyllum radiolarium* (Pl. I. fig. 2), connected with the first by numerous intermediate forms, is composed almost entirely of Radiolarian shells; the spongin-fibrillæ between them are scarce, very thin, of nearly equal breadth. The leaf, therefore, is homogeneous, and in the dry state is like a thin plate of fine sand; the external surface is quite even, finely arenaceous, without zones and ribs. The physical consistence is rather inelastic, stiff, and fragile.

Whilst in these two species the pseudo-skeleton is composed mainly of siliceous Radiolarian ooze, it consists in the third almost entirely of calcareous Globigerina ooze. The spongin-fibrillæ in the connecting maltha of this *Stannophyllum globigerinum* (Pl. I. fig. 5) are very unequal in size, many coarse and thick between the main mass of thin threads which are irregularly interwoven in all directions like cotton threads. Usually they are more fully developed in the softer medullar plate of the leaf, in which the network of symbiontes expands between the canals of the sponge, and in which the smaller shells and fragments of *Globigerina* are crowded; whereas the two parallel porous dermal plates contain only a small quantity of fibrillæ, and are usually composed for the most part of larger *Globigerina* shells. In consequence of this composition the leaf of this species is extremely flaccid and soft in the wet state, non-elastic, fragile and friable in the dry state. The surface is coarsely granular or sandy, and exhibits sometimes (but not always) indistinct concentric zones, like those of *Stannophyllum zonarium*; with this species it is connected by numerous intermediate forms (compare Pl. I. figs. 1, 5).

The two remaining species, *Stannophyllum venosum* (Pl. I. fig. 4) and *Stannophyllum pertusum* (Pl. I. fig. 3), appear in a certain sense as intermediate forms between *Stannophyllum globigerinum* and *Stannophyllum radiolarium*. They are distinguished by the possession of thick, prominent, branched ribs, which arise from the insertion of the basal pedicle. These thick ribs are whitish, and composed mainly of Globigerina ooze, while the thin brown membrane between them is supported by Radiolarian ooze; the quality and quantity, however, of these two different materials is very variable in the different specimens of these two species, *Stannophyllum venosum* approaching generally nearer to *Stannophyllum globigerinum*, and *Stannophyllum pertusum* to *Stannophyllum radiolarium*. The spongin-fibrillæ are in the two latter species more equal and delicate than in the two former. Besides, *Stannophyllum pertusum* is characterised by the presence of a great quantity of siliceous sponge spicules (mainly Hexactinellida), and perhaps to this is due the greater fragility and flaccidity which characterises this species,

and the origin of the numerous holes which pierce its leaf. But this as well as the characteristic lobulation of the distal margin may be due also partly to the mode of growth, which follows that of the symbiotic Hydroid, partly to the different development of the spongin-fibrillæ (compare p. 64).

The Spongoxeniæ, or the different forms of symbiotic Hydropolyps, which are always present in *Stannophyllum*, expand in the soft medullar mass between the two parallel dermal plates, which may be separated more or less easily from the former. The hydranths seem to proceed usually from the distal margin of the flabelliform leaf, but sometimes also from its two faces and also from the base of the pedicle. Usually the imperfect state of preservation prevents the accurate examination of the disposition and structure of these symbiontes, but in a few specimens (principally of *Stannophyllum globigerinum*) they were well preserved and could be recognised as two species of *Stylactella* (*spongicola* and *abyssicola*, Pl. II. figs. 6, 7), compare below p. 78. The canal-system of *Stannophyllum*, unfortunately, is in most of the specimens badly preserved. I was able, however, to recognise in all the species of *Stannophyllum* the small dermal pores of the surface, but not with satisfaction the larger openings, which may be regarded as oscula. In *Stannophyllum zonarium* there are series of larger openings (twice as broad as the usual pores) in the thickened proximal margin of each zone; in *Stannophyllum globigerinum* sometimes apparent oscula are scattered on the two faces of the leaf, but in the other species they were not distinctly recognisable. It may be that the water entering by the pores of the two parallel faces issues by the oscula of the distal margin (compare Pl. IV. figs. 7, 8). The internal canal-system is of variable shape. Larger or smaller subdermal cavities seem to lie immediately below the dermal plates, and to be connected with groups of flagello-chambers, which are disposed in the spongy medullar substance; these, however, were not distinctly recognisable (compare Pl. II. figs. 3, 4).

Stannophyllum zonarium, n. sp. (Pl. I. figs. 1A–1C; Pl. II. figs. 1–4).

Habitat.—Tropical Pacific, Station 271; September 6, 1875; lat. 0° 33′ S., long. 151° 34′ W.; depth, 2425 fathoms; bottom, Globigerina ooze, containing many Radiolaria.

Sponge with an elastic brown coriaceous leaf of subcircular or kidney-shaped outline, with a thin and flat pedicle. Distal margin semicircular, integral. Surface soft, velvet-like, without branched ribs, but with distinct concentric zones of subequal breadth parallel to the distal margin. Skeleton composed mainly of interwoven bundles of spongin-fibrillæ, and forming a dense felty network, in the meshes of which many shells of Radiolaria and a few fragments of *Globigerina* are imbedded.

Stannophyllum zonarium is the most elastic and flexible among the species here

described ; it differs from the others mainly in the composition of the skeleton, in which the interwoven bundles of spongin-fibrillæ predominate, whereas the inorganic xenophya are less numerous. The fibrillæ are much more fully developed than in the other species, and form strong bundles, the smaller of which are composed of ten to twenty, the larger of thirty to fifty or more, parallel fibrillæ. These are nearly equal in size, of medium thickness, their diameter being usually 0·005 mm. on an average (0·002 to 0·008 mm.). Their yellow colour effects the brown tint of the sponge, which is much darker than in the other species. The bundles of fibrillæ are interwoven and cross in all directions, forming an elastic framework, in the smaller meshes of which are imbedded the xenophya, in the larger the canal-system and its flagello-chambers (Pl. II. fig. 2). The xenophya are partly Radiolarian shells, partly fragments of *Globigerina* shells, the former usually much more numerous.

Xenophya.—The foreign bodies which compose the pseudo-skeleton are in *Stannophyllum zonarium* relatively less numerous than in the four other species of the genus ; they are for the most part siliceous shells of Radiolaria, mainly in the distal portion of the leaf, while in the basal portion fragments of *Globigerina* shells and fine inorganic particles are intermingled.

External Form.—The flabelliform body of *Stannophyllum zonarium* is easily distinguished from all the other species externally in the softly coriaceous shape of the thick roundish leaf, the two faces of which exhibit sharp concentric zones, but no ribs. The basal pedicle is flat and thin, tapering towards the basal insertion, 10 to 30 mm. long., 1 to 5 mm. thick. The flat leaf is 40 to 60 mm. in diameter, and is sometimes subcircular, at other times reniform, with a flat basal excision. Its thickness is between 1 and 3 mm., usually 1·5 to 2 mm. The colour is deep brown in the wet state, yellow-brown in the dry state. The thick rounded distal margin is integral and not lobate. The two parallel surfaces of the thick leaf exhibit a most striking zonary structure. Numerous concentric deep furrows, which run parallel to the semicircular distal margin, divide both faces into zones or bands of subequal breadth (between 3 and 5 mm., usually 4 mm.). The proximal part of the concentric bands is somewhat thicker than the distal, so that they exhibit a slight imbrication. This zonary structure presents a striking similarity to that of two other flabelliform but widely remote organisms, viz., *Flustra foliacea* (Bryozoa) and *Zonaria pavonia*, Ag. *Padina pavonia*, Grev. (Fucaceæ Dictyoteæ) ; even the breadth of the concentric zones is usually about the same.

The consistence of this species is much denser and more elastic than in any of the other species of the genus, owing to the much stronger development of the spongin-fibrillæ and the smaller quantity of imbedded xenophya. The thin dermal membrane is denser and more coherent than in the others, and the medullar substance is also more consistent. The dermal pores are very small and regular.

Synoptical Table of the Five Species of Stannophyllum, showing the Specific Characters in External Form and Internal Structure of these Five Transitional Species.

Species.	Material of the Skeleton.	Network of the Fibrillæ Bundles.	Spongin-Fibrillæ.	Consistency of the Flabelliform Leaf.	Distal Margin of the Leaf.	Faces of the Leaf.	Colour.	Size (Diameter of the Leaf).
I. *Stannophyllum zonarium* (Pl. I. fig. 1).	Spongin-fibrillæ prevailing, with many Radiolarian shells.	Very dense and regular, with thick bundles crossed in certain directions.	Very much alike, of medium thickness.	Thick, soft and elastic.	Reniform, integral, rather thick.	With concentric equal zones, coriaceous.	Brown (yellowish).	4 to 8 centimetres.
II. *Stannophyllum radiolarium* (Pl. I. fig. 2).	Siliceous Radiolarian shells prevailing, with few spongin-fibrillæ.	Rather dense and regular, with thin bundles, or many isolated.	Very thin and delicate, of nearly equal thickness.	Thin, rather solid and rigid.	Semicircular, integral, very thin.	Finely granular, even, without zones and ribs.	White or light grey (yellowish).	3 to 6 centimetres.
III. *Stannophyllum pertusum* (Pl. I. fig. 3).	Radiolarian shells prevailing in the distal part, *Globigerina* shells in the ribs and the proximal part.	Rather loose and irregular, especially in the basal portion.	Rather unequal, for the most part thin and interwoven.	Thin, very soft and flabby, inelastic.	Reniform, divided into numerous quadrangular lobes.	Reticular, pierced by numerous holes, very soft, with ribs, without zones.	Brown with greyish ribs.	10 to 20 centimetres.
IV. *Stannophyllum venosum* (Pl. I. fig. 4).	Radiolarian shells prevailing in the distal part, *Globigerina* shells in the ribs and the proximal part.	Very irregular and loose, especially in the ribs, denser in the lamellæ between them.	Very unequal, thick and coarse in the ribs, thin in the lamellæ between them.	Heteromorphous, with thick prominent ribs or veins, and thin tissue between them.	Semicircular, more or less irregularly lobulate or undulate.	Veined, with thick white branched ribs, without zones.	Brown, with white ribs.	20 to 25 centimetres.
V. *Stannophyllum globigerinum* (Pl. I. fig. 5).	Calcareous *Globigerina* shells prevailing, with scanty Radiolarian shells.	Very irregular and loose, felty, interwoven in all directions.	Very unequal, of varying diameter; many coarse between prevailing fine threads.	Thick, very fragile and flabby, inelastic.	Subovate or truncate, integral, not lobate, very thick.	Coarsely granular, very rough, without ribs, often with indistinct zones.	White or yellowish (greyish).	6 to 9 centimetres.

Stannophyllum radiolarium, n. sp. (Pl. I. figs. 2A–2C).

Habitat.—Station 271 ; depth, 2425 fathoms ; bottom, Globigerina ooze.

Sponge with a thin, homogeneous, whitish, flabelliform or reniform leaf, in the basal margin of which a long slender pedicle is inserted. Distal margin hemielliptical, integral. Surface finely granular, without concentric zones and without ribs. Skeleton composed mainly of siliceous Radiolarian shells. Spongin-fibrillæ between them very thin and delicate, many isolated, others aggregated in small bundles.

Stannophyllum radiolarium is the most delicate and fragile among the species here described, differing from the others mainly in the composition of the pseudo-skeleton ; this is composed almost entirely of siliceous Radiolarian shells, between which a scanty maltha is developed, including the spongin-fibrillæ. These are less fully developed and thinner than in any of the other species, and run for the most part isolated or in very small bundles (composed of four to eight fibrillæ, rarely twelve to sixteen or more). The diameter of the fibrillæ is usually between 0·001 and 0·002 mm., often less, rarely more (0·003 to 0·005 mm.).

External Form.—The colour of this species in the dry state is whitish or light yellowish grey. The thickness of the thin and delicate leaf is only 1 to 1·5 mm. (more rarely 2 to 2·5 mm.); its diameter is usually between 30 and 50 mm., and the length of the slender pedicle is about the same. The semicircular margin of the leaf is integral. The two parallel surfaces are nearly smooth, quite even, pierced by very small pores, without concentric zones and without ribs. In the elasticity and consistence of the dry leaf this species is intermediate between *Stannophyllum zonarium* and *Stannophyllum pertusum*. It is connected with both species by transitional forms. The dermal pores are smaller than in the latter, and its finely granular even surface distinguishes this species at once.

Xenophya.—The pseudo-skeleton of this species is a fine collection of Radiolarian shells. The majority of the numerous species of Spumellaria and Nassellaria, which are found in the ooze of Station 271, are to be found aggregated in the skeleton of this delicate sponge, connected by a small quantity of clear maltha, and separated by the numerous thin spongin-fibrillæ, which form a rather regular network between the branches and in the meshes of the symbiotic Hydroid.

Stannophyllum pertusum, n. sp. (Pl. I. figs. 3A, 3B).

Habitat.—Station 271 ; depth, 2425 fathoms ; bottom, Globigerina ooze.

Sponge with a broad, reniform or flabelliform leaf, in the basal margin of which a slender triangular pedicle is inserted. Distal margin semicircular, with numerous

quadrangular lobes and deep incisions. Surface reticular, pierced by numerous holes, very soft, without concentric zones, but with more or less distinct ribs or branched veins. Skeleton composed mainly of Radiolarian shells and siliceous sponge spicules, intermingled in the ribs with numerous *Globigerinæ*; spongin-fibrillæ thin and of nearly equal breadth, loosely interwoven.

Stannophyllum pertusum differs externally very strikingly from the other species of the genus by the numerous lobes of the distal margin and the holes which pierce the reniform leaf and produce its reticular appearance; these characters, however, are found less prominently in the closely-allied *Stannophyllum venosum*, with which it is connected by intermediate forms. The branched ribs of the latter species, too, are usually more or less indicated, but rarely so prominent. The shape of the two species is also similar, produced by the same composition of the skeleton. This contains a loose framework of interwoven spongin-fibrillæ of various sizes, and imbedded in its meshes a variable quantity and quality of xenophya.

Xenophya.—The aggregation of foreign bodies which compose the pseudo-skeleton is a variable mixture of Radiolarian remains and of Globigerina ooze, the latter usually predominating in the proximal portion of the leaf, its ribs and the pedicle, the former in the distal portion and in the thin lamellæ between the ribs. The numerous specimens in the Challenger collection vary a great deal in this respect; when the siliceous shells of Radiolaria are predominant, the structure of the leaf approaches that of *Stannophyllum radiolarium*; when the calcareous shells of the Foraminifera are abundant, it is more like that of *Stannophyllum globigerinum*. The spongin-fibrillæ are also very variable, thinner and finer in the former, thicker and coarser in the latter. The leaf of the latter is far more flabby, soft, and inelastic than that of the former. In some specimens a great quantity of siliceous spicules of sponges (mainly Hexactinellidæ) is embedded in the clear maltha, and these specimens are particularly flabby and easily torn.

External Form.—The general form of the leaf in *Stannophyllum pertusum* is kidney-shaped; its diameter is between 80 and 120 mm., but some larger specimens seem to reach 200 mm. or more, and approach near to *Stannophyllum venosum*. The semi-circular or crescentic distal margin is always lobate, with a great number (forty to sixty or more) of radial incisions, by which the rounded quadrangular lobes are separated. The irregular roundish holes which pierce the flat leaf are evidently produced by the growing together of formerly separated marginal lobes. Their size and number is very variable. Probably the approachment of divergent branches of the symbiotic reticular Hydrocaulus (Spongoxenia) is the first cause of this formation. The proximal margin of the leaf is integral, broadly triangular, and tapers into a slender triangular pedicle. This has a length of 30 to 50 mm., a breadth of 4 to 8 mm., and is attached by a basal plate at the bottom of the sea.

Stannophyllum venosum, n. sp. (Pl. I. fig. 4).

Habitat.—Station 271 ; depth, 2425 fathoms ; bottom, Globigerina ooze.

