

- Fig. 10. One of the small slender acerate spicula of the dermal membrane, magnified 123 linear.
 Fig. 11. One of the small skeleton-spicula intermingled with the slender acerate spicula of the dermal membrane, magnified 123 linear.
 Fig. 12. A full-sized skeleton-spiculum, magnified 123 linear.

2. Report on a Collection of Sponges found at Ceylon by
 E. W. H. Holdsworth, Esq. By J. S. BOWERBANK,
 F.R.S., F.Z.S., &c.

(Plates V.-VII.)

[Received November 6, 1872.]

On the return of Mr. Holdsworth from Ceylon, in 1871, he brought with him a small collection of Sponges which he obtained at the Pearl-banks and from the beach near his house at Aripo, on the north-west side of the island. The total number is 25 specimens; many of those from the beach were in a condition in which specimens thus obtained are usually found, either well-washed skeletons, or so much deteriorated as to have destroyed a considerable portion of their softer parts, on which their specific characters frequently depend. I examined the whole of the specimens; and the following is a list of the genera and the number of species of each:—*Chalina* 11 specimens, consisting of 7 species; *Spongia* 6 specimens, of 3 species; *Stematomenia* 2 specimens, of 1 species; *Dysidea* 2 specimens, of different species; and 1 species each of the following genera, *Hali-chondria*, *Desmacidon*, *Isodictya*, *Spongionella*, and *Haliphysema*. The last three of these species and one *Dysidea* are not only in a fine state of preservation, but they also possess more than the usual degree of interest from the singularities and beauties of their structural peculiarities, as well as from having been hitherto unknown to science; and I have therefore selected these species for description and illustration.

SPONGIONELLA HOLDSWORTHII, Bowerbank. (Plate V.)

Sponge cup-shaped, margin entire or lobed; parietes very thin; pedestal short and stout; surface smooth and even. Oscula simple, rather equally dispersed; orifices circular, or more or less radiating; pores inconspicuous. Dermal membrane thin and pellucid. Skeleton—primary lines regular, comparatively stout; secondary lines rather irregular, slender.

Colour in the living state dark brown, like dirty leather (*Mr. Holdsworth*).

Hab. Nine-fathom line, or western margin of the great Pearl-bank off Aripo, Ceylon (*Mr. Holdsworth*).

Examined in the dried state.

I received five specimens of this interesting species of sponge for examination from my friend Mr. Holdsworth. They were all of nearly the same size as the one represented by figs. 1 & 2, Plate V.

The normal form is that of a thin, more or less expanded cup, sometimes cleft at the edges, as in the one figured; in others the margin is quite perfect; and in all the pedicle is very short and slightly expanded, and the substance of the parietes of the sponge is equally thin and delicate, so thin that if it be held up to the light the radial structures of the primary lines of the skeleton may be readily seen by the aid of a lens of two inches focus; the margin of the cup is very little thicker than a stout sheet of paper, and even near the base it rarely exceeds a line in thickness.

The oscula are dispersed on the inner surface of the cup, at nearly equal distances from each other. The circular ones rarely exceed half a line in diameter. In many cases, instead of the usual circular form, they consist of three or four narrow shallow lines radiating from a centre. This variation in their form is remarkable, and I do not recollect ever having seen the like of it before.

I could not detect the pores on any of the portions of the outer or inhalant surface of the sponges which were examined. The dermal membrane is very thin and delicate in its structure.

The primary lines of the skeleton are very much stouter than the secondary ones. They do not radiate in strictly straight lines, and frequently meander to some extent in their course; but their general direction is distinctly in lines radiating from the central basal attachment of the sponge.

Mr. Holdsworth, in a letter to me descriptive of its locality, states as follows:—" *Spongionella* is only found on the 9-fathom line of the large pearl-bank. It is attached to pieces of dead coral or stones. When alive it is of a dark brown; and when taken out of the water it looks exactly like dirty wet leather. If you soak a bit of one of the dark specimens you will see it with as nearly as possible the original appearance.

