in the ribs, from which they branch off laterally towards the furrows.

Mr. Davidson's specimens were taken in from 45 to 50 fathoms water, on the Agulhas Bank, south coast of Africa. The locality has suggested to me the generic name which has been given to the species.

EXPLANATION OF PLATE XI.

Fig. 1. Natural-sized outline of *Agulhasia Davidsonii*.
Fig. 2. Same species, dorsal view, showing position of the foramen.
Fig. 3. Same species, ventral view.
Fig. 4. Same species, lateral view.
Fig. 5. Same species, interior of dorsal valve, showing loop, teeth, and cardinal muscular fulcrum.
Fig. 6. Same species, profile view of the loop.
Fig. 7. Same species; view of the interior of ventral valve and of the upper aspect of the beak, the latter showing the area (*a*), deltidium (*b*), foramen (*c*), inflexed sides of the beak (*d*), and one of the sutures bounding the area (*e*).
Fig. 8. Represents tubuli characteristic of *Terebratulina caput-serpentis*.

I am very much indebted to Mr. Davidson for finishing off my rough sketches of the above figures.

XIV.—*On Fossil Sponge-spicules of the Greensand compared with those of existing Species.* By H. J. Carter, F.R.S. &c.

[Plates VII.-X.]

The material which furnished the fossil sponge-spicules from which all the figures, except three, in the accompanying four plates were taken, was found by my kind and intelligent friend Mr. W. Vicary, of Exeter, in the "Upper Greensand" of Haldon Hill, near Exeter, and of Black Down, near Cullompton, respectively,—the former portion in a stratum of greenish-brown, loose, fine sand, about 25 feet thick, and the latter in a rounded pebble of the same nature, more consolidated.

They were brought to my notice by Mr. Vicary and my friend Mr. Parfitt, also of Exeter, who read a valuable paper on them at the meeting of the "Devonshire Association for the advancement of Science, Literature, and Art," in July last, which was subsequently printed in their 'Transactions' for 1870.

The frequently loose state of the whole material, in which the spicules are sometimes almost as numerous as the grains of sand among which they are imbedded, together with their large size, render their extraction with a simple but powerful lens and a hair-pencil a work of time rather than one of difficulty.

Mr. Vicary and myself have thus taken out several hundred, from which I have selected seventy-six out of the seventy-nine illustrations in the plates. These, however, must not be viewed as rare specimens, but rather as the more perfect ones of myriads of the same kind in the deposit, which are all more or less fractured, worn away by attrition, or otherwise altered by petrifaction.

When we consider that they are imbedded in quartz-sand, and that therefore they must be the spicular remains of dead and disintegrated sponges which, for some time previously, had been drifting about at the bottom of the sea with the material in which they are now found, we cannot wonder that, under such circumstances, they should be chiefly the larger spicules of the sponges to which they respectively belonged, and that they should be more or less fragmental, and more or less altered in shape by the trituration to which they have been exposed—also that there should be almost an entire absence among them of the delicate and more minute spicular forms which in addition characterize most sponges.

Nor should we wonder that the solvent influences which have been affecting them for ages during and since their transformation into chalcedony (for such is their present state) have involved a certain amount of change in their form as well as in their composition. Thus we find that their canals are frequently distorted and enlarged, that they are more or less filled with glauconite or brown oxide of iron, &c., or that they are altogether obliterated, while their surfaces partake of the botryoidal character, in miniature, of the mineral (chalcedony) into which they have been transformed.

Still, uneven as their surface now is, and great as is the alteration in other respects which they have thus undergone, the greatest wonder of all is, how such delicate little objects could survive the changing hand of time so long as to be presented to us now, after an interval almost too oppressive in extent to be conceived, in forms so unmistakable and so easily obtained that they almost fall out of themselves from the sand in which they are imbedded as distinctly and as separately as if the deposit had been but of yesterday's formation.

No less remarkable is the fact that, while the grains of quartz-sand still retain their angles and smooth surfaces, the surfaces of the spicules and those of every other organic particle amongst them present the dimpled or tubercled form of chalcedony. Hence it becomes easy to determine at once what has not been organized, from the beginning, however small the particle may be. In short, the quartz-sand has yielded less to the chalcedonizing influence than the organic remains.

True enough as this is, still the characteristic form of the chalcedonic crystallization is so minute that it is often very difficult to determine whether that which we are looking at through the microscope is dimpled or mammillated, seeing that the circles or little monticules which represent this are seldom more than 1-3000th of an inch in diameter. Frequently the botryoidal surface is distinct; as frequently also the little mammilliform projections are surrounded by rings; and not unfrequently there appears to be a dimple in the centre. But such differences are of little moment if we remember that the surface of these spicules, originally as smooth as glass, is now rendered more or less uneven by the forms of crystallization presented by chalcedony, and that this character distinctly marks the difference between the organic and inorganic particles of which the deposit is composed. With this exception, the spicules are but "pseudomorphs," to use a mineralogical term, of what they were in the living animal, where they were produced.