Sponge with a broad flabelliform or reniform leaf, in the basal incision of which a stout and short pedicle is inserted. Distal margin semicircular, undulate and lobulate. Surface distinctly veined, with numerous thick, whitish, branched ribs, which diverge from the insertion of the pedicle ; between them thin, flabby, brown lamellæ. In the ribs the skeleton is composed mainly of calcareous Globigerina ooze, in the lamellæ of siliceous Radiolarian tests ; spongin-fibrillæ thick and coarse in the former, thin and fine in the latter.

Stannophyllum venosum, represented in Pl. I. fig. 4 half natural size, is the largest of all the Deep-sea Keratosa, the longitudinal diameter of the flabelliform leaf reaching 200 mm. and the transverse diameter 250 mm. It is distinguished at once from the other four species of the genus by the strong, prominent, white ribs or veins arising divergently from the insertion of the thick basal pedicle and tapering towards the thin lobulate margin. The pseudo-skeleton of these thick whitish ribs is composed principally of calcareous Globigerina ooze, while that of the thin yellowish or brown lamellæ between them consists for the most part of siliceous Radiolarian shells. The spongin-fibrillæ are very unequal in size, thicker and rather coarse in the ribs, thinner and finer in the lamellæ between them, the network formed by them being loose and irregular in the former, denser and finer in the latter.

External Form.—In the largest specimens there are seven of the peculiar thick veins or branched ribs, which are prominent on the two faces of the thin flaccid leaf. In the middle there is an odd rib, or a prolongation of the thick basal pedicle, and three divergent pairs on each side, each rib being again branched or beset with secondary ribs. The tapering distal ends of the branches pass gradually over into the thin brown web of the distal portion of the leaf, which is very flabby and easily torn. The development of these ribs seems to be produced partly by strong bundles of reticular symbiotic Hydroids, partly by strong bundles of coarser spongin-fibrillæ ($0·006$ to $0·01$ mm. in diameter), strengthened by crowded Globigerina ooze ; the thin brownish membrane between the thick whitish ribs is composed mainly of Radiolarian tests and of thinner fibrillæ ($0·001$ to $0·002$ mm. in diameter).

The thick and short basal pedicle which is inserted into the proximal portion of the reniform leaf is 20 to 30 mm. in length and 6 to 8 mm. in thickness. It is attached to the sea-bottom by a basal plate, 15 to 20 mm. in diameter. The thickness of the lamellar leaf diminishes gradually towards the very thin and flabby distal margin, which is slightly undulate and lobulate ; sometimes the distal portion of the leaf is pierced by small irregular holes, but neither these perforations nor the marginal lobes are so pronounced as in the closely-allied *Stannophyllum pertusum*.

Xenophya.—The foreign bodies which compose the pseudo-skeleton of this, the largest, species seem to offer a new argument in favour of my opinion, that such a pseudo-skeleton is constructed, in the Psammospongiæ as well as in other animals (for instance, in the Physemaria, &c.), with a certain amount of selection of materials, for the skeleton of the thick ribs approaches that of *Stannophyllum globigerinum*, whilst that of the thin membrane between them is more like that of *Stannophyllum radiolarium*.

Stannophyllum globigerinum, n. sp. (Pl. I. figs. 5A–5C).

Habitat.—Station 271 ; depth, 2425 fathoms ; bottom, Globigerina ooze.

Sponge with a flabby, white, arenaceous leaf of subovate or triangular outline, the tapering base of which is supported by a conical pedicle. Surface coarsely granular, friable, without radial ribs, but often with more or less distinct concentric zones. Skeleton composed mainly of calcareous Globigerina ooze, the shells and fragments of which are larger in the two cortical faces, smaller in the medullar mass between them. Spongin-fibrillæ very unequal in size, many coarser and branched between the interwoven finer ones.

Stannophyllum globigerinum is the opposite end in the series of continuous links which are presented by the five species of this genus, beginning with the coriaceous *Stannophyllum zonarium*. In contrast to this latter the true fibrillar skeleton is here very weak, especially in the dermal plates, and the main mass of the arenaceous leaf is a pseudo-skeleton, composed almost entirely of Globigerina ooze. Intermingled between the shells and fragments of *Globigerina* and *Pulvinulina* there occur many small siliceous shells of Radiolaria, in far smaller quantity, however, than in the other four species. The spongin-fibrillæ which support the cementing maltha are of very unequal and irregular shape, and are most irregularly interwoven in all directions. There are many very thick fibres, 0·006 to 0·01 mm. in diameter and more, and in these the medullar or axial thread is twice as broad as the surrounding cortical wall. The thickest fibrillæ are often richly branched, and sometimes begin to anastomose (transition to *Psammophyllum*).

Xenophya.—The foreign bodies which compose the pseudo-skeleton of this species are in the majority of the numerous preserved specimens almost wholly calcareous shells of Globigerina ooze, and their fragments; usually the two parallel dermal plates of the foliaceous body are composed of larger shells, the softer medullar mass between them of smaller shells and fragments; within this latter is expanded the rich brown network of the symbiotic Hydroid. The scanty maltha between the fibrillæ includes often rather numerous Radiolarian shells, and, in the basal pedicle, sponge spicules.

External Form.—The flabelliform body of *Stannophyllum globigerinum* is easily

distinguished from the other species externally in the arenaceous and coarsely-granular appearance of the white surface, due to the large, densely crowded, *Globigerina* shells which compose the two thick, parallel, dermal plates. The dry sponge, therefore, is very stiff, friable and fragile, arenaceous and inelastic. In the wet state it is extremely flaccid, and may be easily torn. The outline of the leaf is usually ovate or obliquely elliptical; its thickness is considerable, and nearly equal throughout its whole extent, about 2 to 3 mm., sometimes 4 mm. or more. The diameter of the leaf is usually between 40 and 60 mm., sometimes 80 to 90 mm., or even more. The tapering proximal part is prolonged into a conical pedicle of variable thickness, the basal insertion of which is often bulbous. Sometimes the thick pedicle is prolonged as a prominent median rib in the proximal half of the leaf, gradually tapering distally. The coarsely-granular surface of the leaf usually exhibits more or less distinct traces of the concentric zones which are characteristic of *Stannophyllum zonarium*, but they are never so regular nor so distinct as in that species, and sometimes they are absent altogether.

A few specimens of this species were distinguished by the production of one or two surface lobes arising from one or both sides of the leaf (Pl. I. fig. 5B). This production forms a transition to the genus *Stannarium* (Pl. III. figs. 6–14).

Stannophyllum globigerinum is the fittest for anatomical examination of all the five species of this genus, for the greatest part of the skeleton, viz., the calcareous Globigerina ooze, is easily dissolved in hydrochloric acid. The remaining portion of the body is partly a scarce maltha (sometimes containing ova), partly a very loose felty mass, composed of irregular bundles of spongin-fibrillæ, interwoven in all directions, and of the branched canals of the sponge, which run between the brown network of the symbiotic Hydroid. The reticular hydrorhiza of this latter is usually richly developed, and may be more easily isolated than in the other species of the genus (Pl. II. fig. 5). In a few specimens the hydranths (y'') and gonangia (g) were well preserved, and could be recognised as belonging to two distinct species of *Stylactella* (*Stylactella spongicola*, Pl. II. fig. 6; and *Stylactella abyssicola*, fig. 7).

Genus 10. *Stannarium*,[1] n. gen.

Definition.—Stannomidæ with branched lamellar body, forming vertical plates, which arise as lateral branches from a primary flabelliform body.

The genus *Stannarium* comprises those Stannomidæ in which the body is composed of several vertical leaves, which are either free or growing together. There can be no doubt that this peculiar form has originated from *Stannophyllum* by lateral budding, and that two opposite of these vertical wings are the halves of the primary flabelliform leaf

[1] *Stannarius* = Cementing or soldering workman.

(*Stannophyllum*), whilst all the others are secondary wings, budding from its two parallel faces (compare Pl. I. fig. 5B). The internal structure as well as the external form of these leaves are the same as in the ancestral *Stannophyllum*, and the material of the pseudo-skeleton is variable in a similar way.

Two different species of *Stannarium* were found in the Challenger collection, the first (*Stannarium alatum*) with free wings, the second (*Stannarium concretum*) with united wings, so grown together that funnel-shaped cavities remain between them. The pseudo-skeleton of the former is composed mainly of Radiolarian ooze, while in the latter more or less Globigerina ooze is intermingled. The spongin-fibrillæ are more regular, equal, and thin in the former, coarser and unequal in the latter, so that the differences between these two species are similar to those between their ancestral forms, *Stannophyllum radiolarium* and *Stannophyllum globigerinum*.

Stannarium alatum, n. sp. (Pl. III. figs. 6–9).

Habitat.—Central Pacific, Station 272; September 8, 1875; lat. 3° 48′ S., long. 152° 56′ W.; depth, 2600 fathoms; bottom, Radiolarian ooze.

Sponge rather consistent, with several vertical, free, foliaceous wings, which are not grown together, and arise from a primary flabelliform leaf. Skeleton composed mainly of Radiolarian ooze.

There are several specimens of *Stannarium alatum*, varying in diameter from 30 to 60 mm. From a thick basal pedicle arises vertically a primary flabelliform leaf (*Stannophyllum*), and this produces by lateral budding several secondary leaves, which also stand nearly vertical. Usually there are two larger secondary leaves arising obliquely from the two sides of the primary leaf, so that the sponge seen from above represents an irregular four-winged cross (fig. 8). Sometimes several smaller lateral wings arise between the larger. The wings are ovate, or semicircular, of the same thickness as the primary leaf, between 1 and 2 mm. The distal margins are integral or slightly lobulate.

The surface of the leaves is finely arenaceous (from the conglomeration of Radiolarian shells), and at the same time felty (from the irregular web of the fine spongin-fibrillæ). Innumerable very small pores pierce the thin dermal membrane, which may be stripped off from the dense, felty, medullar mass. This is rather compact, traversed by the same canal-system and the same network of the symbiotic Hydroid as in the ancestral *Stannophyllum radiolarium*.

Skeleton.—Amongst the xenophya or foreign bodies which compose the pseudo-skeleton, siliceous Radiolarian shells are predominant, but sometimes spicules of siliceous sponges and also fragments of calcareous *Globigerina* shells are intermingled, the latter mainly in the basal pedicle. All the xenophya are surrounded and connected by the

clear maltha, in which the framework of the spongin-fibrillæ is imbedded. These are very thin and fine (for the most part between 0·001 and 0·003 mm. in diameter), exhibit a distinct medullar thread or axial canal, and are densely interwoven in all directions. The main support of the body is formed by the network of the symbiotic Hydroid, which is expanded in the medullar substance of the sponge.

Stannarium concretum, n. sp. (Pl. III. figs. 10–14).

Habitat.—Central Pacific, Station 270 ; September 4, 1875 ; lat. 2° 34′ N., long. 149° 9′ W.; depth, 2925 fathoms ; bottom, Globigerina ooze.

Sponge rather flabby, with several vertical foliaceous wings, which are grown together and surround one or more funnel-shaped cavities. Skeleton composed mainly of Globigerina ooze.

Stannarium concretum has a peculiar appearance, produced by the coalescence of the irregular lateral wings, which arise vertically from the two sides of the primary leaf (*Stannophyllum*). Usually there are between four and eight wings of different sizes, and these grow together with their faces touching in such a manner, that one or more infundibular cavities are formed between them. A subregular form, of rather firm consistence, is shown in figs. 10–12, where four vertical wings are so crossed that they form together a four-sided pyramid with four prominent edges, and a funnel-shaped central cavity at the top (fig. 11). Two opposite wings of these four represent the primary leaf; the other two, also opposite to one another, arise from the median line of the two parallel faces of the former ; their separate roots growing together with the former enclose the pyramidal central cavity. Another specimen of very flabby consistence is composed of eight irregular vertical wings, four larger and four smaller (fig. 13 from above, fig. 14 from one side). The thickness of these leaves is between 2 and 4 mm., the diameter of the whole sponge between 20 and 50 mm.

Skeleton.—The surface of the leaf is in this species far more coarse and granular than in the preceding, and the consistence softer and flabbier. This is produced by the different composition of the skeleton, in which a great quantity of calcareous Globigerina ooze is mixed with the siliceous Radiolarian remains. Sometimes the former predominates. *Globigerina* shells and their fragments compose mainly the two parallel dermal plates, while in the soft medullar mass between them they are intermingled in different degrees with Radiolarian shells. The greater the proportion of Globigerina ooze, the more unequal become the spongin-fibrillæ of the skeleton, very coarse ones (0·006 to 0·008 mm. in diameter and more) being intermingled with finer ones (0·002 to 0·004 mm. or less) ; they are interwoven irregularly in all directions. Between this felty mass and the xenophya, surrounded by the fibrillæ-bundles, there is expanded the network of the symbiotic Hydroid.

Genus 11. *Stannoma*, n. gen.[1]

Definition.—Stannomidæ with arborescent body, divided into numerous free or anastomosing cylindrical branches.

The genus *Stannoma* differs from the other Stannomidæ in the arborescent form of the body, which is like a small tree or coral stock. The ramifications of the corm are sometimes regular and dichotomous, at other times irregular.

Two species of *Stannoma* were found in the Challenger collection, both taken at two neighbouring stations in the Central Pacific, viz., Station 271 (2425 fathoms) and Station 272 (2600 fathoms). The Radiolaria in the ooze covering the bottom at these two stations make up the pseudo-skeleton in both species; the xenophya are imbedded in a scanty clear maltha, which is supported by a dense framework of thin spongin-fibrillæ.

The branches of the arborescent body are cylindrical in both species. They are free in *Stannoma dendroides* (Pl. III. fig. 1), while they anastomose and form a loose network (similar to *Clathria*) in *Stannoma coralloides* (Pl. III. fig. 5). A transverse section (Pl. III. figs. 2, 3) shows numerous brown tubes of the symbiotic Hydroid (*h*); the tubes seem to belong to two different genera (*Stylactis, Halisiphonia*). The branches of the reticular hydrorhiza give a firm support to the arborescent sponge, and between them branch its canals, the course of which could not be made out. The dry *Stannoma* is very light and friable, the surface loosely woolly and finely sandy; the dermal membrane which covers the surface of *Stannophyllum* is absent here.

Stannoma dendroides, n. sp. (Pl. III. figs. 1–4).

Habitat.—Tropical Pacific, Station 271; depth, 2425 fathoms; bottom, Globigerina ooze. Station 272; depth, 2600 fathoms; bottom, Radiolarian ooze.

Sponge arborescent, irregularly branched (partly dichotomous, partly polychotomous), with slender cylindrical branches tapering towards the conical distal end. Branches free, without anastomoses.

The body of the tree-like sponge is 30 to 50 mm. high, 20 to 30 mm. broad, very soft and flexible, in the dry state friable. The short stem, 10 to 20 mm. in height, 3 to 5 mm. in thickness, is either cylindrical or inversely conical, tapering towards the small base, and divided into three to six stout main branches, 3 to 4 mm. in diameter. These divide again into secondary and tertiary branches of varying lengths, between

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[1] *Stannoma* = Cemented body, στεγνώμα.

5 and 20 mm. The branches are slightly curved, and gradually taper from 3 or 2 mm. to 0·5 mm. or less in thickness ; the conical end also tapers gradually.

Internal Structure.—Transverse and longitudinal sections through the branches of the arborescent sponge (Pl. III. figs. 2, 3) exhibit a loose framework of the symbiotic Hydroid (Spongoxenia), and between its meshes are the branches of the canal-system of the sponge and its skeleton, which is composed of Radiolarian ooze and of spongin-fibrillæ, connected by the scanty clear maltha. The structure of the canal-system, and especially the disposition of the flagello-chambers, unfortunately, could not be made out, owing to the bad state of preservation of the tissues. The woolly surface of the branches is porous, but they have no distinct dermal membrane.