"This sponge is so strictly confined to the locality above mentioned, that its discovery by the divers is considered the strongest evidence that the outer part of the bank has been reached.

"I should mention that the banks, strictly speaking, are only beds of gravel, stones, and dead shells in the midst of the general sea-bottom of fine white sand, and the water is as deep over them as in the neighbourhood."

DYSIDEA CONICA, Bowerbank. (Plate VI.)

Sponge conical, pedicelled; surface covered with small acutely conical papillæ. Oscula simple, large, dispersed. Pores inconspicuous. Dermal membrane thin, pellucid, abundantly arenulous. Skeleton fibro-membranous, unsymmetrical, abundantly arenulous. Interstitial membranes aspiculous.

Colour in the living and dead state—pedestal light grey, conical mass dark purple.

Hab. Large Pearl-bank, Ceylon, in 8 fathoms (*Mr. Holdsworth*). Examined from spirit, as it came from the sea.

This interesting little species of *Dysidea* was dredged up by Mr.

Holdsworth from the 8-fathom part of the Great Pearl-bank at Ceylon. It was immediately immersed in spirit ; and my friend states that it "has not appreciably altered in appearance, shape, or colour since I first took it in my hand. It is the only one of the kind I have seen."

The regular conical form of this species is very characteristic, as I do not know any other species of the genus, either British or foreign, that has any well-defined form. The surface characters also are unlike those of any other known species.

The internal structure very closely resembles that of our British species *D. fragilis*, exhibiting precisely the same mode of increment that I have described in my 'Monograph of British Sponges,' vol. i. pp. 78 & 211, figs. 270-272, as prevailing in that species. The skeleton-structure is more membranous than fibrous, the latter being frequently more like thickened membranous edges than true fibres, with the membrane extending between them. Most frequently the membranous extensions are completely covered by a single stratum of particles of sand firmly cemented to them, which are so closely packed as to completely resemble a piece of fine mosaic work ; and no artist could adjust the positions of the large and small pieces of sand with greater precision than that exhibited on the membranes of the sponge. There is something more than the mere adhesion by chance in the attachment of the grains of sand to the membrane. The close and accurate adjustment of the particles to each other, the filling in of all the angles as completely as the most careful workman in mosaics would have adjusted them to each other, plainly indicate something more than a mere dispersion of the grains over the membranous surface. We find the fibres projected from the mass of the sponge in search of grains of sand with which to form the artificial skeleton of the animal ; and it is but a step further in the organization possessed by the animal to imagine that this beautiful arrangement of the particles of sand on the membrane is achieved by the contractile power that we know those tissues to possess. It is well known that they can contract any portion of their own substance, and thus open pores for the imbibition of nutriment, and, if alarmed, again close them so completely that their very position becomes invisible ; and it is but a step further to believe that the same description of voluntary contractile power has enabled them so to operate by contractions of the tissue as to bring every molecule of sand cast upon its surface into close conjunction with each other in the complete and beautiful manner that obtains in this sponge, and thus form the exquisite mosaic arrangement that may be seen on its membranes.

If we are to judge by the amazingly various and beautiful structures exhibited in the sponges, we must certainly credit them with an amount of instinctive power they have hitherto never been imagined to possess, and assign them a much higher position amidst the lower animals than they have hitherto been supposed to merit. Occasionally there are spots of interstitial membrane unoccupied by grains of sand ; and these were abundantly furnished with lenticular nucleated cells of rather unequal sizes, the nucleus being visible in the largest ones only.

Where the true fibre prevails, and the increment of the skeleton is progressing, a single thread may be seen projected from the outer surface of a grain of sand, to some distance, without having met with a grain to which it could attach itself, and at its distal extremity there will be seen a single large or small molecule of sand elevated, as it were, on a pedestal, or an irregular cup-shaped membrane which has only partially enveloped a particle and then lost it; or a column of large and small grains will be seen projected from the mass, the distal grain of which always exhibits more or less extensions of keratose tissue in search of additional grains of sand to be incorporated in the fibrous skeleton of the sponge.