Nor should we forget the effect of the "solvent influence" to which I have alluded, seeing that this also may have acted at one time in one and at another in another way during the transformation of the atomic constitution of the spicule, thus, under certain circumstances, eroding the surface which received an additional chalcedonic layer under others,—and hence, as regards erosion, the "reticulated" aspect noticed by Mr. Parfitt in his excellent paper (*l. c.*), which on the surface of some of the spicules is so marked as to indicate that in this way many may have altogether disappeared. This, too, may partly account for the apparently entire absence, above stated, of the minuter and more delicate spicules which existing species, almost identical with the fossil ones, as will be hereafter seen, show us must have been present in the sponges to which they originally and respectively belonged.

Be this as it may, the coarser features alone of the spicules remain; and so far altered is their original smooth surface by erosion or the presence of the botryoidal form of chalcedony, that not only is there an absence of the minuter and delicate spicules, but also of all the minute spines, tubercles, and other markings which, in many instances, more or less cover and characterize the large spicules of existing species, and thus may be inferred to have equally covered and characterized many of the fossil ones.

As above stated, out of the seventy-nine illustrations there are three only, viz. figs. 7, 8, and 9, which are not representative of the spicules in the greensand; and these have been copied from Schmidt and Du Bocage respectively, not less to illustrate the general plan on which I shall endeavour to show that many of the spicules have been developed, than to identify some of them with existing species.

All the figures have been drawn on the same scale, viz. 1-24th to 1-1800th of an inch, whereby their relative sizes respectively can be at once seen, their real sizes computed by compass and rule, and the introduction of measurements avoided.

Some of the figures appear very large; but when it is remembered that others would have been inconveniently small if the whole had been proportionally more reduced in size, this will be fully explained. At the same time it should be remembered that, as all are sufficiently large to be extracted with the aid of a simple but powerful lens, and therefore that there are hardly any spicules present so small as to require the microscope for detection, it is evident that nothing but coarse and large spicules exist in this deposit, that if there were originally minuter forms in it there is nothing now left to show that this was the case, and, therefore, that the great bulk of the sea-shore Spongiadæ, in which all the spicules are too small to be seen individually with a quarter-inch lens, have no representatives in this deposit.

Of the deep-sea sponges, such as *Hyalonema*, *Holtenia*, *Pheronema*, *Askonema*, *Corbitella*, Gray (?), &c., there is, of course, no representative; their delicate spicules slightly held together by equally delicate sarcode, and their habitat in the deep valleys of the ocean, almost entirely preclude the possibility of their spicules ever reaching such tidal currents as could drift together the gritty materials of the Haldon deposit.

Not so, however, with the Coralliospongiæ of Dr. Gray, and the Euplectellidæ, whose spicules are supported by a rigid structure of keratose fibre *silicified*. The habitat of the latter, at the Philippine Islands, in from ten to twenty-four fathoms (Bowerbank, Proc. Zool. Soc. London, 1869, p. 344), and that of most of those in the Gulf of Florida &c., forwarded by M. de Pourtales to Dr. Schmidt for examination, in minimum depths of from 90 to 152 fathoms (Grundzüge einer Spong. Faun. des atlantisch. Gebietes, 1870) show that these might have representatives in such deposits; and thus we find that, in the spiculiferous sand of Haldon Hill and Black Down, nearly half the organic remains consist of spicules and fragments of the silicified fibre of the Coralliospongiæ. The rest, chiefly belong to that group of sponges for which I have proposed the term "Pachytragiæ" (Annals, vol. vii. Jan. 1871), viz. the Geodidæ, *Stelletta*, *Dercitus*, &c., but not the Tethyadæ proper, of which *T. cranium* is the type, since the spicules of these sponges, with the exception, perhaps, of the large acerate one, whose form is too common to be of any value specifically, are far too delicate to survive the amount of trituration through which the coarser forms of the spicules of the other Pachytragiæ might pass, as we see in this deposit, for the most part, unaltered.

Nor have we met with any *stellates* (spicules), especially the larger ones of *Tethya lyncurium* and its like, better named by Dr. Gray "*Donatia*," to separate it from the true Tethyadæ, of which *T. cranium* is the type, although the little globular crystalloids (spicules), or little "siliceous balls," as they have been termed, which characterize the crust &c. of the Geodidæ, are extremely abundant.

If, then, there are none of these stellates present, which, in some species of *Donatia*, are equal in size to the larger globular crystalloids of the Geodidæ, we can hardly wonder at the entire absence of the minuter stellates of the Pachytragiæ generally, or of any other spicules so minute that a quarter-inch compound power is required to make them visible.