Fibrillæ.—The fine spongin-fibres are scantily developed, and form an irregular very loose framework throughout the whole maltha of the mesoderm. They are for the most part not arranged in bundles, but isolated and very loosely interwoven in all directions, in the medullary as well as in the cortical substance. Ramifications of the fibrillæ were not observed ; their usual diameter is between 0·001 and 0·003 mm., often less, rarely more (figs. 2, 3, *f*). The fibrillæ are imbedded in the scanty clear maltha which connects the foreign bodies (*r*).

Xenophya.—The foreign bodies compose the main mass of the sponge (probably 90 to 95 per cent. of the solid substance) ; they are almost exclusively siliceous shells of Radiolaria ; rarely small fragments of Hyalospongiæ or Hexactinellidæ are found among the Radiolaria (fig. 4).

Symbiontes.—The tubular hydrorhiza of the symbiotic Hydroid, which supports the sponge and all its branches, forms an irregular network with large and loose meshes, usually five to ten times as long as broad; in transverse sections of the branches usually twenty to thirty or more tubes are visible, usually 0·06 to 0·08 mm. in diameter. They appear to belong to two different genera, viz., *Stylactis* (Pl. II. figs. 5–7) and *Halisiphonia* (Pl. IV. fig. 9).

Stannoma coralloides, n. sp. (Pl. III. fig. 5).

Habitat.—Tropical Pacific, Station 271 ; depth, 2425 fathoms ; bottom, Globigerina ooze. Station 272 ; depth, 2600 fathoms ; bottom, Radiolarian ooze.

Sponge arborescent or coral-shaped, irregularly branched (usually dichotomous), with short cylindrical branches of equal thickness, truncated or club-shaped at the distal end. Branches anastomosing and forming a network.

The reticular body of the coralliform sponge is of subglobular outline, 30 to 40 mm. high, and in the distal part about the same in breadth. The short stout stem, 3 or 4 mm. high, divides into numerous short and stout cylindrical branches, which are again

dichotomously branched. The cylindrical branches are connected by numerous anastomoses and form a loose network, the meshes of which are 2 to 5 mm. in diameter. The thickness of most of the branches is between 2 and 3 mm. The distal ends are rounded or nearly truncate, sometimes club-shaped, not tapering or conical, as in the preceding species. These differences, and especially the reticular shape of the sponge, might perhaps justify its separation as a peculiar genus (*Stannoplegma*).

Internal Structure.—Transverse and longitudinal sections through the branches of the coralliform sponge exhibit the same structure as in the preceding species, viz., a loose framework of the symbiotic Hydroid (Spongoxenia), and between its meshes are the branches of the canal-system of the sponge, and the skeleton composed of Radiolarian ooze and of spongin-fibrillæ. The anatomical structure of the canal-system here also could not be made out.

Fibrillæ.—The fine spongin-fibres are much more numerous, larger and more richly developed, than in the preceding species; they are arranged partly in bundles, partly interwoven in all possible directions, in the cortical as well as in the medullary mass. Most of the fibrillæ are simple and run isolated, but often two to six parallel fibrillæ are found associated; more rarely there are small bundles of ten to twenty or more. Ramifications of the fibrillæ, which I could not find in *Stannoma dendroides*, are not rare in *Stannoma coralloides*. The diameter of the larger fibres is 0·005 to 0·01 mm., that of the smaller fibres 0·001 to 0·004 mm., often less. The firmer consistence of this species is mainly produced by the richer development of the fibrillæ, which surround and connect the xenophya, or the foreign bodies composing the main mass of the sponge; these are, as in the preceding species, almost exclusively Radiolarian shells (figs. 2–4, *r*).

Symbiontes.—The chitinous tubes of the symbiotic Hydroid are in this species less numerous than in the preceding; a transverse section of the branches exhibits usually ten to fifteen tubes, rarely more, often less. The network of the tubes is in *Stannoma coralloides* much looser than in *Stannoma dendroides*; the Hydroid is apparently *Halisiphonia spongicola* (Pl. IV. fig. 9).

APPENDIX.

Symbiotic Hydroida living in the Deep-sea Keratosa.

The majority of the Deep-sea Keratosa described in the preceding pages live constantly in symbiosis with certain Hydroids, viz., all the Stannomidæ (nine species), all the Spongelidæ (five species), and a part of the Psamminidæ (two species). No symbiotic Hydroida were found in the remainder of the Psamminidæ (five species) nor in the Ammoconidæ (five species). The symbiosis and the mutual relations between the Deep-sea Keratosa and the Hydroida seem to be so important for both parts of the organism (at least in the majority of the species enumerated) that the whole growth, the general form, and the special structure have been modified by their influence.

In spite of the imperfect state of preservation, which presented great obstacles to the recognition of the symbiotic animals, I have been able, by continuous examination of numerous specimens, not only to state with sufficient certainty the Hydroid nature of the reticular symbiontes hidden in the Keratose body, but also to distinguish at least four different forms, in three of which the genus could be recognised. Two species (one of which is the most frequent inhabitant of the sponges) belong to the genus *Stylactis*, Allman (Pl. II. figs. 5–7) ; a third species to *Halisiphonia*, Allman (Pl. IV. fig. 9) ; and a fourth probably to *Eudendrium* or an allied genus (Pl. IV. fig. 4).

The characters common to all these symbiotic Hydroida are : (1) the enormous development of a reticular hydrorhiza; (2) the small size of the hydranths arising from it ; (3) the production of sporosacs or sessile gonophores directly from the hydrorhiza; (4) the production of a dark (brown or greenish) pigment in the entoderm cells.

Hydrorhiza of the Symbiotic Hydroida.—The hydrophyton (Allman) or the common basis of the trophosome, by which its zooids are connected into a single colony, is represented in all the symbiotic Hydroids not by a free branched hydrocaulus, but by a reticular hydrorhiza, which is fully enclosed in the body of the hospitable sponge. Usually all the parts of the sponge are traversed by the network of the hydrorhiza, but sometimes this is confined to a certain part of the host, while the other part is free.

The anastomosing branches of the hydrorhiza are usually cylindrical and of nearly equal diameter in the majority of specimens, but sometimes they form irregular dilata-

tions, either between two neighbouring branches or on the connecting nodal points of the network, and then its configuration becomes more irregular (Pl. II. fig. 7, *h*). The meshes of the network are usually roundish or polygonal, sometimes more oblong; their diameter is very variable, but usually small (Pl. II. figs. 5, 6, *h*).

Perisarc.—The chitinous tube which surrounds the tubular branches of the reticular hydrorhiza is of special physiological importance to the symbiotic Deep-sea Keratosa, since it replaces the absent strong spongin-fibres. The network of the perisarcal tubes forms the firm pseudo-skeleton of the soft sponges, and constitutes the solid framework which supports their canal-system. It is very probable that the absence of the usual strong spongin-fibres in these Deep-sea Keratosa is effected by the association with the symbiotic Hydroids, the growth of which determines the form of the sponge.

Cœnosarc.—The soft and delicate epithelia of the cœnosarc (ectoderm and entoderm) hidden in the chitinous tubes of the perisarc were usually scarcely recognisable, and more or less destroyed in the specimens examined; they presented the same difficulties in examination as the epithelia of the sponge itself, being much injured by the conditions of capture and the sudden change of the physical conditions of existence. In a few cases, however, they were tolerably well preserved, and I was able to convince myself that the wall of the tubular cœnosarc possesses the same structure as in the smaller Hydroids. A striking character of these deep-sea Hydroids is the dark coloration of the cœnosarc produced by the accumulation of brown, greenish, or blackish pigment-granules. These are very similar to the phæodella, or the peculiar pigment-granules, which constitute the phæodium, or the extra-capsular pigment-body of the Phæodaria, described in my Report on the Challenger Radiolaria.[1] The striking similarity of these dark pigment-bodies, and their general presence in the cœnosarc and the hydranths of the symbiotic Hydroids, caused some naturalists, who examined these Keratosa, to declare them to be " large-sized Rhizopods with reticular tubes filled up by phæodia." This mistake is the more conceivable, as usually the epithelia of the cœnosarc are destroyed, and their scattered pigment-granules fill up the cavity of the perisarcal tubes.

Hydranths.—The nutritive zooids of the symbiotic deep-sea Hydroids are small, and were in all the specimens examined highly contracted, usually more or less injured, so that it was no easy task to recognise their true nature with certainty. This was possible, however, in the case of *Stylactis spongicola* inhabiting *Stannophyllum*, and especially in those species in which the pseudo-skeleton is composed of Globigerina ooze. After having dissolved the calcareous matter by hydrochloric acid, I could observe hundreds of hydranths arising from the superficial layer of the hydrorhiza, and prominent on the dermal surface of the sponge. The hydranths were ovate or club-shaped, sessile in *Stylactis spongicola*, shortly pedunculated in *Stylactis abyssicola*, and had a diameter of 0·2 to 0·3 mm. in the former, 0·5 to 0·6 mm. in the latter. The tentacles were

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[1] Zool. Chall. Exp., pt. xl. vol. xviii. p. 1532.

usually contracted, turned inwards to the mouth, and difficult to distinguish, but sometimes they were prominent over the conical hypostome, and formed a single circlet, composed of eight to sixteen cylindrical tentacles (Pl. II. figs. 5–7, *y*). The entoderm of the hydranths exhibited the same dark coloration as that of the hydrorhiza.

The hydranths of *Halisiphonia spongicola* (a Campanularian Hydroid allied to *Lafoëa*) were not preserved in the few specimens of Stannomidæ in which it occurred; but in this case the chitinous hydrotheca, very similar to that of *Halisiphonia megalotheca* (Allman), permitted me to recognise the genus of the symbiotic Hydroid.

Gonophores.—Sexual zooids bearing eggs in their walls were observed in both species of *Stylactis*, but not in *Halisiphonia;* they were, however, rare, and not found in the majority of hydrosomes. They were in both species ovate or club-shaped naked bodies, which arose from the hydrorhiza between the hydranths (Pl. II. figs. 6, 7, *g*). *Halisiphonia* exhibited a few chitinous oviform gonangia (Pl. IV. fig. 9, *g*). The entoderm of the gonophores in *Stylactis* is of the same dark phæodium-like colour as that of the hydrorhiza and the hydranths.

Halisiphonia spongicola, n. sp. (Pl. IV. fig. 9).

Habitat.—North Pacific, Station 241 ; depth, 2300 fathoms. Central Pacific, Station 272 ; depth, 2600 fathoms ; symbiotic with *Stannoma* and *Psammophyllum.*

Halisiphonia with a reticular hydrorhiza, the anastomosing tubes of which are cylindrical, of equal breadth. Hydranths probably cylindrical, enclosed in a slender cylindrical hydrotheca, which arises by a thin and short pedicle from the hydrorhiza. Gonangia ovate, with a circular opening, twice as broad and about as long as the hydothecæ, arising scattered between them from the hydrorhiza.

Halisiphonia spongicola is very similar to *Halisiphonia megalotheca*, described by Allman.[1] This latter species was collected by the Challenger at Station 160 (south of Australia), at a depth of 2600 fathoms. Allman gives the following description of it :— "Hydrocaulus a creeping and adherent tube which supports at irregular intervals pedunculated hydrothecæ. Hydrothecæ very large, cylindrical, gradually passing below into the long smooth cylindrical peduncle. Gonangia spathuliform, borne on short peduncles, and with the summit opening by a long narrow transverse slit."

The trophosome of *Halisiphonia spongicola* is very similar to the figure given by Allman, but its network is much more developed, and traverses the whole body of *Psammophyllum flustraceum* (p. 52, Pl. IV. fig. 5), and probably also that of *Stannoma coralloides* (Pl. III. fig. 5) ; from the surface of the former is prominent only the distal part of the hydrothecæ, with their openings. It seems, therefore, more reasonable to call the trophosome of this symbiotic species hydrorhiza (as in *Stylactis*),

[1] Zool. Chall. Exp., pt. lxx. p. 31, pl. xvi. figs. 1, 1*a*.

not hydrocaulus. The entoderm of the cœnosarc, enclosed in the chitinous cylindrical tubes of the perisarc, is of the same dark colour as in *Stylactis*. A few gonangia were observed scattered between the hydrothecæ and arising immediately from the perisarcal network (fig. 9, *h*). They had the same size and subovate form as those of *Halisiphonia megalotheca*, but they were not compressed or spathuliform, with a slit-shaped opening ; their transverse section and the distal opening are circular (fig. 9, *g*).

The genera Stylactis and Stylactella.

The genus *Stylactis* was founded in 1864 by Allman, in his leading paper on construction and limitation of genera among the Hydroids.[1] It is the first genus of the family Podocorynidæ, and one of the most primitive among the Tubulariæ or Gymnoblastic Hydroids. Allman's definition of *Stylactis* is as follows :—"*Trophosome :* Cœnosarc mainly composed of a retiform hydrorhiza, which consists of anastomosing tubes invested by a periderm ; hydrocaulus rudimental or absent. Polypites claviform, with a single verticil of filiform tentacles surrounding the base of a conical metastome. *Gonosome :* Gonophores adelocodonic, borne on the body of the polypite at the proximal side of the tentacles." Two species are mentioned, *Stylactis fucicola* (= *Podocoryne fucicola*, Sars) and *Stylactis sarsii*, Allman (= *Podocoryne carnea*, Sars).

Similar to this first definition of *Stylactis* by Allman is the one which he gave in 1871, in his excellent Monograph of the Gymnoblastic or Tubularian Hydroids,[2] where he describes a third species, *Stylactis inermis* (p. 306). But afterwards, in his Challenger Report,[3] the definition of *Stylactis* was essentially altered, and given in the following words :—"*Trophosome :* Hydrocaulus rudimental, being reduced to short tubular processes, which spring at intervals from a creeping, stolon-like hydrorhiza and support the hydranths on their summit ; hydrorhiza destitute of external cœnosarcal investment. Hydranths clavate, with a single circlet of filiform tentacles, which surround the base of a conical hypostome. *Gonosome :* Gonophores adelocodonic, borne by the hydranth at the proximal side of the tentacles, or by the creeping stolon." The new deep-sea species, which Allman describes and figures, *Stylactis vermicola*,[4] was found symbiotic on the back of an *Aphrodite*-like Annelid, *Lætmonice producta*, taken in the North Pacific at Station 244, depth 2900 fathoms.

This new deep-sea species, *Stylactis vermicola*, symbiotic with an Annelid, is of particular interest, since it occurs at the same Station (Station 244, depth 2900 fathoms) as our *Stylactis abyssicola*, symbiotic with different Keratosa (Spongelidæ and Stannomidæ). Considering the formation of the gonophores, which spring in this latter directly from the hydrorhiza, and not from the body of the hydranths, I find it

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[1] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. xiii. p. 353.   [2] Allman, Monogr. of the Tubularian Hydroids, 1871, p. 302.
[3] Zool. Chall. Exp., pt. lxx. p. 1.   [4] *Loc. cit.*, p. 2, pl. i. fig. 2.

identical with that of *Stylactis vermicola*, but not with that of the three species of true *Stylactis* which originally constituted this genus. I am therefore of the opinion that it would be better, and justified by general systematic principles, to retain the older definition given by Allman in 1871 (p. 302), viz. :—" *Gonosome :* Sporosarc borne on the hydranths at the proximal side of the tentacles," and to separate the symbiotic deep-sea species as a new genus, *Stylactella*, " with gonophores borne on the creeping stolon or the hydrorhiza." The full definition of this genus would then be as follows :—

Stylactella, nov. gen.—Tubulariæ without hydrocaulus, with a reticular hydrorhiza, from which arise single sessile or pedunculate hydranths, and scattered between them single gonophores. Hydranths claviform, naked, with a single circlet of filiform tentacles, which surround the base of a conical hypostome. Gonophores ovate, naked, with a simple central spadix. Chitinous perisarc investing only the tubular branches of the hydrorhiza.

Species of Stylactella.

1. *Stylactella vermicola*, Allman, Report, *loc. cit.*, p. 2, pl. i. fig. 2.—Symbiotic with an Annelid. Station 244 ; depth, 2900 fathoms.