The dermal membrane is thin and pellucid; it is covered with a single stratum of grains of sand and a few foraminated shells; in the interstices of these grains a few open pores were visible.

The oscula are variable in size; ten or twelve were dispersed over the surface of the sponge; the largest rather exceeded a line in diameter.

ISODICTYA DONNANI, Bowerbank. (Plate VI.)

Sponge cup-shaped, parietes thick and strong; margin strongly undulated, distal edge finely plicated, surface externally and internally even, minutely hispid. Oscula and pores inconspicuous. Dermal membrane abundantly spiculous; spicules the same as those of the skeleton, and very small and slender acuate ones, dispersed. Skeleton—primary lines multispiculous, strongly developed, rather irregular; secondary lines very irregular, varying from multispiculous to unispiculous, very numerous; spicula acuate, short and stout. Interstitial membranes abundantly spiculous; tension-spicula acuate, small and slender, dispersed, rather numerous. Sarcode dark amber-colour.

Colour, alive, bright orange; dark purple in the dried state.

Hab. Pearl-banks, Ceylon (*Mr. Holdsworth*).

Examined in the dried state.

I have named this species after Capt. Donnan, the present Superintendent of the Pearl-banks.

I received a single specimen of this interesting sponge from Mr. Holdsworth for examination. The parietes of the cup are remarkably firm and thick; and at about half its height from the distal end of the short pedicle the undulation of the marginal portion of the cup commences, and increases to such an extent as to occupy at least two thirds of its entire diameter. The extreme edge of the cup is thick and rounded, and is plicated in such a manner as to closely resemble the distal end of a lady's fan when in a closed condition. The short basal column does not exceed half an inch in height in its present condition. It has every appearance of having been broken from its natural attachment while in a living state.

The surface of the outer and inner portions of the cup are even, but not smooth to the touch, from the projection of the terminations of the primary lines of the skeleton. The hispidation is visible only

when examined microscopically. It is produced partly by the extension of the primary lines of the skeleton, and partly by the projection of single spicula, of the same size and form as those of the skeleton, through the dermal membrane. I could not detect either oscula or pores on any parts of the external surface; and it is very possible that inhalation takes place on the outer surface, within the folds of the plications of the skeleton-tissues, and that the excurrent streams are ejected on the inner surface in a similar manner. And this mode of inhalation and of exhalation is the more probable as these plications are distinctly visible to the unassisted eye for about half an inch downwards on the outer surface, and to twice as deep on the inner one. The plications are composed of closely packed parallel thin plates of the sponge-tissue, all disposed at right angles to the dermal surface; but this regular arrangement of the skeleton-tissues does not seem to obtain beyond the limits stated above; the lower portions of the skeleton-structure appear to meander in every possible direction.

The dermal membrane does not spread uniformly over the surfaces of the sponge, but it appears to follow and encase the plications of the skeleton; and I could obtain a view of it only on the surface of the plates, and on the terminations of the defensive prolongations of the primary lines of the skeleton projected from the external surface of the sponge, when mounted in Canada balsam, and with a power of about 80 linear. On those parts it was abundantly supplied with the slender tension-spicula, intermixed with which were a considerable number of the larger or skeleton-spicula.

The skeleton is very strongly developed. The primary lines frequently throw off branches which pursue their course in lines parallel to the parent branch. This habit, in conjunction with the great irregularity in the size and mode of disposition of the secondary lines of the skeleton, often produces a considerable amount of confusion among the skeleton-structures.

I have never observed the same singularly plicated form of the skeleton-tissues in any other species of *Isodictya* with which I am acquainted.

Mr. Holdsworth, in his letter to me, writes:—"The dark, thick, cup-shaped sponge with undulated margin is not uncommon on the large pearl-bank in from $6\frac{1}{2}$ to 9 fathoms; and I have met with it once or twice on rough ground on other parts of the coast; it is usually attached to some bit of rock, and is always, when alive, of a uniform bright orange-colour. It turns black an hour or two after being taken out of the water. The largest specimen I have seen was about as large again as the one you have. The general shape and colour are always the same."