Whether *Donatia* (*Tethya lyncurium*) and its like existed at this period may be another question which the limited examination of the Haldon sand made by Messrs. Vicary, Parfitt, and myself is in no way sufficient to answer; for it may be assumed that, in a stratum 25 feet thick which is almost entirely composed of grains of sand and the spicular remains of various sponges, almost any amount of examination, most especially ours, must indeed be "limited."

Again, it is evident that there were sponges like the Esperiadæ (Gray) present, if bihamate spicules be allowed to determine this; for here, also, the other spicular element of these sponges, viz. the anchorates, are so much smaller, for the most part, than the bihamates in the existing species, that the anchorates, like the stellates of the Pachytragiæ, may have disappeared, either by the triturative effect of the sand at the time of deposit, or by the solvent effect of the fluids which have since percolated through it.

Lastly, it is possible that, in solid masses of flint, such minute spicules may be found to be most perfectly preserved, and in some parts representatives of the deep-sea sponges may be found entire; but neither appear, elementarily or entire, in the sandy grit of Haldon Hill or Black Down, so far as our observation has extended, nor, for the reasons above stated, is it likely that one ever so extended would be more successful.

Still there are a great number of forms in the Haldon sand which have living representatives, and probably a great many which have none. Let us, then, first see generally how far we are borne out in this conclusion by reference to those which I have delineated.

It will be observed, as before stated, that they are for the most part all large—that is, the largest spicules of the species to which they belonged; and therefore, if we compare them with living species, it must be with the larger spicules of these species.

There is no question, then, as to whether we shall take our characters from the large spicules of the latter for this purpose in preference to the small or minute ones—for, as before stated, most sponges contain two sizes (that is, the large and the minute—those which can be seen for the most part by the unaided eye or a low magnifying-power, and those which require the aid of a very high microscopic one)—since, as also before stated, the latter appear to be entirely unrepresented among these fossil spicules.

Our characters, then, among the fossil spicules (for it should be remembered that we have no *entire* sponges here) must, in common with their living allies, be taken from the largest spicules generally; and such we shall observe to be chiefly confined, in the latter, to the periphery, where their shafts are provided with heads which meet together externally, and thus form a shield-like surface to the sponge.

These heads, like the heads of so many nails, present forms which are peculiar to the species, and are developed inversely to the shafts; that is to say, the more expanded the head the shorter the shaft, and *vice versâ*. (The position of the shaft, branch, or arm where broken off is always indicated in the figures by a little circle, which is the axial canal, within a larger circle, which is the circumference of the spicule.) Hence, the shaft only differing in length or size, we must look to the head for the character; and here we shall at once see that, whether we take the simple trifid or ternate one in fig. 36 &c. Pl. IX. (existing species, *Geodia*), or the hexternate one fig. 30 (that is, the dichotomous division of the trifid or ternate head, ex. sp. *Stelletta*), or once more divided (dodecaternate, as in *Dactylocalyx Bowerbankii*, Brit. Spong. fig. 53), or still more divided (polyternate, as in fig. 1—ex. sp. *Dactylocalyx McAndrewii*, Bk., *McAndrewia azorica*, Gray, Proc. Zool. Soc. Lond. 1869, pl. v. fig. 3), or where the divisions are more or less united into a disk, figs. 3, 4, 5 (ex. sp. *Dactylocalyx polydiscus*, Bk., Proc. *cit.* 1869, pl. vi. figs. 10 &c.), we observe from Schmidt's and Du Bocage's figures of *D. polydiscus*, respectively copied into our Plate VII. figs. 7, 8, and 9, which are confirmed by Dr. Bowerbank's fig. 102 (Brit. Spong.), and my own actual observation of the spicula, that there are three canals in the centre diverging from a common one, which proves that, from the simplest trifid or ternate head to the most elaborately divided one, all begin with a trifid or ternate development—in short, that all are some multiple of three, and therefore that in it we have a distinct trifid or ternate system from the beginning for the grouping of the large spicules with which we are now concerned, which character is the most practicable, at least for our purpose.

In this view I have been alike anticipated by Dr. Bowerbank (1858) and Mr. Parfitt (*l. c.* 1870) independently, the former of whom, in 1869, writing on the "siliceo-fibrous" sponges, observes:—"The apices of the connecting spicules are exceedingly various in their form; but they are all modifications of a triradiate one, even the peltate forms" (Proc. *cit.* p. 73). I prefer much the term "ternate" or "trifid" to "triradiate," because the former apply to the branching of a stem (the axial canal), and the latter to a branching or radiation from a point, since this avoids a confusing of the tri- or quadriradiate spicules of the Calcispongiæ in particular with the trifid or ternate division of those of the Coralliospongiæ and Pachytragiæ; and as we are most familiar with the term "ternate," I shall henceforth use this with its necessary prefixes—a grammatical violation, it is true, but one, perhaps, which the desirableness of using short instead of long cumbrous terms may sanction.