2. *Stylactella spongicola*, n. sp.—Symbiotic with many Deep-sea Keratosa (Spongelidæ and Stannomidæ). Stations 241, 244, 270 to 274, &c. ; depths between 2000 and 2900 fathoms.

3. *Stylactella abyssicola*, n. sp.—Symbiotic with several Deep-sea Keratosa (Spongelidæ and Stannomidæ). Stations 198, 270 to 272, &c.

The genus *Hydranthea*, Hincks, is also similar to our *Stylactella*. Allman, in his Tubularian Monograph (p. 301), places it between *Wrightia* (*Atractylis*) and *Stylactis*. Comparing the figures of his *Hydranthea margarica*, which Hincks gave in 1863,[1] I find it rather different, not only in the formation of the hydranth (with a short hydrocaulus and a double circlet of tentacles), but also in the formation of the gonophores. These are true medusiform sporosacs, with four radial canals in the rudimentary umbrella. The gonophores of *Stylactella*, however, like those of *Stylactis*, are simple club-shaped sacs, with a central blind-canal or spadix, between which and the ectodermal membrane the ova are developed. I am much inclined to regard this formation as a primitive one, not as having arisen from reduced Medusoids (as in the case of *Hydranthea*). I suppose that *Stylactella* (and probably also *Stylactis* and some allied genera) belong to the oldest and most primitive forms of Hydroids, and that their gonophores are not reduced Medusoids, but either simple genital buds, organs of the hydranth (as in *Hydra*), or sexual zooids, separated from the nutritive zooids by division of labour. Perhaps *Stylactella* and the allied genera may represent together a distinct family, Stylactidæ.

[1] *Ann. and Mag. Nat. Hist.*, ser. 3, vol. x. pl. ix. fig. 4.

Stylactella spongicola, n. sp. (Pl. II. figs. 5, 6).

Habitat.—Northern and Central Pacific, symbiotic with Stannomidæ, Spongelidæ, and Psamminidæ; Stations 241, 244, 270, 271, 272, 274; depths between 2300 and 2900 fathoms.

Stylactis with a reticular hydrorhiza, the anastomosing tubes of which are cylindrical and of equal breadth. Hydranths ovate or clavate, springing at short intervals from the hydrorhiza, sessile or very shortly pedunculate, with a single circlet of eight(?) tentacles. Gonophores ovate, twice as large as the hydranths, arising scattered between them from the hydrorhiza.

Stylactella spongicola is by far the most frequent among the Hydroids which live in symbiosis with the Deep-sea Keratosa. It is the usual symbiotic Hydropolyp in all the species of Stannomidæ, and occurs too in some Spongelidæ (*Psammophyllum*, *Cerelasma*) and in some Psamminidæ (*Psammopemma*). Its hydrorhiza traverses the body of these sponges in all directions, and replaces the absent strong spongin-fibres, giving to the sponge a firm support and a distinct form. Since the network of the hydrorhiza is continuous throughout the whole sponge, it reaches in the largest species of *Stannophyllum* (*venosum*) the enormous size of 100 to 200 mm. and more. The polygonal or roundish meshes of the network are of variable diameter, usually between 1 and 0·5 mm., but sometimes they are far larger, 3 to 5 mm. or more, at other times only 0·2 to 0·4 mm. The chitinous tubes of the network are cylindrical, of nearly equal breadth, usually between 0·05 and 0·1 mm., but sometimes 0·12 mm. and more (Pl. II. fig. 6, *h*). The thin, yellowish, chitinous wall is of variable thickness. The entoderm of the hydrorhiza, inside the chitinous tubes, is always dark coloured, greenish brown or yellowish brown.

The hydranths are usually developed in the superficial layers of the network only, and mainly in the distal portion of the sponge. But in many specimens they are difficult to observe, and sometimes I failed to discover them at all. They are most easily examined in those Stannomidæ in which the skeleton is for the most part composed of Globigerina ooze. After having dissolved the calcareous matter by hydrochloric acid, there remains the transparent and colourless mesoderm of the sponge, in which the dark network of the hydrorhiza is easily seen (Pl. II. fig. 5).

The hydranths of *Stylactella spongicola* are ovate or club-shaped, and spring at irregular intervals directly from the branches of the hydrorhiza. They are very small, only 0·2 to 0·3 mm. in diameter, whilst the hydranths of *Stylactis vermicola* (Allman, *loc. cit.*) are ten times as large. The small basal pedicle, which is very distinct in this latter, invested with a chitinous perisarc ("rudimental stem," Allman), is wanting in the former species. The small claviform or oviform hydranths exhibit at the distal

end a rounded or conical hypostome, and beyond it a circlet of a few short simple tentacles; their number seems to be usually (or always?) eight. The tentacles are usually highly contracted and turned inwards, rarely distinctly protruded (fig. 6, *ij*).

The gonophores are wanting in the great majority of the specimens examined. They were, however, very distinct in a few specimens which were found in *Stannophyllum globigerinum* and in *Stannarium alatum*. They are shortly pedunculate, of the same ovate or club-shaped form as the hydranths, but twice or three times as long and broad, without tentacles, and represent sporosacs, which in a few cases were distinctly filled with eggs (fig. 6, *e*). The entoderm of the gonophores and hydranths exhibits the same dark brown or greenish colour as that of the hydrorhiza.

Stylactella abyssicola, n. sp. (Pl. II. fig. 7).

Habitat.—Northern and Central Pacific; symbiotic with Stannomidæ and Spongelidæ: Stations 244, 271, 272; depths between 2300 and 2900 fathoms.

Stylactis with a reticular hydrorhiza, the anastomosing tubes of which are of variable breadth, fusiform dilatations alternating with narrower cylindrical portions. Hydranths ovate, pedunculate, springing at short intervals from the hydrorhiza, provided with a simple circlet of twelve to sixteen tentacles. Gonophores of about the same size as the hydranths, arising scattered between them from the hydrorhiza.

Stylactella abyssicola is much less abundant than the preceding closely-allied species; it occurs in several specimens of *Psammophyllum* and *Stannophyllum*, taken at Stations 244, 271, and 272. It is easily distinguished from the smaller *Stylactella spongicola* by the larger size of all the parts, and the irregular formation of the tubes of the hydrorhiza. These are not cylindrical and of equal breadth, but exhibit irregular fusiform dilatations (often a single one between every two hydranths). Often also the nodal points of the anastomosing tubes exhibit triangular dilatations. The diameter of the tubes is usually between 0·2 and 0·3 mm., twice or thrice as large as in *Stylactella spongicola*, and the chitinous perisarc is thicker than in the latter; the network of the hydrorhiza is looser and its meshes larger.

The hydranths arise from the hydrorhiza with short peduncles, usually of their own length; they are club-shaped or ovate, 0·5 to 0·6 mm. in diameter, and bear beyond the shortly conical hypostome a single circlet of tentacles (about ten or twelve to sixteen). I was, however, able in a few cases only to recognise the form of the hydranths distinctly (fig. 7, *ij*). The same must be said of the gonophores, which are scarcely larger than the hydranths, of the same form, but without tentacles (fig. 7, *g*), springing from the hydrorhiza (*h*) scattered between the hydranths.

CLASSIFICATION OF SPONGES.

The principles of classification have assumed in modern zoology a general importance previously unknown, since we maintain that these principles are essentially phylogenetical, that morphological relation in a certain sense is historical, and that a true natural system approaches to the hypothetical pedigree of the related forms. The class of sponges possesses in this respect a particular interest, because they are the lowermost among the Metazoa, the simplest in organisation, and the most variable as regards constancy of species. Led by this conviction, I began in 1867 my researches on the Calcispongiæ, the results of which were published in 1872 in my Monograph of this order.

The general principles of classification there given are in accordance with those which have been employed in three excellent Monographs among the five Reports hitherto published on the sponges collected by the Challenger Expedition. W. J. Sollas in his Report on the Tetractinellida,[1] F. E. Schulze in his Report on the Hexactinellida,[2] and S. O. Ridley and A. Dendy in their Report on the Monaxonida,[3] have expressed opinions and followed principles in the classification of the Spongiæ which are essentially the same as my own. But the same cannot be said of two other reports on sponges belonging to this series, viz., those which Dr. Poléjaeff has published on the Calcarea[4] and on the Keratosa.[5] Since my own researches concerned just these two groups, and since my general statements are severely attacked by Dr. Poléjaeff, I may be permitted here to add some remarks on his opposing views, and to explain the contradictions in our systematical aims.

Poléjaeff has explained his systematical principles not only in the two Reports above mentioned, but also in the general account of his chief results communicated in the Narrative of the Cruise of H.M.S. Challenger.[6] His first and foremost principle is, that a natural classification of the sponges, hitherto wanting, can only be reached by comparative physiology. "So long as spongiology will not attach due influence to comparative physiology in its systematic proceedings, no hopes can be entertained of a natural arrangement of the sponges."[7] The most important part of a natural systematic classification, according to Poléjaeff, consists in the task of proving actually which of the so-called genera and subgenera "are really to be regarded as subgenera (*i.e.*, groups which, although connected by numerous intermediate stages with their systematic neighbours, still present in their organisation a new principle fit for a further development) and not as species and even varieties. This latter question is to be decided (perhaps exclusively) by the methods of comparative physiology."[8] Poléjaeff also

[1] Zool. Chall. Exp., pt. lxiii. vol. xxv. p. cv.
[2] Zool. Chall. Exp., pt. liii. vol. xxi. p. 485.
[3] Zool. Chall. Exp., pt. lix. vol. xx. p. 53.
[4] Zool. Chall. Exp., pt. xxiv. vol. viii.
[5] Zool. Chall. Exp., pt. xxxi. vol. xi.
[6] Narr. Chall. Exp., vol. i. p. 639.
[7] *Loc. cit.*, p. 643.
[8] *Loc. cit.*, p. 644.

concludes his Report on the Keratosa with general considerations on the systematic importance of comparative physiology, which, according to him, shall solve the difficult problems that no morphological science, neither comparative anatomy nor comparative ontogeny, may be able to solve.

My own systematic principles, based on classificatory work of thirty years, and practically employed in my General Morphology (1866), as well as in my Monographs of the Radiolaria, Calcispongiæ, Medusæ, and Siphonophoræ, start from quite an opposite point of view. My firm conviction is, that every systematic task can be solved only by morphological, not by physiological work. I cannot find, in the immense systematic literature of zoology and botany, a single work in which any important progress has been made by the help of comparative physiology; I cannot even understand in what possible way this science should be useful. All classificatory works, clearing our views on the natural system of major or minor groups, are based only upon morphological researches either of comparative anatomy (in the widest sense) or of comparative ontogeny and palæontology. Morphology and physiology, the two main branches of biological science, are of equal value and equal importance, but their methods and aims are totally different, and in systematic work, in the distinction and phylogenetic arrangement of forms, morphology alone is applicable, not physiology. Dr. Poléjaeff himself, although so emphatically praising the latter, has in his classification employed only the former; he has not demonstrated the way in which classification shall be elucidated by comparative physiology.

The second important point in which my systematic views are quite opposed to those of Dr. Poléjaeff, is the true meaning and the proper signification of the systematic categories, or of the larger and smaller groups of forms, which are distinguished in each system as classes, orders, families, genera, species, varieties, &c. Two different and opposite conceptions are possible in this respect: either all these categories are artificial and of only relative value, divisions produced by the logical mind of the systematic naturalist, or they are all natural and possess an absolute character, founded on their morphological differences and justifying their absolute distinction. We may briefly call this latter the dogmatic conception, the former the critical conception of the systematic categories.

The dogmatic conception, supported by Dr. Poléjaeff, has been explained in the most ingenious manner by Louis Agassiz, in his well-known essay on classification (1859). He undertook the task of giving an absolute definition to each of the systematic categories, and to prove that they are distinct not only in a relative and quantitative respect, but also in an absolute and qualitative respect. I have given a careful critical analysis of these views in chapter xxiv. of my General Morphology.[1] I have stated there that each absolute definition of any category, in the sense of L. Agassiz, is perfectly

[1] Generelle Morphologie, vol. ii. pp. 374–402.

artificial and in no way tenable. I quite agree with Jean Lamarck, who has entitled the first chapter of his classical Philosophie Zoologique (1809) :—"Des parties de l'art dans les productions de la nature"; he has clearly proved that all our systematic categories, classes and orders, no less than the genera and species, are artificial products of the human mind, and that they all possess only a relative, not an absolute, character. The theory of selection, given half a century afterwards by the immortal Charles Darwin, explains how all these categories have arisen, and shows that natural classification can only be phylogenetical, and that all apparently "good species" were originally "bad species."

Special diligence has been displayed by Poléjaeff in giving an absolute definition of the category of genus. According to him, "generic unity serves as a firm basis, which has been wanting in descriptive zoology since the mutability of species was actually proved."[1] He regards "the generic character to be a character of sufficient constancy, and together with this, allowing numerous modifications either in the direction of a further development or in the direction of different variations."[2] But may we not say the same of the family? the same of the species? the same of the variety? This dogmatic definition, and also any other attempt to characterise any category of the system by an absolute definition, are, in my opinion, quite untenable and worthless. I think I have proved this in chapter xxiv. of my General Morphology. Genera are artificial conceptions in the same way as species; varieties are incipient species, species incipient genera.

Poléjaeff gives in chapter ii. of his Report on the Keratosa a criticism of the genera, and commences it with an enumeration of the three conditions which Nägeli holds indispensable for the absolute distinction of genera.[3] But what Nägeli demands for the allied species of one genus may be demanded for the genera of one family, the same for the families of one order, the same for the varieties of one species. Poléjaeff adopts the opinion of Nägeli, that "the existence of an absolute distinction of genera is indispensable,"[4] and he undertakes to give such an absolute distinction. In my opinion, these genera are no more and no less artificial than all other genera. The history of systematic classification shows us that the absolute distinction of genera is quite impossible, and that the progress of one century has been sufficient to dissolve the definitions and the conceptions of nearly all the older genera, and to replace them by a larger number of smaller genera; the latter, of course, must increase in the same degree as the specialisation of our knowledge and the specification of minor morphological differences.

Having stated that the first principles of classification employed by Poléjaeff and by myself are quite contrary to each other, and that we have adopted quite opposite general views, it will be understood that as a natural consequence this diligent Russian author severely attacks the less important parts of my Monograph of Calcispongiæ.

[1] Zool. Chall. Exp., pt. xxxi. p. 82.		[2] Narr. Chall. Exp., vol. i. p. 644.
[3] *Loc. cit.*, p. 21.		[4] Narr. Chall. Exp., vol. i. p. 645.

This is not the place to answer his objections; I may only remark, that he has not taken into account the main intention of my classificatory essay, which was to prove analytically the theory of descent, and to prove that so-called "bonæ species" do not exist in nature, that they are all originally "bad species." I have noted this principal intention in the preface to my Monograph of Calcispongiæ (pp. xi, xii), and explained it in the second part of the fourth chapter (Phylogeny, pp. 340–360). A natural consequence of my phylogenetic conviction is the opinion that "natural species" do not exist, and therefore the 21 genera and 111 species which I have distinguished in my "natural system" can possess only a relative value. They are, indeed, more natural than those of the older artificial system. Poléjaeff, always looking for absolute distinction, must, of course, reject them. But his own distinctions are also more or less artificial, and exposed to the same general objections as all others.

Curiously enough, Poléjaeff says in the Narrative,[1] that "the whole Report on the Keratosa is almost exclusively of a critical character." My own view, based upon opposite principles, is that his Reports are more dogmatical than critical. For example, I must regard it as perfectly dogmatical when Poléjaeff unites all the Keratosa in a single family and all the Asconidæ in a single genus. What advantage is got by this summary blending? It would be scarcely less dogmatical to unite all the Keratosa in a single genus, or all the sponges in a single family. Poléjaeff strongly blames the *circulus vitrosus* which most authors follow in distinguishing genera and families among the sponges.[2] In my own opinion, his whole systematic work turns in a large *circulus vitrosus*. It is based upon dogmatic convictions which are quite incompatible with our modern phylogenetical views and with the first principles of the theory of descent.