HALIPHYSEMA TUBULATUM, Bowerbank. (Plate VII.)

Sponge massive, sessile. Surface minutely mamillated. Oscula and pores inconspicuous. Dermal membrane obsolete. Skeleton composed of numerous single and separate cylindrical tubuli radiating from the base to the surface of the mass; tubuli closed, termi-

nating more or less hemispherically, furnished abundantly with large and small defensive and skeleton-spicula projected from all parts of their surfaces at various angles; large skeleton-spicula flecto-attenuato acuate, stout and strong, usually procumbent on the tubuli; small defensive spicula subflecto-attenuato acuate, incipiently spinous, small and slender. Interstitial spicula the same as those of the skeleton, dispersed, numerous. Sarcode blood-red.

I received this very remarkable sponge among the series of specimens from Ceylon, collected by Mr. Holdsworth. There is no other genus with which I am acquainted to which it can be referred but *Haliphysema*. The only two species known and described are remarkably small, one consisting of a single simple fistulous skeleton, and the other of a ramous fistulous one; the species under consideration consists of a congregation of numerous single fistulæ. Although varying from each other greatly in size, there is a perfect accordance in the principle of their skeleton-structures, all of them exhibiting the tubular form, with the distal termination closed and more less dilated, that especially characterizes the genus.

There are no distinct indications of any recent attachment of the sponge. The position of its natural base is indicated by the convergence of the skeleton-tubes at their proximal extremities; and it is probable that the specimen had been freely floating about in a living condition for some time before it was taken.

There are several large irregular openings on the upper surface of the sponge, which extend deeply into its mass. These orifices have none of the characters of excurrent or cloacal ones. As the internal structures, both in form and mode of disposition, strongly indicate a carnivorous habit in the sponge, it appears highly probable that these large irregular orifices are provided for the double purpose of the admission of water to its tubuli and to allow of the free entrance of minute annelids and other similar prey on which it subsists.

The skeleton-tubuli are not closely packed together, and there is frequently a considerable space between them; and the projection of the defensive spicula from their surfaces maintains this separation from each other, their adherent connexion being accomplished by a loose arrangement of interstitial skeleton-spicula, between which there is ample space for the admission and flow of water amongst the skeleton-tubes.

If this reading of their history from their structure be correct (and it is quite in accordance with what we know to occur in other carnivorous sponges abounding in especial organs for the destruction of intruders within their interstitial cavities), the inhalation through the parietes of the tubes will be as in the other species of the genus, and the excurrent streams will take place in their natural positions at the distal ends of the tubes, which project from the surface of the sponge, and form the numerous minute mamillæ of the dermal surface.

On fig. 2, Plate VII., representing a single skeleton-tube, near the distal end, at *a*, there is a minute, rather long and very sinuous tube or skin of what appears to have probably been a slender annelid.

Its diameter very slightly exceeds that of one of the large spicula of the sponge; and its figure, full of contortions, is just such as we may imagine that of a dying, struggling, slender worm would have been under such circumstances. It is so far covered and partially hidden by the surrounding sarcode, and so completely emptied of its former contents, that nothing but its form is distinctly visible; but be it what it may it is certainly no part of the organization of the sponge.

It is no uncommon event to find in living sponges such slender worms attempting to prey either on the dermal surface or on the interstitial membranes within the sponge.

With such a structure as that of the specimen in course of description, a common investing dermal membrane could scarcely be supposed to be required or to exist, and the true dermis must be sought at the external surface of each of the skeleton-fistulæ; but as these organs are so small and their parietes so thin, it is extremely difficult to discriminate the dermal tissue from the parietes of the fistulæ. In some of the specimens mounted in Canada balsam, their surfaces are frequently much obscured by sarcode; but in some parts there are strong indications of a very delicate dermal membrane enveloping the fistula.