From the ternate system of the peripheral spicules let us go to the silicified fibre of the interior; and here we have all the figures from 10 to 29 inclusively illustrating this structure, many of them, no doubt, somewhat worn by trituration at the time of their deposit, but otherwise the irregular knot-branching of the Dactylocalycidæ, and the more rectangular hexradiate one of the Euplectellidæ, together with the canalated fibre of *Farrea occa* (Bk. Proc. *cit.* 1869, pl. xxiv. fig. 1), all find their representatives respectively in these figures, many of which, also, are almost facsimiles of Schmidt's figures of *Lyidium torquila*, obtained by M. de Pourtales in 270 fathoms, off the island of Cuba (Atlantisch. Spong. Fauna, p. 84).

We now leave the Coralliospongiæ and go to the heads of the first and second divisions of the ternate system, for which group I have proposed the name of "Pachytragiæ" (*l. c.*); and here we revert to the condition of the deep-sea sponges, so far as the absence of silicified fibre is concerned; but instead of the, for the most part, soft, silky nature of their spicular structure, we have the short, rigid, ternately developed spicules of the Pachytragiæ, which grow and develope themselves, in many instances, on the shore-rocks, where they are exposed to the beating of the most tempestuous seas. Hence we shall not be surprised to find representatives of these in the Haldon deposit.

They will be found in Plates IX. and X. figs. 32–37 and 59–74 respectively.

Some of the hexternate heads, as figs. 30, 31, and 33, might either have belonged to Schmidt's Ancorinidæ, in which are included *Stelletta* &c. (Atlant. Spong. Faun.), or to the periphery of the Dactylocalycidæ (see Dr. Bowerbank's figures of *D. Masoni* and *D. Bowerbankii*, 2, 3, and 6 respectively, Proc. *cit.* 1869, pl. vi.); for they all have such hexternate heads for their periphery, although those of the Dactylocalycidæ appear to be the thickest and to have the stoutest shafts, which, in the fossil species are, for the most part, unfortunately broken off.

Where, however, the heads have not been so expanded, although still irregularly hexternate (as in Pl. X.), the shafts have consequently become more developed, and therefore have partly remained, thus giving us facsimiles of the spicules which characterize the Pachytragiæ generally,—that is to say, Schmidt's Ancorinidæ and Geodidinæ (Atlant. Spong. Faun.).

The figures 37–39 and 72–74 inclusively all appertain to a quadrifid or quaternate system, which, whether belonging to the Coralliospongiæ or to the Pachytragiæ, only find their parallel now, so far as I am aware, in *Hyalonema* (*Carteria*, Gray), where the minute feathered spicules have the like heads in miniature—some of the large ones with more extended arms also—and all the long large ones a crucial branching of the axial canal, with more or less inflation in the centre.

In *Askonema setubalense*, Kent, a similar condition exists; but here the minute spicules are hexradiate, and the large long ones present a hexradiate cross, with more or less central inflation. It is almost impossible to see all six arms of the cross at the same time in the long spicules; but the *quadrilobate* form of the inflation in many, if not most, is satisfactory evidence of this condition when the cross is not otherwise visible.

Returning to the Pachytragiæ, we find that the ternate spicules of the circumference, in the absence of silicified fibre for support, are accompanied by strong acerate, fusiform, smooth, and, generally, slightly curved spicules, which not only abound in the interior, crossing each other in all directions to form the skeleton, but frequently project somewhat beyond the surface in connexion with the peripheral spicules—also that this form is often accompanied by strong acuate spicules of the same kind, in which one half of the spicule seems to be more or less shortened in proportion to its thickness and the inflation of its rounded extremity.

Such spicules are represented in figs. 76 and 77 respectively; and as they greatly exceed in number all other large sorts in the existing Pachytragiæ (being *the* spicule of the mass), so they abound in a fossil state in this deposit, both entire and fragmentary, of various sizes, from 1-5th of an inch downwards, with proportional thickness.

As in no instances are such large stout spicules of this kind to be found in any species but the Pachytragiæ, so, for the most part, the whole of the fossil ones must be inferred to have come from sponges of this group. With one exception, however, viz. *Dercitus niger* (Ann. vol. vii. Jan. 1871), which differs from all others of the Pachytragiæ with which I am acquainted in having *no* acerate spicule, while its body, being crammed full of stout ternate ones in which the shaft but slightly exceeds in length the arms, finds its representative in fig. 71, which, with shorter shaft and of various sizes below this figure, is nearly as abundant as any other form of spicule in the Haldon deposit.

Lastly, we come to the smaller spicules; and here there are only four figures, 40, 41, and 42, 43, and 55, and 56 which can with any certainty be assigned to species like the existing sponges.

The first two evidently belong to the Dactylocalycidæ; but their smallness and differences respectively from those figured in Pl. VII., being strongly marked, may be easily appreciated by comparison.