RELATION OF THE KERATOSA TO THE OTHER SPONGES.

The new forms of so-called Keratosa (or Ceratina) which are described in this Report, and which inhabit the abyssal regions of the deep sea, seem to throw a new light on this remarkable group of sponges, and to modify somewhat our views on their relations to the other Porifera. The general opinion of most modern spongiologists (maintained by F. E. Schulze, Lendenfeld, Vosmaer, Sollas, and others) is, that the horny sponges or Keratosa have descended from Silicosa, or from sponges which possessed siliceous spicules. The uninterrupted chain which connects certain Keratosa with certain Silicosa is the mainstay of this opinion. I must confess that this phylogenetical hypothesis, though based on many acceptable arguments, seems to me by no means to be decidedly demonstrated. The new Keratosa here described present several great difficulties to its acceptance. It seems to me very improbable that all these characteristic horny sponges of the deep sea (and especially the cannocœlous Ammoconidæ) are degenerate Silicosa

[1] *Loc. cit.*, p. 645.   [2] Zool. Chall. Exp., pt. xxxi. p. 83.

which have lost the siliceous spicules. In my opinion, the common ancestral group of all sponges (provided that the whole class is monophyletic) has been skeletonless, and the various main groups (subclasses or orders) descending from it have acquired the different skeletal forms in different ways polyphyletically. This does not exclude the possibility that in some skeletonless sponges the want of a proper skeleton is secondary, produced by reduction.

For the sake of brevity and clearness I will here call the hypothetical common ancestral group, in which originally no skeleton was formed, Archispongiæ. To this primordial group may perhaps belong some Myxospongiæ (Halisarcidæ, Chondrosidæ) and some Psammospongiæ (Ammoconidæ, Psamminidæ). From the same common ancestral group may have arisen, as independent main branches, on one side the Calcispongiæ, on the other side a part of the true Keratosa (not descended from Silicosa), and further the Demospongiæ (Monaxonida and Tetractinellida) and the Hyalospongiæ (Hexactinellida). It is quite possible that a horny skeleton, produced by the formation of spongin-fibres, has arisen polyphyletically, independently in different groups of sponges. The now prevailing opinion of their monophyletic origin seems to me not very probable.

The nature and origin of the horny skeleton is an important point in these phylogenetical problems. In my opinion, the spongin-skeleton must not be regarded as a formation of the same order and value as the calcareous skeleton of the Calcispongiæ, or the siliceous skeleton of the Silicosa. Regarded from a general histological point of view, the horny tissue of the sponges seems to present many analogies in form and development to the elastic tissue in the higher Metazoa. The different forms of thin fibrillæ and strong fibres, simple and branched fibrillæ, isolated and reticulated fibres, bundles and networks of fibrillæ, which are found among the numerous modifications of the elastic tissue, and which arise in the maltha or the ground-mass of the connective tissue, occur also in the horny fibrous tissue of the sponges. The chemical nature is little different, and even the origin may often be similar. The strong fibres of many Keratosa are produced by series of associated spongoblasts (F. E. Schulze), but the fine fibrillæ of the Stannomidæ and the spongin-capsules and lamellæ of *Cerelasma* are certainly formed in another way. Perhaps each fine fibrilla of the Stannomidæ is the filiform product of a wandering amœbocyte, in a similar way as a dentin-fibrilla is secreted from an odontoblast. But it may also be that these and similar spongin-fibrillæ are produced by a chemical and physical alteration of the ground-mass, without the direct action of a cell, in a similar way as is the case in the fibrous cartilage.

Comparing the horny skeletons in the new Keratosa here described (especially the Stannomidæ), and in the various groups of the so-called Cornacuspongiæ, it seems to me very probable that horny fibres, as strengthenings of the maltha, have arisen in different groups of Keratosa and of Silicosa, independently one from another; it is even very probable that the fossil Pharetrones (Zittel), that remarkable group of Calcispongiæ which

was extinct in the cretaceous period, possessed a similar fibrous horny skeleton as in many Halichondriæ.

Greater difficulties still arise against the modern views on the phylogeny of sponges when we consider the different forms of the canal-system. The two main forms of it, as now generally considered, are the tubular form of the Asconal-type (Asconidæ) and the vesicular form of the Leuconal-type (and the allied Syconal and Aplysinal types). The latter, being the more complex, must have originally risen from the former, in which is found the simplest architype of all, the *Olynthus*, closely allied to the *Gastræa*. The great phylogenetical importance of this archisponge, first pointed out in my Monograph of the Calcispongiæ, is now generally accepted. But the *Olynthus* there described, and the allied Asconidæ, possess a calcareous skeleton ; they must have been derived from an older simple sponge of the same type, which was as yet skeletonless. A slight modification of this hypothetical *Archolynthus* seems to be our interesting *Ammolynthus*. This typical form and the other closely-allied Ammoconidæ (*Ammosolenia, Ammoconia*) supply a new and strong argument in favour of the opinion that the vesicular sponges (with flagellated chambers) originally descended from tubular sponges (with tubular flagellated epithelium) ; we may call the latter (with canal-system of the Asconal-type) Protospongiæ, the former (with canal-system of the Leuconal-type) Metaspongiæ. Starting from this point of view, we may arrive at the following classification of the sponges:—

First Class. PROTOSPONGIÆ,

With tubular canal-system (Asconal-type).

Order   I. AMMOCONIDÆ (Malthosa)=CANNOCŒLA.

Order II. ASCONIDÆ (Calcarosa)=HOMOCŒLA.

Second Class. METASPONGIÆ,

With vesicular canal-system (Leuconal, Syconal, or Aplysinal type).

Order III. MALTHOSPONGIÆ (originally skeletonless Keratosa)=DOMATOCŒLA (Psamminidæ, and perhaps many Ceratinæ).

Order IV. DEMOSPONGIÆ (Sollas, Zool. Chall. Exp., pt. lxiii. p. xcviii).

Order V. HYALOSPONGIÆ (Hexactinellidæ).

Order VI. CALCISPONGIÆ (Syconidæ, Leuconidæ, Tichonidæ, Pharetronidæ, excluding Asconidæ)=HETEROCŒLA.

We may have another classification of the main groups of sponges if we consider as the first principles of classification, not those important differences of the tubular and vesicular canal-system (corresponding to the structures of the tubular and vesicular glands), but the differences in the materials of the skeleton. The great value of these skeletal differences has been acknowledged since Grant's time, and employed in various ways by later authors up to this time, but it seems to me that no single author has pointed out the important difference, phylogenetically, between a primary want of the skeleton and a secondary one (by reduction); further, all authors of recent time, in my opinion, have followed too far the monophyletic way (especially in judging of the Keratosa), whilst in animals of such simple structure and low degree of organisation polyphyletic hypotheses often approach nearer to the truth.

Particular attention should be paid in this respect to the Psammospongiæ, under which name I comprise those remarkable so-called Keratosa in which no trace of spongin is found, but in which the whole skeleton consists only of agglutinated xenophya, crowded in the maltha, and is therefore a false or pseudo-skeleton. These Psammospongiæ, or pure arenaceous sponges, are represented in the Challenger collection by the Ammoconidæ (Pl. VIII.) and Psamminidæ (Pl. VII.) described above, with six genera and twelve species of peculiar interest. Most authors, following the presently accepted views, would regard these Psammospongiæ as most reduced forms, derived from Silicosa, which have lost the siliceous spicules as well as the spongin-skeleton. In my opinion, it is more natural to regard these low forms as primitive ones, as Archispongiæ, which begin the skeleton formation by taking up xenophya.

Accepting this theory, we may even assume that the double formation of the mineral skeleton of sponges, the calcareous and the siliceous, has a causal relation to the double composition of the deep-sea ooze, from which the eldest Psammospongiæ have taken their skeleton materials, the calcareous Globigerina ooze and the siliceous Radiolarian ooze. The descendants of the oldest Archispongiæ (which certainly were skeletonless) began to take up deep-sea ooze from the bottom, and to crowd this supporting and protecting material in their maltha. By and by the mesodermal tissue was adapted to dissolve certain quantities of those two mineral bodies, and afterwards a certain portion of the dissolved mineral matter contained in the maltha was secreted in the form of spicules. This secretion may have been perfectly independent from the formation of spongin-fibres in the maltha. In such a manner the oldest Calcispongiæ (Asconidæ) may have descended perhaps from Psammospongiæ, which had taken up Globigerina ooze (e.g., *Ammolynthus haliphysema*, Pl. VIII. figs. 2–4), and in a similar manner the Silicispongiæ (perhaps polyphyletically in several independent branches) may have arisen from the oldest Psammospongiæ, which had taken up Radiolarian ooze (e.g., *Ammolynthus prototypus*, Pl. VIII. fig. 1).

Starting from this standpoint, we may accept as provisional the following classification

Order VII. Leucospongiæ (Syconidæ, Leuconidæ, and Tichonidæ).—Calcisponges without spongin-skeleton, with vesicular canal-system.

Order VIII. Pharospongiæ (Pharetronidæ).—Calcisponges with a fibrous spongin-skeleton, with vesicular canal-system.

Position of the Sponges in the Animal Kingdom.

The important question of the natural affinities of the sponges and of their position in the animal kingdom has been fully discussed in the former Reports of this series already quoted, and especially in the excellent Report of Sollas on the Tetractinellida.[1] Agreeing in general with the deductions of Sollas, as well as with his general conceptions of the sponge organisation, it seems to me not necessary to separate the Spongiæ from the other Metazoa. The fact that the sponges develop from a true Gastrula, and their tissues from two primary germ-layers, as in all other Metazoa, seems to prove the validity of their position within this kingdom. This position is mainly maintained by Lendenfeld in his works above quoted (1886). The same opinion is confirmed afresh if we look upon the flagellated chamber as the primitive individual, and as homologous with a Gastræa on the one hand and with a simple Hydroid on the other. I agree with Sollas that the sponges form a separate phylum within the sub-kingdom Cœlenterata, but the distance between them and the Cnidaria (especially the Hydroida) is not greater than that between the Cnidaria and the Platoda. The general results of this Report on the Deep-sea Keratosa seem to confirm this opinion.

The position of the sponges in the animal kingdom (as a separate phylum of the Cœlenterata), which in the present state of our daily increasing knowledge seems to be the most natural, will be best understood from the following synopsis of the Metazoa, which I have employed in my lectures during recent years :—

Systematical Synopsis of the Main Branches, Phyla, and Classes of the Metazoa.

A. First main branch of the Metazoa.

Cœlenteria (Cœlenterata vel Zoophyta).

Phylum I. Gastræada.

Classes : 1. Physemaria ; 2. Cyemaria (Orthonectidæ, Dicyemidæ).

[1] Zool. Chall. Exp., pt. lxiii. vol. xxv. p. cxii.

Phylum II. S P O N G I Æ (Porifera).

Classes : 1. Malthospongiæ ; 2. Silicispongiæ ; 3. Calcispongiæ [or perhaps better, 1. Protospongiæ (Tubulosæ) ; 2. Metaspongiæ (Vesiculosæ)].

Phylum III. C N I D A R I A (Acalephæ).

IIIA. Subphylum 1. HYDROZOA.

Classes : 1. Hydropolypi ; 2. Hydromedusæ (Craspedotæ) ; 3. Siphonophoræ.

IIIB. Subphylum 2. SCYPHOZOA.

Classes : 4. Scyphopolypi ; 5. Anthozoa (Corolla) ; 6. Scyphomedusæ (Acraspedæ).

Phylum IV. P L A T O D A (Plathelminthes).

Classes : 1. Turbellaria ; 2. Trematoda ; 3. Cestoda ; 4. Ctenophora (?).

B. Second main branch of the Metazoa.

Cœlomaria (Cœlomata vel Bilateria).

Phylum V. H E L M I N T H E S (Vermes).

VA. Subphylum 1. ARCHELMINTHES.

Classes : 1. Trochozoa ; 2. Rotatoria.

VB. Subphylum 2. STRONGYLARIA.

Classes : 3. Nematoda ; 4. Acanthocephala ; 5. Chætognathi.

VC. Subphylum 3. RHYNCHOCŒLA.

Classes : 6. Nemertina ; 7. Enteropneusta.

VD. Subphylum 4. PROSOPYGIA.

Classes : 8. Bryozoa ; 9. Phoronida ; 10. Brachiopoda.

Phylum VI. M O L L U S C A.

VIA. Subphylum 1. COCHLIDES.

Classes : 1. Placophora ; 2. Gastropoda ; 3. Scaphopoda ; 4. Pteropoda.

VIB. Subphylum 2. CONCHADES.

Class : 5. Acephala.

VIc. Subphylum 3. TEUTHODES.

Class : 6. Cephalopoda.

Phylum VII. ECHINODERMA.

VIIA. Subphylum 1. THECOSTELLÆ.

Classes : 1. Holothuriæ ; 2. Echinida.

VIIB. Subphylum 2. PECTOSTELLÆ.

Classes : 3. Cystidea ; 4. Crinoidea ; 5. Blastoidea.

VIIc. Subphylum 3. ANTHOSTELLÆ.

Classes : 6. Ophiuræ ; 7. Asterida.

Phylum VIII. ARTICULATA.

VIIIA. Subphylum 1. ANNELIDA.

Classes : 1. Hirudinea ; 2. Chætopoda ; 3. Gephyrea ; 4. Myzostomida.

VIIIB. Subphylum 2. CRUSTACEA.

Classes : 4. Caridonia (Carides) ; 5. Aspidonia (Merostomata).

VIIIc. Subphylum 3. TRACHEATA.

Classes : 6. Onychophora ; 7. Myriapoda ; 8. Arachnida ; 9. Insecta.

Phylum IX. CHORDONIA.

IXA. Subphylum 1. TUNICATA.

Classes : 1. Copelata ; 2. Ascidiæ ; 3. Thaliæ.

IXB. Subphylum 2. VERTEBRATA.

Classes : 1. Acrania ; 2. Cyclostoma ; 3. Pisces ; 4. Dipneusta ; 5. Amphibia ;
6. Reptilia ; 7. Aves ; 8. Mammalia.

PLATE I.

Family STANNOMIDÆ.

Genus *Stannophyllum*.

PLATE I.

Stannophyllum.

Figs. 1A–1C. *Stannophyllum zonarium*, n. sp. (p. 62).

Figs. 1A, 1B. Two complete sepcimens, ...   nat. size

Fig. 1C. A small portion of the surface ; magnified.

Figs. 2A–2C. *Stannophyllum radiolarium*, n. sp. (p. 65).

Figs. 2A, 2B. Two complete specimens, ...   nat. size

Fig. 2C. A small portion of the surface ; magnified.

Figs. 3A, 3B. *Stannophyllum pertusum*, n. sp. (p. 65).

Fig. 3A. Complete specimen, ...   nat. size

Fig. 3B. A small portion of the surface ; magnified.

Fig. 4. *Stannophyllum venosum*, n. sp. (p. 67).

Fig. 4. Complete specimen, ...   half nat. size

Fig. 5A–5C. *Stannophyllum globigerinum*, n. sp. (p. 68).