Some of the large flecto-acuate spicula are procumbent and closely adherent for the whole of their length to the surface of the fistulæ. They are disposed in lines more or less in accordance with its long axis; and in this position they perform the office of skeleton-spicula, strengthening and supporting the delicately constructed fistula by their longitudinal position on its surface, and maintaining it in its normal position; while others of them are projected as defensive organs from its surface. Very few of the small incipiently spinous defensive spicula are seen to be procumbent; and by far the greater number are projected backward at various angles to the surface of the fistula.

The direction in which both descriptions of defensive spicula are projected from the surfaces of the fistulæ is more frequently backward than forward, or at right angles to the surface. This seems to indicate that they are carnivorous feeders, and that this position of the spicula is destined to obstruct the egress of any small annelids that may have entered the body of the sponge, and to destroy them for its own nutrition.

No adventitious substances are incorporated with the skeleton of this species as in the other two known ones, and all its spicula are undoubtedly secreted by itself; and in every respect it forms the best type of the genus *Haliphysema* with which we are acquainted.

DESCRIPTION OF THE PLATES.

PLATE V.

Spongionella Holdsworthii.

Fig. 1. The type specimen, natural size, exhibiting the numerous oscula within the cup or upper surface of the sponge.

Fig. 2 represents the outer or inhalant surface of the sponge, with the remaining portion of its short pedicel.

For its anatomical structure see Plate VI. fig. 7.

PLATE VI.

Dysidea conica.

Fig. 1. The type specimen, natural size.

Isodictya Donnani.

Fig. 2 represents the type specimen, natural size.

Fig. 3. A section, at right angles to the dermal surface, exhibiting the skeleton-reticulations and the interstitial membranes and their spicula, magnified 80 linear.

Fig. 4. One of the very small acuate spicula from the dermal membrane, magnified 250 linear.

Fig. 5. A full-sized skeleton-spiculum, magnified 250 linear.

Fig. 6. One of the smaller skeleton-spicula from the interstitial membranes, magnified 250 linear.

Spongionella Holdsworthii.

Fig. 7 represents a small portion of the keratose skeleton of the sponge from the thinnest part of the distal margin, magnified 80 linear.

PLATE VII.

Haliphysema tubulatum.

Fig. 1 represents the type specimen, natural size.

Fig. 2. The distal portion of one of the skeleton-tubuli and its numerous skeleton- and defensive spicula, with the remains of, apparently, the skin of a minute annelid at *a*, and a small portion of the interstitial spicula at *b*: magnified 80 linear.

Fig. 3. Portions of two of the skeleton-tubuli from near the middle of their length, showing their loose and tortuous course, and their interior structure through longitudinal sections of the tubuli: magnified 80 linear.

Fig. 4. One of the largest skeleton- and defensive spicula, magnified 150 linear.

Fig. 5. A small-sized skeleton- and defensive spiculum, magnified 150 linear.

Fig. 6. Two of the small subflecto-attenuato-acuate incipiently spinous defensive spicula, magnified 150 linear.

3. Note on the Occurrence of *Xenospongia patelliformis*, Gray, on the Coast of Ceylon. By E. W. H. HOLDSWORTH, F.L.S., F.Z.S.

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This curious form of sponge was described and figured by Dr. Gray in the 'Proceedings' of this Society in 1858, p. 229, pl. xii., from two dried specimens received from Torres Straits; and, so far as I can discover, no other locality was known for it until I fortunately met with a single young example on the Ceylon pearl-bank. This specimen was obtained from a depth of about 8 fathoms, on a sandy part of the bank; and, knowing that an opportunity of examining this sponge in as nearly as possible its natural condition was desired at home, I at once put it in spirit, and on my return to England placed it in the hands of Dr. Gray.



Bowerbank, J. O. 1873. "Report on a collection of sponges found at Ceylon by E.W.H. Holdsworth, Esq." *Proceedings of the Zoological Society of London* 1873, 25–32.

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