In fig. 43 we immediately recognize a sharp-pointed bihamate spicule of large size, which may represent the Esperiadæ, its usual companions (viz. the anchorates) being assumed to have been too small to have survived the trituration of the deposit, or the solvent effect of the petrifactive process.

Figs. 55 and 56 are lateral and upper views respectively of the globular crystalloids, or siliceous balls, which characterize the crust of the Geodidæ, and which so abound, of many sizes below the figure, and of so many shapes between spheroidal and oval, that their presence in regard to numbers, not less than their variety in size and form, distinctly points out their origin from the disintegration of more than one kind of *Geodia*.

Of the rest, figs. 44, 45, 46, and 47 are figures of two spicules which are equally beautiful and abundant, but to whose origin nothing that I know of among existing sponges gives me any clue. They may have belonged to the Dactylocalycidæ, and future observation may throw some light upon their history; but at present I know of no moniliform spicules having curved, cylindrical, and quadiradiate forms respectively to which they can be likened.

Fig. 54 appears to have been one of the curved cylindrical spicules which has suffered from erosion, and thus shows the effect of the solvent power, which may thus be inferred, not only to have fretted out partially, but to have fretted away altogether many of the spicules that were originally in this deposit. Indeed we cannot have a more satisfactory example of this power than in fig. 70, which shows a very common occurrence in the Haldon deposit, viz. the bare extension of the axial canal in a consolidated state beyond the rest of the fossil shaft or spicule, which has thus evidently been removed by some solvent influence.

The remainder of the small spicules here represented are abundantly present in the deposit, but more remarkable for their multiplicity than for any peculiarities by which they could be identified with existing species; they represent the smallest spicules of the mass, and those forms which perhaps are most abundant, but by no means all the varieties which are present. In many instances the chalcedonizing influence has so firmly united them, as well as the little globular crystalloids of the Geodidæ, to the larger spicules, especially to the fragments of silicified fibre from the Coralliospongiæ (see figs. 19, 20, and 24), that they cannot be detached without fracture of the latter; but it does not follow from this that such small spicules have ever formed part of the sponges from which the large fragments or spicules to which they now adhere were derived. They were thrown together at the time of deposit, and became adherent afterwards. I have frequently destroyed a fine large spicule by endeavouring to detach the small ones from it.

Among the small spicules, however, are some pointed at one end and truncated at the other, as if fractured at this part, which appear to have originally belonged to the silicified fibre of the Coralliospongiæ; for such are occasionally seen to be not merely adherent to the fragments of this fibre, but actually with one end imbedded *in* it for some distance (figs. 25 and 28), just as with the *Aphrocallistes*, for a good example of which see Bowerbank's illustrations (Proceed. *cit.* 1869, pl. xxi. figs. 2, 3, and 4). The specimen of *Aphrocallistes Bocagei*, which was examined by Schmidt, was found by M. de Pourtales on a reef in the Gulf of Florida, 283 fathoms deep (Atlant. Spong. Faun.).

So long as we are content with the coarser features of the larger spicules of the Spongiadæ contained in the Haldon deposit, we shall find what we want; but if we allow our expectations to go beyond this, and seek for the minuter elements, either in the shape of spines or tubercles on the large spicules, or in that of the minute stellates or other spicules of this kind, which most probably accompanied them in the sponges from which they originally came, we shall be disappointed, at least so far as our investigations have extended. And although it would be too hazardous to state that such minute elements are *entirely* absent, still the effect of trituration at the time of deposit, and the subsequent solvent influence attending petrifaction, together with our want of success in this way, preclude all reasonable hope of their being present anywhere in such a sandy deposit. Where whole masses or entire sponges, as before stated, have become consolidated in the form of flint &c., they may be preserved, as flies in amber; but it seems hopeless to hunt for them in this sandy grit.

Nor is there much dependence, for the same reasons, to be placed on the forms of the smaller spicules, such as figs. 51 and 52; for what may have carried away the minute spicules and have affected the surfaces of the large ones, is not likely to have spared those of the smaller ones, in which the alteration in form would thus be proportionally more extensive and disfiguring.

Having now reviewed the illustrations in the accompanying plates *generally*, let us hastily go over the figures somewhat more *specially*, which, while it entails a little repetition of what has gone before, will serve to curtail much of the usual tabular explanation.

Of figs. 1 to 5 there can be no doubt that the latter belonged to a coral-sponge like *Discodermia polydiscus*, Bocage (Journ. des Sc. Mathémat. Phys. et Nat. Lisbonne, no. iv. 1869), from which are copied our two figures 8 and 9, being the upper and lateral views respectively of the disk. It was previously called *Dactylocalyx polydiscus* by Dr. Bowerbank, for whose illustrations, of a similar kind, see Proceed. Zool. Soc. Lond. 1869, pl. vi. figs. 10 &c.; since then it has been figured by Schmidt under the name of *Corallistes polydiscus* (Atlant. Spong. Faun. Taf. iii. fig. 8, 1870), of which our fig. 7 is a tracing. Bocage found his specimens implanted on a piece of *Halichondria*; but from what locality is not mentioned. That described by Schmidt was obtained at the minimum depth of 152 fathoms in the Gulf of Florida.