Figs. 5A, 5B. Two complete specimens, 5B having a facial branch (transition
to *Stannarium*), ...   nat. size

Fig. 5C. A small portion of the surface ; magnified.
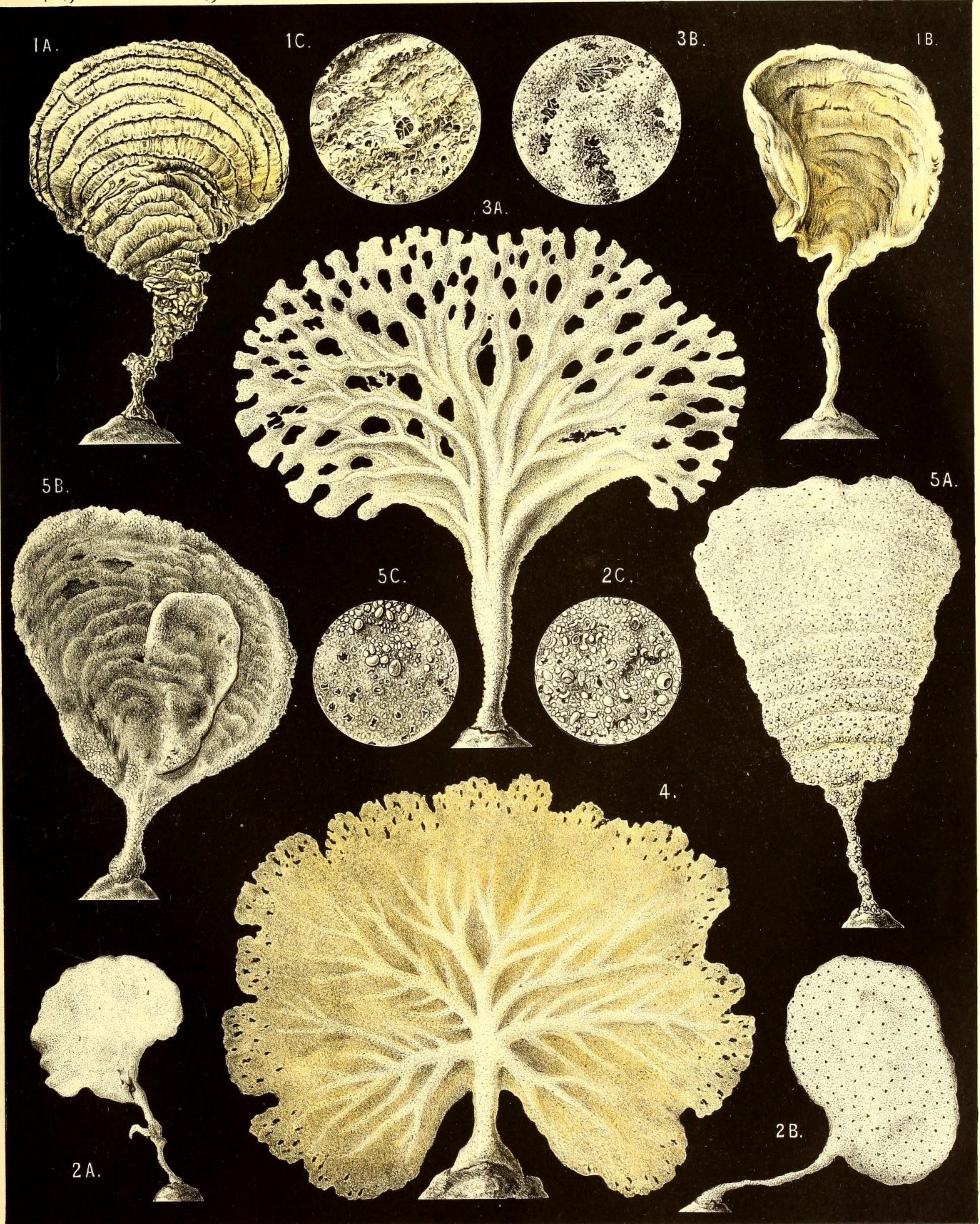
1-5. STANNOPHYLLUM, 1. S.ZONARIUM, 2.S. RADIOLARIUM,
3. S. PERTUSUM, 4.S.VENOSUM, 5.S.GLOBIGERINUM,

PLATE II.

Family STANNOMIDÆ.

Genus *Stannophyllum.*

PLATE II.

Stannophyllum.

Figs. 1–4. *Stannophyllum zonarium*, n. sp. (p. 62).

Diam.

Fig. 1. A small portion of the dermal surface, with a single pore (*p*), . × 70

Fig. 2. Another small portion of the dermal surface, more highly magnified, with three pores (*p*). *m*, maltha (ground-mass of the mesoderm); *f*, spongin-fibrillæ; *r*, Radiolarian shells, ... × 200

Fig. 3. Section through a large subdermal cavity. Characters as in fig. 2. *h*, symbiotic hydrorhiza, ... × 70

Fig. 4. View of the distal margin of the flabelliform sponge, with the irregular lacunar cavities of the canal system, ... × 30

Figs. 5, 6. *Stylactella spongicola*, n. sp. (Tubularian Hydroid, p. 80).

Fig. 5. Network of the symbiotic hydrorhiza, creeping below the dermal membrane of *Stannophyllum globigerinum*, with numerous well preserved hydranths, ... × 30

Fig. 6. Tubularian polyp-stock symbiotic with *Stannophyllum globigerinum*. *h*, hydrorhiza; *g*, gonophores; *e*, eggs; *v*, germinal vesicles; *ÿ*, hydranths, ... × 70

Fig. 7. *Stylactella abyssicola*, n. sp. (p. 81).

Fig. 7. Tubularian polyp-stock symbiotic with *Psammophyllum annectens* (see p. 53). Characters as in fig. 6; *s*, spermarium, . . × 70
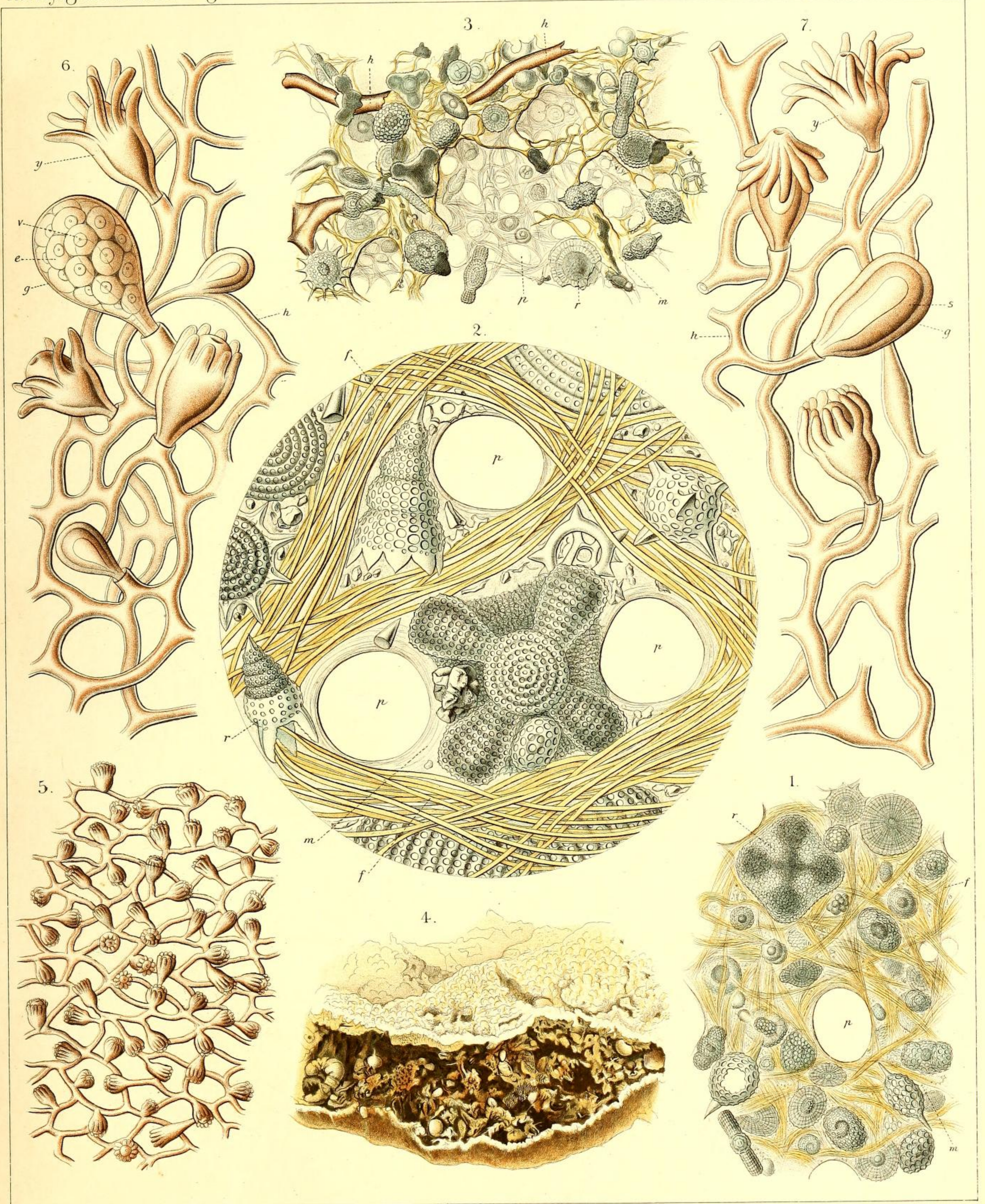
1–4. STANNOPHYLLUM ZONARIUM,

5–7. STYLACTELLA, 5,6. S. SPONGICOLA, 7. S. ABYSSICOLA.

PLATE III.

Family STANNOMIDÆ.

Genera *Stannoma, Stannarium.*

PLATE III.

Figs. 1–4. *Stannoma dendroides*, n. sp. (p. 72).

Diam.

Fig. 1. Complete specimen, ... × 2

Fig. 2. Transverse section through a branch. *f*, spongin-fibrillæ; *r*, Radiolarian shells; *h*, tubular portions of the reticular hydrorhiza of the symbiotic Hydroid (*Stylactella*), ... × 40

Fig. 3. A small portion of the same transverse section (fig. 2); more highly magnified. Characters as in fig. 2, ... × 150

Fig. 4. Surface of a branch. Characters as in fig. 2, ... × 70

Fig. 5. *Stannoma coralloides*, n. sp. (p. 73) .

Fig. 5. Complete specimen, ... × 3

Figs. 6–9. *Stannarium alatum*, n. sp. (p. 70).

Figs. 6, 7. Lateral views, from different sides, ... × 1·5

Fig. 8. Apical view, ... × 1·5

Fig. 9. A bunch of spongin-fibrillæ, ... × 400

Figs. 10–14. *Stannarium concretum*, n. sp. (p. 71).

Figs. 10–12. Small specimen, the xenophya of which are principally Radiolarian shells, ... × 1·5

Fig. 10, lateral view; fig. 11, apical view; fig. 12, basal view.

Figs. 13, 14. Larger specimen (of a softer consistency than the specimen represented in figs. 10–12), the xenophya of which are principally fragments of *Globigerina* shells, ... × 1·5

Fig. 13, apical view; fig. 14, lateral view.
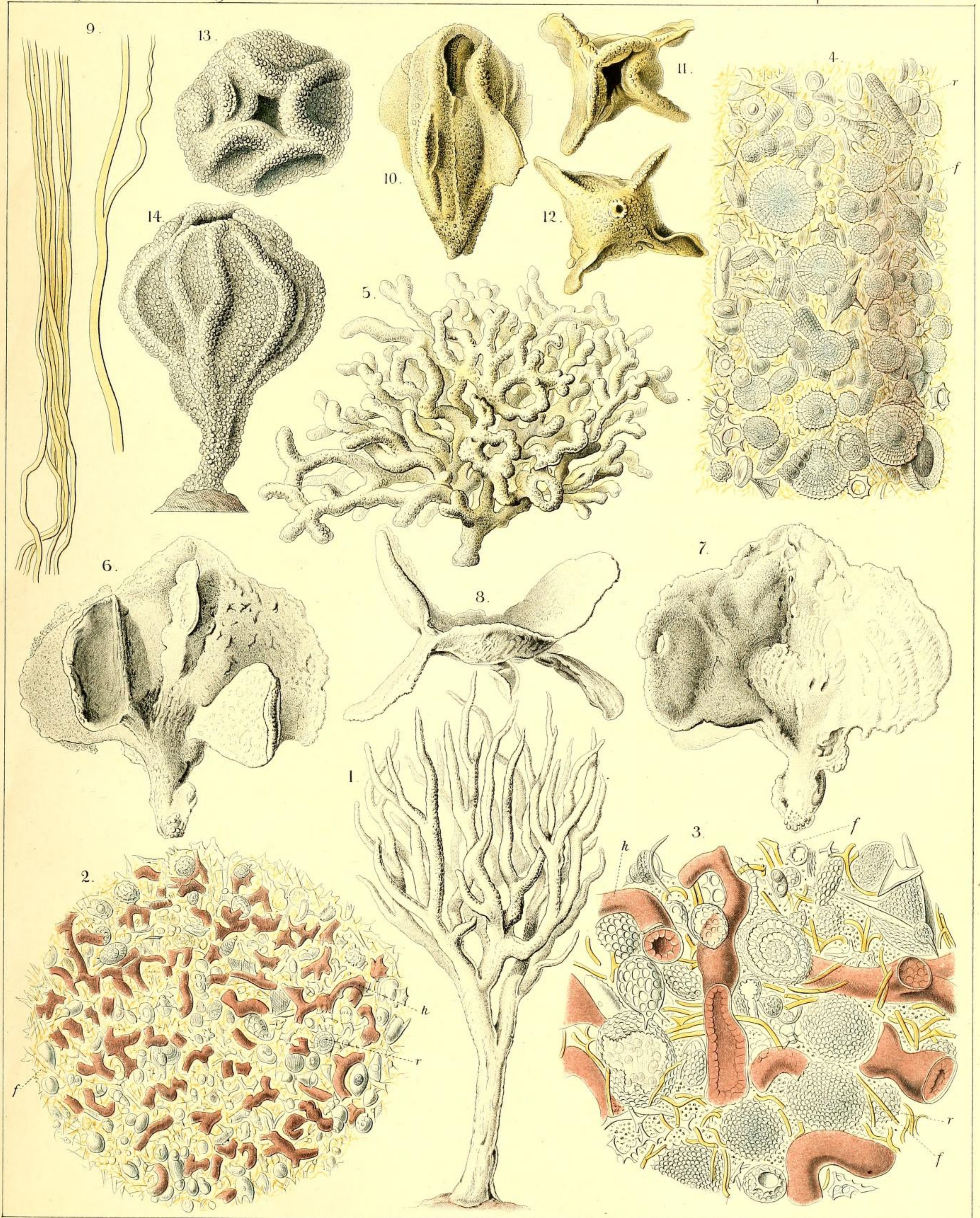
1-5. STANNOMA, 1-4. S.DENDROIDES, 5.S.CORALLOIDES,
6-14. STANNARIUM, 6-9. S.ALATUM, 10-14. S.CONCRETUM.

PLATE IV.

Family SPONGELIDÆ.

Genus *Psammophyllum.*

PLATE IV.

Psammophyllum.

Figs. 1–4. *Psammophyllum annectens*, n. sp. (p. 52).

		Diam.
Fig. 1.	A complete flabelliform specimen, ...	nat. size
Fig. 2.	Portion of a section through the same. *f,* network of spongin-fibrillæ ; *r,* Radiolarian shells, ...	× 300
Fig. 3.	Some spongin-fibrillæ, including Radiolarian shells, . . .	× 400
Fig. 4.	Chitinous tubes of the hydrorhiza of a symbiotic Hydroid, with annular constrictions (*Eudendrium ?*), ...	× 100

Figs. 5–8. *Psammophyllum flustraceum*, n. sp. (p. 51).

Fig. 5.	A complete flabelliform specimen, ...	nat. size
Fig. 6.	Portion of a section through the same. *f,* network of spongin-fibrillæ ; *r,* Radiolarian shells and sponge spicules, . .	× 300
Fig. 7.	Portion of the surface of fig. 5, from its distal part, exhibiting three concentric zones, with the dermal pores (*p*), and the larger openings (oscula, *o*) at the thickened proximal margin of each zone, .	× 4
Fig. 8.	A small portion of the outermost distal zone ; more highly magnified. The surface exhibits the smaller openings (pores), and scattered larger openings (oscula, *o*) at the thickened proximal margin of the zone, ...	× 12

Fig. 9. *Halisiphonia spongicola*, n. sp. (p. 77).

Fig. 9.	Hydroid living in symbiosis with *Psammophyllum flustraceum.* *h,* the reticular hydrorhiza ; *g,* gonangia ; *p,* hydrothecæ, . .	× 20
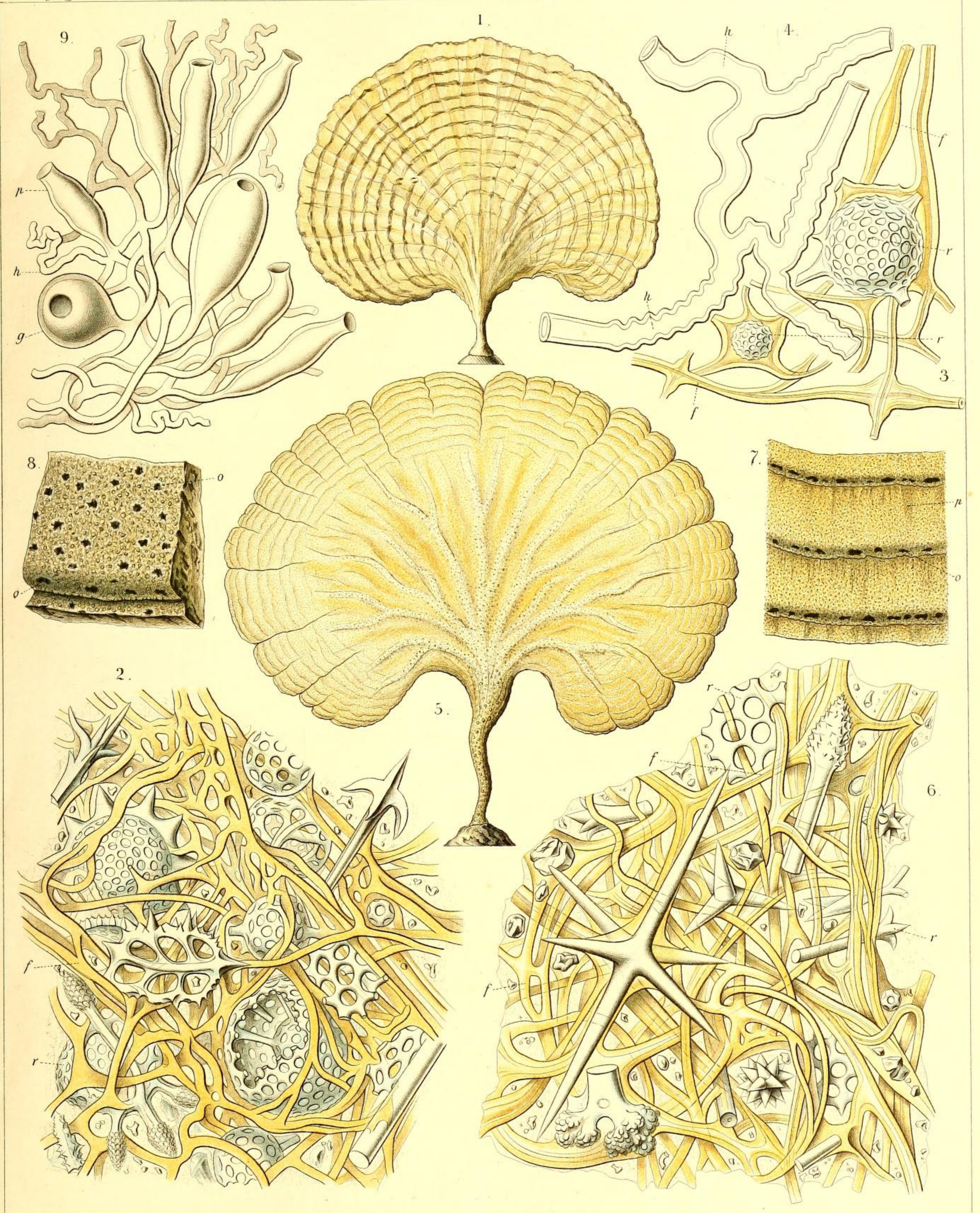
1-8. PSAMMOPHYLLUM, 1-4. P. ANNECTENS, 5-8. P. FLUSTRACEUM.
9. HALISIPHONIA SPONGICOLA.
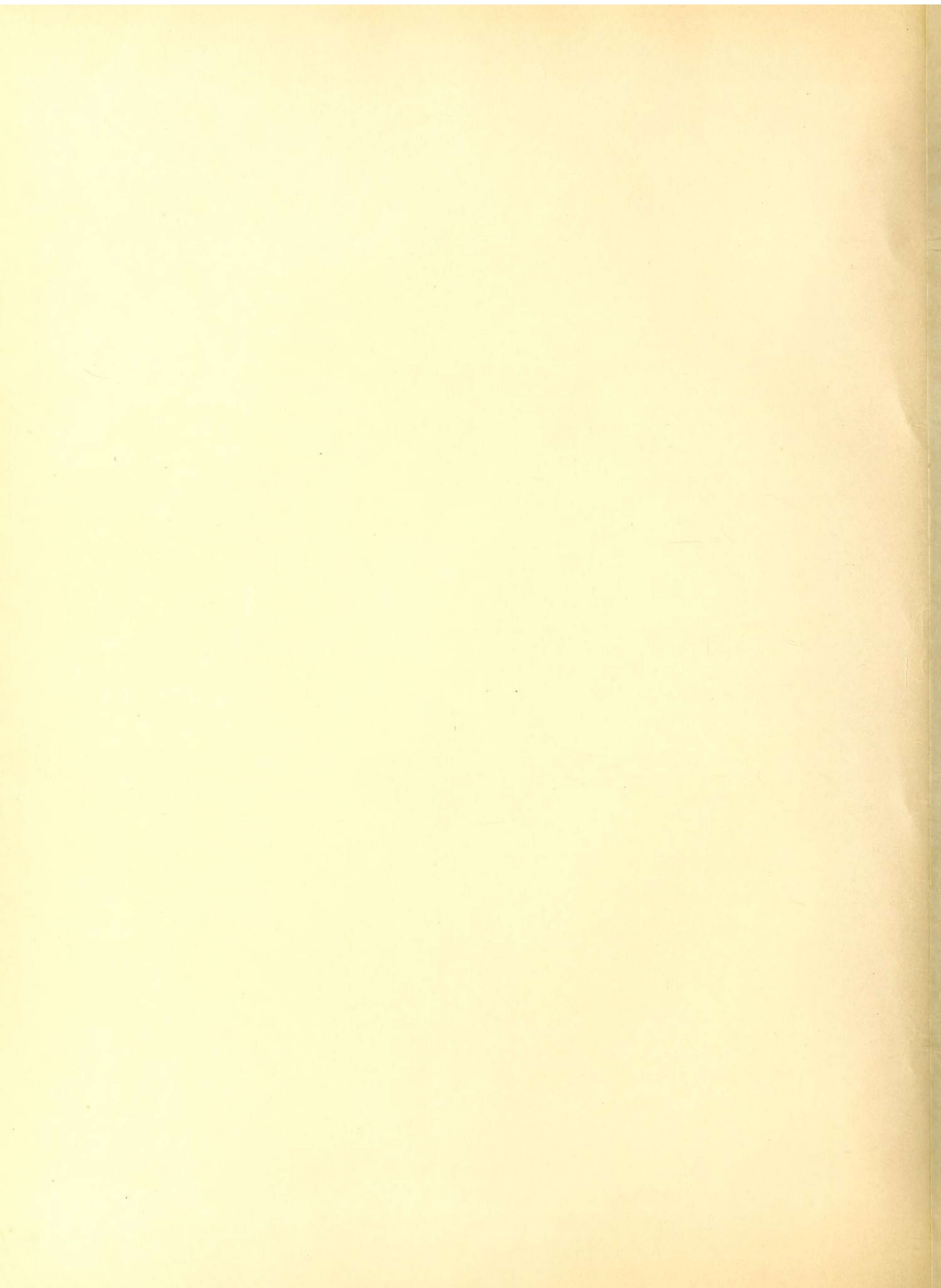
PLATE V.

Family SPONGELIDÆ.

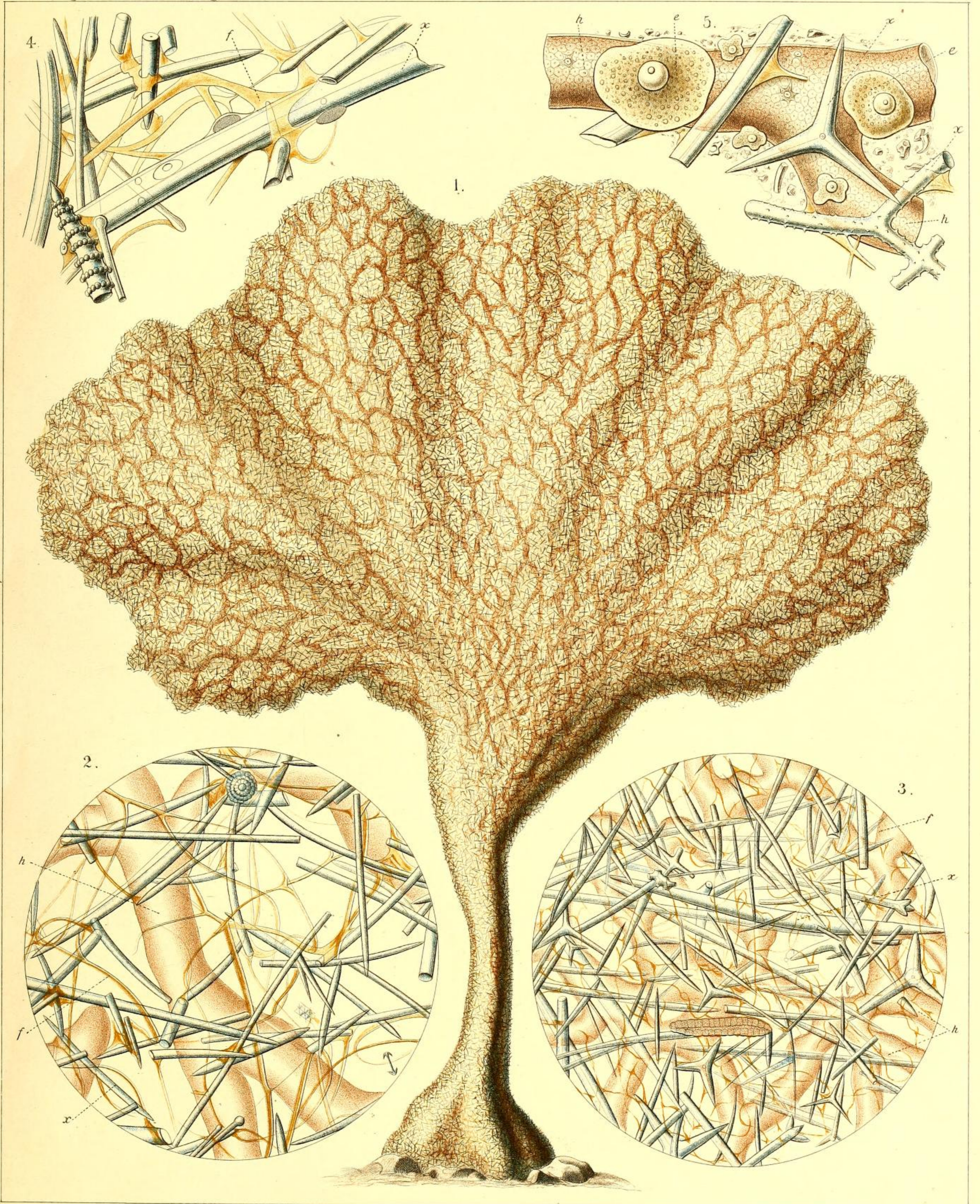Genus *Psammophyllum.*

PLATE V.

Psammophyllum.

Figs. 1–4. *Psammophyllum reticulatum*, n. sp. (p. 50).

Diam.

Fig. 1. A young specimen. The entire parenchyma of the flabelliform sponge is traversed by a coarse network of brown cylindrical tubes, the hydrorhiza of a symbiotic Hydroid (*Stylactella?*). The meshes of this coarse network are filled up by a very fine and delicate network, composed of branching and anastomosing spongin-fibrillæ, which enclose and connect foreign bodies, mainly siliceous spicules of different sponges, ... × 10

Fig. 2. A small portion of the skeleton of the flabelliform sponge. Between the thick brown tubes of the symbiotic Hydroid (*h*), the fine network of the yellow spongin-fibrillæ (*f*), and numerous scattered xenophya (*x*) are visible, ... × 100

Fig. 3. A small portion of the same; less highly magnified. Characters as in fig. 2, ... × 50

Fig. 4. A few xenophya (sponge spicules and Radiolarian fragments) cemented together by the scanty yellow spongin-fibres (*f*), . . . × 300

Fig. 5. *Psammophyllum flustraceum*, n. sp. (p. 51.)

Fig. 5. A forked chitinous tube of a symbiotic Hydroid (*h*); the epithelium on its inside is exceptionally well preserved. In the surrounding maltha of the sponge are visible single amœboid cells and eggs (*e*), and between them are scattered a few xenophya (*x*), and the connecting yellow spongin-fibres, ... × 200

PSAMMOPHYLLUM RETICULATUM.

PLATE VI.

Family SPONGELIDÆ.

Genus *Cerelasma*.

PLATE VI.

Cerelasma.

Figs. 1–5. *Cerelasma gyrosphæra,* n. sp. (p. 46).

Diam.

Fig. 1. A complete spherical specimen of the sponge, . . . nat. size

Fig. 2. A small portion of a transverse section through a branch. *f,* spongin-lamellæ; *x,* pseudo-skeleton composed of xenophya; *h,* greenish hydrorhiza of the symbiotic Hydroid, ... × 50

Fig. 3. A small portion of the section, fig. 2; more highly magnified. Characters as in fig. 2; *r,* Radiolarian shells, ... × 300

Fig. 4. Spongin-lamellæ of the skeleton (*f*), without the imbedded xenophya, observed in glycerine. *h,* a forked tube of the hydrorhiza, . × 300

Fig. 5. A single Radiolarian shell, enclosed by a spongin-sheath; from the edges of the sheath arise spongin-lamellæ (*f*), . . . × 300

Figs. 6, 7. *Cerelasma lamellosa,* n. sp. (p. 47).