Neither Bowerbank nor Du Bocage gives his figures of the disk that amount of indentation which is found in Schmidt's; but if the latter be not another species, then it is probable that my figures 3, 4, and 5, which, with their like, abound in the

Haldon deposit, all come from a sponge or sponges closely allied to, if not identical with, *Dactylocalyx polydiscus*; in which case we appear to have the species still extant.

Not so, however, with figs. 1 and 2, which, with their like, are equally abundant. These disks, in addition to the difference of branching off almost close to the shaft, are much more lacinulated than any of the figs. 3, 4, and 5; besides which, the ends of the branches are not rounded. Indeed the characters are so distinct and so different from those of the disk of *Dactylocalyx polydiscus*, or any other species of *Dactylocalyx* with which I am acquainted, that I do not hesitate to designate them by the name of "*Dactylocalycites Vicaryi*," in honour of Mr. W. Vicary, of Exeter, to whom we are not only indebted for the discovery of these spiculiferous deposits, but for that of many other important geological facts in this neighbourhood. Fig. 6 is a lateral view of this disk.

It is possible that if the filagree terminations of the lacinulated disks of *McAndrewia azorica*, Gray (for good illustrations of which see Bowerbank, Proc. *cit.* 1869, pl. v. figs. 2 and 3), were broken off, we might produce figures something like 1 and 2; but in no instance have I observed the least remnant of a termination like these to the branches of *Dactyocalycites Vicaryi*.

Lastly, the heads, figs. 40 and 41, 42, Pl. IX., also appear to have belonged to the Coralliospongiæ, especially the latter, viz. figs. 41, 42, whose elliptical disk and sinuous margin so cause it to differ from all the rest, that for this I would propose the name of "*Dactylocalycites ellipticus*." Of fig. 40 I have only found two specimens; they are very small, but are so beautifully marked, that for these the most appropriate appellation that I can think of would be *Dactylocalycites callodiscus*. It should be remembered that we are here naming spicules only, and not entire sponges.

In figs. 10 to 18 inclusively we have specimens of "knots," so to call them, or branching centres of the silicified fibre of the Coralliospongiæ and Euplectellidæ, the rectangular branching of figs. 10 and 11, and the hexradiate appearance of figs. 10 and 15, being more particularly like that of the sponges last mentioned.

Fig. 12 is an instance of the canalled silicified fibre characterizing *Farrea occa*, Bk. (Proc. *cit.* 1869, pl. xxiv. fig. 1 and Brit. Spong. fig. 277).

And the rest may be siliceous knots from the Dactylocalycidæ generally.

In Pl. VIII. figs. 19 to 29 inclusively, we seem to have nothing but the coarsest parts of the silicified fibre of the

Coralliospongiæ. Such fragments are so abundant and so infinite in the variety of their forms in this deposit, that it has been a matter of difficulty to make any selection that could give even their general character.

Most of them have small spicules, fragmental or entire, adhering to them, as in figs. 19 and 24, which are drawn upon the same scale as the rest of the figures (indeed it should be remembered that not only all the figures except 7, 8, and 9, but every thing connected with them, are drawn upon the same scale in these representations). Such small spicules, as has been heretofore explained, need not have had any previous existence in the sponges from which the fragments to which they now adhere belonged.

Again, as there is also a great abundance of the globular crystalloids (little siliceous balls) of the Geodidæ in the deposit, many of these also, as represented in figs. 20 and 24, adhere firmly to the larger spicules of *all* kinds; these, in like manner, need not have had any connexion before the deposit took place with the spicules to which they are now attached. I particularly mention this, because the occurrence has often led me to the opposite conclusion, which subsequent reflection has thus corrected.

Figs. 25, 26, and 28 represent instances where the small spicules *did* appear to have been incorporated with the silicified fibre from the beginning, as seen especially in the *Aphrocallistes.* Indeed the imbedding of the spicules in the silicified fibre of the Coralliospongiæ, while it has its analogue in the entire enclosure of them in the living fibre of the Chalineæ, or in the insertion of their blunt ends only, as in that of the Oplitospongiæ, Bk., seems, in the Coralliospongiæ, to have been as present and necessary for the support of their delicate spicular structure in the more shallow tidal seas in which they live and have lived as it is absent and unnecessary in the flimsy spicular structure of the deep-sea sponges, which, like *Askonema setubalense*, Kent, attains "upwards of three feet in diameter" in the quiet valleys of the Atlantic Ocean (Monthly Microscop. Journ., Nov. 1870, p. 245, pl. lxiv.).

Fig. 29 represents a piece of silicified fibre with holes in it (*a*)—a very common occurrence, as may be supposed, in the Coralliospongiæ.