Fig. 6. A portion of the sponge, with a partial section through the surface, . × 4

Fig. 7. A small portion of a section through the sponge. *f,* spongin-lamellæ; *x,* xenophya (sponge spicules and mineral particles), . . × 300

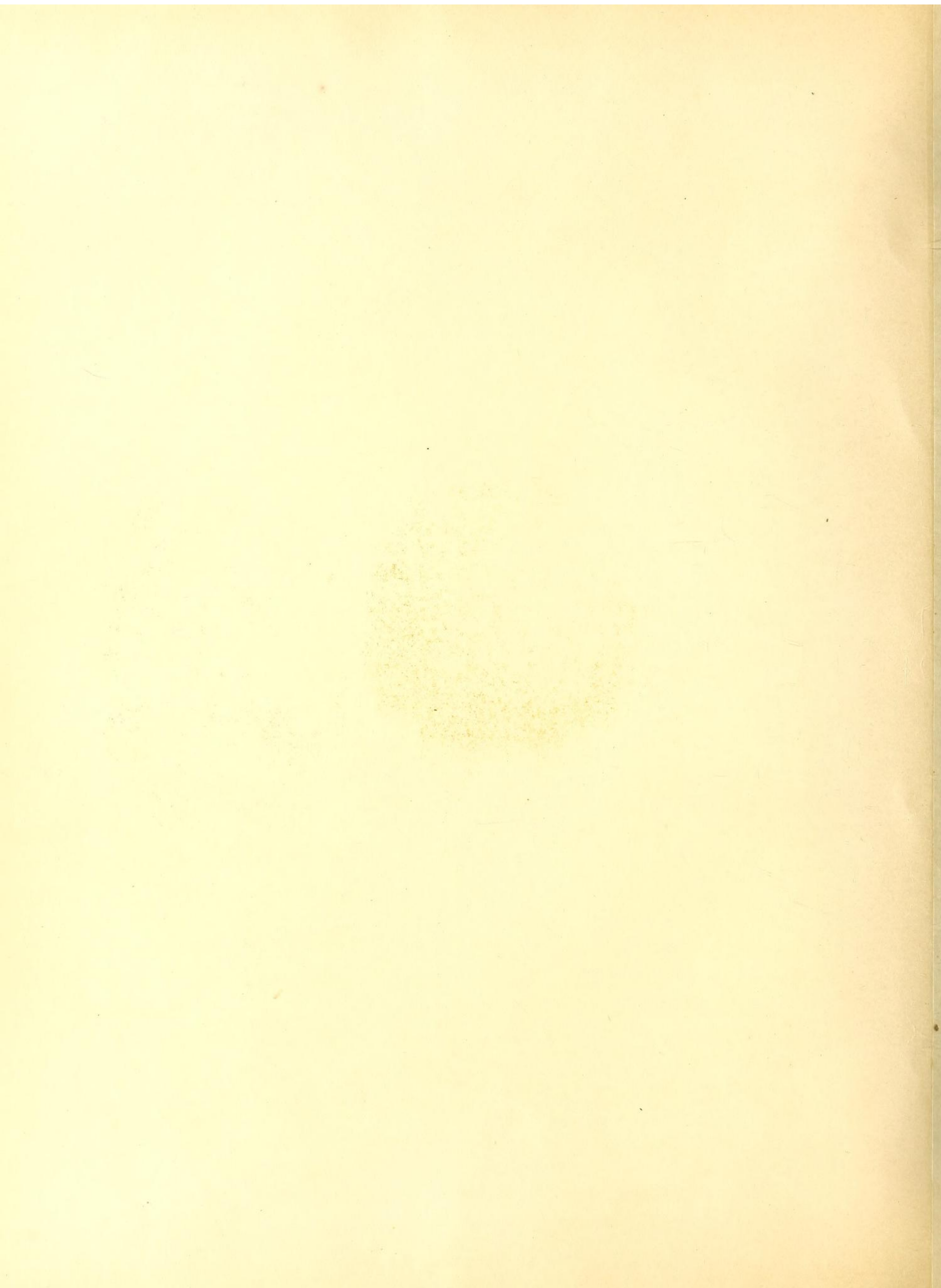1 - 7. CERELASMA, 1 5. C. GYROSPHAERA, 6,7. C. LAMELLOSA.

PLATE VII.

Family PSAMMINIDÆ.

Genera *Psammina, Psammopemma, Holopsamma.*

PLATE VII.

PSAMMINIDÆ.

Figs. 1A–1D. *Psammina plakina*, n. sp. (p. 35).

Diam.

Fig. 1A. Facial view of the discoidal sponge, ... × 5

Fig. 1B. Marginal view of the same, ... × 5

Fig. 1C. Vertical section through the discoidal sponge. *g*, its gastral cavity; *o*, exhalent opening (osculum); *i*, inhalent openings (dermal pores); *k*, flagello-chambers; *e*, eggs (partly in segmentation); *x*, xenophya (*Globigerina* shells); *x'*, upper plate of the pseudo-skeleton; *x"*, lower plate of the same, ... × 70

Fig. 1D. A small portion of the same section; more highly magnified. Characters as in fig. 1C, . × 200

Figs. 2A–2D. *Psammina globigerina*, n. sp. (p. 36).

Fig. 2A. Facial view of the discoidal sponge (superior face). The whole surface is protected by a carapace composed of *Globigerina* shells, ... × 20

Fig. 2B. Marginal view of the same, exhibiting the corona of exhalent openings (*o*), on the peripheral edge of the discoidal sponge, ... × 20

Fig. 2C. Horizontal section through the discoidal sponge, exhibiting the radiating network of the symbiotic Hydroid, expanded in the medullar substance, between the two parallel cortical plates, ... × 20

Fig. 2D. A portion of the medullar parenchyma, after the removal of the calcareous shells by hydrochloric acid. Two different branched canal-systems are visible, the yellowish canals of the sponge, not anastomosing (*c*), and the dark greenish brown reticular canals of the symbiotic Hydroid (*h*). The maltha includes some Radiolarian tests (*r*), × 200

Fig. 3. *Psammina nummulina*, n. sp. (p. 37).

Fig. 3. After removal of the upper dermal plate, the soft medullar disc is visible, in which the network (*h*) of the symbiotic hydrorhiza (*Stylactis?*) is expanded, . . . × 4

Figs. 4A, 4B. *Psammopemma radiolarium*, n. sp. (p. 41).

Fig. 4A. Lateral view of the sponge, ... × 2

Fig. 4B. Basal view of the same, ... × 2

Fig. 5. *Psammopemma calcareum*, n. sp. (p. 41).

Fig. 5. The turbinate sponge, seen half from above, half from the lateral side, . . . × 3

Figs. 6A, 6B. *Holopsamma argillaceum*, n. sp. (p. 39).

Fig. 6A. Lateral view of the sponge; *o*, oscula, ... × 2

Fig. 6B. Vertical section through the sponge, exhibiting the branched canals (*c*) and their oscula (*o*). *x*, xenophya, ... × 5

Figs. 7A–7C. *Holopsamma cretaceum*, n. sp. (p. 39).

Fig. 7A. Superior view of the sponge, drawn by Miss Traill, ... nat. size

Fig. 7B. Inferior view of the same, ... nat. size

Fig. 7C. A branched canal of the sponge, isolated after the removal of the calcareous pseudo-skeleton, × 20
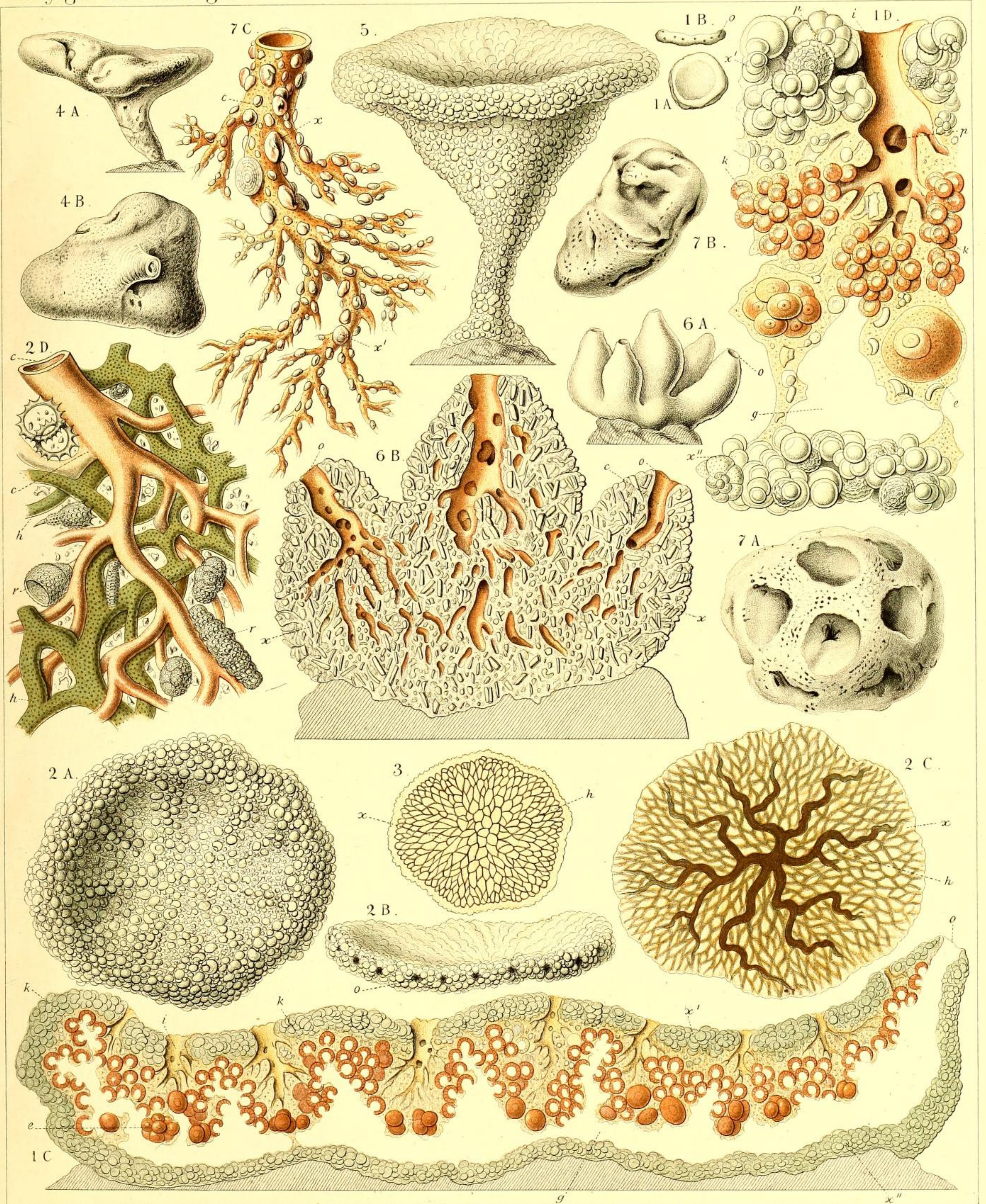
1–3. PSAMMINA, 1. P. PLAKINA, 2. P. GLOBIGERINA, 3. P. NUMMULINA,
4,5. PSAMMOPEMMA, 4. P. RADIOLARIUM, 5. P. CALCAREUM,
6,7. HOLOPSAMMA, 6. H. ARGILLACEUM, 7. H. CRETACEUM.

PLATE VIII.

Family AMMOCONIDÆ.

Genera *Ammolynthus, Ammosolenia, Ammoconia.*

PLATE VIII.

Ammoconidæ.

Figs. 1A–1C. *Ammolynthus prototypus*, n. sp. (p. 27).

Diam.

Fig. 1A. A complete specimen, exhibiting the pores (*p*) in the thin wall of the urn-shaped body. The greatest part of the wall is composed of various Radiolarian shells cemented together by a scanty maltha. The simple gastral cavity opens above by a cylindrical osculum (*o*), ... × 50

Fig. 1B. Transverse section through the basal portion of the body (semi-diagrammatic). *r*, Radiolarian shells; *m*, maltha of the mesoderm; *e*, eggs; *v*, germinal vesicle; *n*, remnants of the flagello-epithelium; *p*, pores, ... × 200

Fig. 1C. A small piece of the body-wall, seen from the inside. In the clear maltha (*m*) between the Radiolarian shells are visible single eggs (*e*) and amœboidal wandering cells (*a*); some pieces of the entodermal flagellated epithelium (*n*) are visible; *p*, pores, . × 150

Fig. 2. *Ammolynthus haliphysema*, n. sp. (p. 28).

Fig. 2. *o*, osculum; *p*, pores; *x*, xenophya (Globigerina ooze), . . × 8
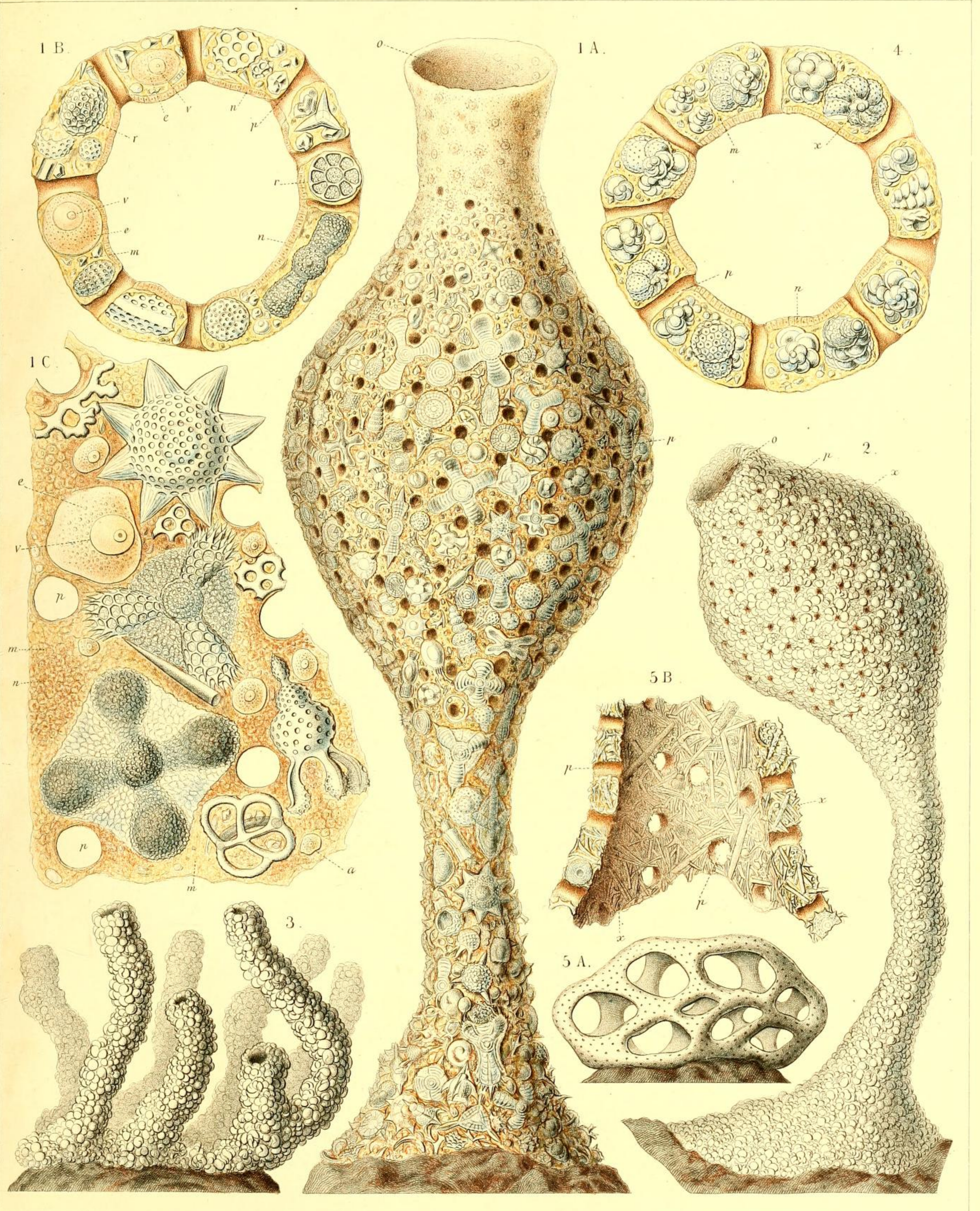
Fig. 3. *Ammosolenia rhizammina*, n. sp. (p. 29).

Fig. 3. A small corm, composed of eight persons, ... × 6

Fig. 4. *Ammoconia auloplegma*, n. sp. (p. 31).

Fig. 4. Transverse section through a cylindrical branch of the reticular sponge (semi-diagrammatic); *n*, flagello-epithelium; *m*, maltha; *x*, xenophya (Foraminifera shells); *p*, pores, . . . × 50

Figs. 5A, 5B. *Ammoconia sagenella*, n. sp. (p. 31).

Fig. 5A. The reticular body of the sponge, composed of anastomosing cylindrical tubes, ... × 4

Fig. 5B. A small portion of the porous wall of a cylindrical tube, seen from the inside. *x*, xenophya; *p*, dermal pores, . . × 200

1.2. AMMOLYNTHUS, 1.A.PROTOTYPUS, 2.A.HALIPHYSEMA, 3. AMMOSOLENIA RHIZAMMINA.
4.5. AMMOCONIA, 4.A.AULOPLEGMA, 5.A.SAGENELLA.