Following the numbers, we now come to the spicules of the Pachytragiæ, whose heads, where the shafts have been broken off entirely, and where fragments of them still remain, are represented in Plates IX. and X. respectively; and here we meet with the difficulty of determining, not only how many of those in Pl. IX., where the heads are without shafts, belonged to the Coralliospongiæ, but also which of these, and of those *with* shafts in Pl. X., belonged to the different divisions included under the head of Pachytragiæ.

We must here, for reasons above stated, omit from these altogether the Tethyadæ, of which *T. cranium* is the type, likewise *Donatia* (*T. lyncurium*) and its type, since, if neither the trifid spicules of the former nor the stellates of the latter can, from their extreme delicacy, be expected to be found in the deposit, these species have no other spicular element by which they can be recognized with certainty.

The thickness of the shaft at its base in the headed spicules rather indicates a short than a long shaft, as is well known to those who have studied the anchor- and vasiform trifid-headed spicules respectively of the Geodidæ &c., for which compare our fig. 63 with 59 in Pl. X.; but, as before stated, the expansion or elaboration of the head seems to take place at the expense of the shaft; and hence this so accords with what is found in the Coralliospongiæ, that where there is no part of the shaft left, and the thickness of the latter at its base is no indication of length, the development of the head is our only guide.

Thus, in the figures of Pl. IX., I *know* 32 to be the end view of the shafted spicule 66 in Pl. X., because I myself drew it from this spicule: and figs. 35 and 36 had also shafts; but they are omitted because there was no room left in the plates for lateral views of these spicules. Fig. 34 probably had a long shaft; and the head of 69, when viewed endwise, presented a hexternate form somewhat like 33; but whether figs. 30, 31, and 33 had short shafts or long ones there is nothing to determine, as they are broken off close to the heads in the fossils.

Thus, while there can be little doubt of the heads which have long shafts having originally come from some species of the Pachytragiæ, I have no means of deciding whether figs. 30, 31, and 33 belonged to the latter or to the Coralliospongiæ, since nearly facsimiles of 31 and 33 are given by Dr. Bowerbank in his illustrations of *Dactylocalyx Masoni* and *D. Bowerbankii* respectively (Proceed. *cit.*), and a facsimile of fig. 30 appears in Schmidt's illustrations of *Stelletta* (*S. discophora*, tab. iv. fig. 5 *a*, Adriat. Spong. 1862). The latter also, in its hexradiate form, is no less characteristic of Wright's *Wyville-Thomsonia Wallichii* (Quart. Journ. Microscop. Sc. Jan. 1870, pl. ii. fig. 3), also Schmidt's *Stelletta* (*Tisiphonia*) *agariciformis* (Atlant. Spong. Faun. Taf. vi. fig. 12), also *Dorvillia agariciformis*, Kent (Monthly Microscop. Journ., Dec. 1870, pl. lxvi. fig. 7), and, lastly, my own figures of the spicules in *Stelletta aspera* and *S. lactea* (Ann. Nat. Hist. vol. vii. Jan. 1871).

Thus the hexternate head seems to take us from the Pachytragiæ of the shore through the Coralliospongiæ of the comparatively shallow seas, down into the deep recesses of the ocean, where, at 1913 fathoms, Dr. Wallich found the diminutive but important little sponge to which Dr. Wright (*l. c.*) has given the name *Wyville-Thomsonia Wallichii*. Already it will have been seen that M. de Pourtales found this (for *Stelletta* (*Tisiphonia*) *agariciformis* of Schmidt appears, *mut. mutand.*, to be identical with it) in 178 fathoms; so that here we have a sponge, in form and habitat respectively, connecting the Pachytragiæ of the shore, through the Coralliospongiæ, with the Calycispongiæ (Kent) of the deepest seas.

Figs. 37, 38, and 39, Plate IX., and figs. 72, 73, and 74 Pl. X., are nail-like spicules, whose crucial or four-armed heads as plainly show that they do not belong to the ternate as that they do belong to a quaternate or quadrifid system, whose parallel, as before stated, is only found in the spicules of *Hyalonema* (*Carteria*, Gray).

On this, however, it may be observed that the minute spicules with feathered shafts and quadrifid heads are not confined to *Hyalonema*, but are found also in *Holtenia Carpenteri*, W. Thomson (Phil. Trans. 1869, pl. lxviii. figs. 9–11), and in *Pheronema Grayi*, Kent (Monthly Microscop. Journ., Nov. 1870, pl. lxiii. figs. 9 and 10). So are there minute hexradiate spicules in many of the Coralliospongiæ and Euplectellidæ; but Dr. W. Thomson states, respecting the former, that "opposite to the point of junction of the vertical with the four transverse rays there is frequently a more or less distinct rounded elevation or tubercle. This undoubtedly represents the sixth ray, the continuation of the primary axis of the spicule" (Phil. Trans. 1869, p. 704); so that *these* feathered shafts with quadrifid heads in *Holtenia* evidently belong to the hexradiate system. But where Dr. W. Thomson goes on to state that in some cases "the tubercle is developed into a branch, and the spicule becomes hexradiate, recalling the ordinary hexradiate spicule of the sponge-mass of *Hyalonema*," I must join issue, inasmuch as I have never been able to see such a tubercle in the minute spicules with feathered shafts and quadrifid heads, nor in the large quadrifid spicules of *Hyalonema*, although examined carefully for this purpose; nor have I ever seen in any illustrations, or in my own examination of my mounted specimens of the sponge of *Hyalonema*, any *hex*radiate spicules; while, as before stated, the simple cross in the centre of the longer spicules, which was first pointed out by Schultze (Ann. *l. c.*), has always appeared to me *quadri*radiate, as stated by him, and not *hex*radiate with quadrilobate inflation, as it is, for the most part, in *Askonema setubalense.*

Still it is not with the plan on which the minute spicules of sponges are developed that we have to deal in the Haldon deposit; for, as already mentioned, their entire absence there compels us to consider only the system of the larger spicules; and here we have one which is as distinctly quaternate in the division of its head as the quadriradiate cross, with and without shaft and extended arms respectively, in the large spicules of *Hyalonema.*

Fig. 39 is a lateral view of one of these spicules, and fig. 38 the end view of its head, in which the central lines represent the quadrifid branching of the axial canal. (The dotted lines, for the most part, in these figures represent restored parts.) Fig. 37, although on the same system as the last, much exceeds the rest in size; the central canals are enormously enlarged, apparently at the expense of the walls of the spicule, which are very thin; but whether this was originally the case, or subsequently produced during petrifaction, we will not consider now, as the subject (viz. the enlarged state of the canal in many of the fossil spicules) will by-and-by come before us separately. It will be observed that the ends of this quadrifid head have also disappeared; but a portion of the shaft, which cannot be made apparent in the drawing, still remains; nor is it improbable that the arms were carried out, as in the long-armed spicules of *Hyalonema*, to a much greater extent than the dotted lines conjecturally indicated.

Fig. 74, Pl. X., is a lateral view of another specimen of this spicule, showing the peculiar form of the arms; and fig. 73 represents the head end of fig. 72, which, being smaller and somewhat different from the rest, and furnished with a longer shaft, may have belonged to another species; while the short-shafted ones may perhaps, by the union of their heads (for in one instance I found two together), have formed the surface of some coral-sponge. Still, in the absence of all decisive evidence in this respect, I propose for these spicules (which are by no means uncommon, although not so plentiful as many of the rest, and bear a remarkable resemblance to nails) the generic name "*Gomphites.*" Those with the shorter shafts and more expanded heads I would call *Gomphites Parfittii*, in honour of Mr. Parfitt, who early recognized the value of these fossils generally, who partly brought them to my notice, and who subsequently wrote the valuable paper on them to which I have alluded, in which is figured the peculiar form under consideration. For the long-shafted one (fig. 72) with contracted head I would propose the name of *G. parviceps.*

Before returning to the ternate system again, I may here briefly allude to two other kinds of spicules, *not in this deposit*, called respectively by Dr. Bowerbank "biternate" and "trifurcated attenuato-hexradiate" spicules, the former belonging to *Dactylocalyx subglobosa*, Gray (Proceed. *cit.* 1869, pl. 22. fig. 11), and the latter to *Euplectella aspergillum* (Brit. Spong. pl. 8. fig. 189), since the straight lines in fig. 34 are introduced to show how these two forms might be produced. Viewing, then, those marked *a a a* as branches of the axial canal, producing the ternate system, we have the lines *b a b*, *b a b*, and *b a b* with the shaft in the centre, forming Dr. Bowerbank's "biternate" spicule; and by adding another branch with *b a b*, so as to produce the quadrifid head, together with one above and one below in the axis of the shaft, we get the "trifurcated attenuato-hexradiate" form. But as these forms are only to be found among the minute spicules of the existing species to which they respectively belong, they do not come into the category with which we are most concerned, although it seemed desirable to give them a passing notice. Again, it should be remembered, as enlarged figures often mislead, that if the spicules in question were drawn to the scale of our figure 34, under reference, their utmost size would not be more than the semidiameter of the circle representing the broken end of the shaft; hence their subordinate nature in respect of size.

It is very desirable, where we can, to take our characters rather from large than small objects; for it is much more useful to the many, who cannot afford to purchase microscopes for seeing the latter; and it becomes questionable how far species-splitting should be subject to microscopical examination, since there might be no end to this if there were no limit to microscopic power: hence the desirableness of restricting the latter in the formation of species, even as it is, to some practicable extent.

Returning to the ternate system of the large fossil spicules with long shafts, we have, in figs. 32, 35, & 36, Pl. IX., heads only, in which the shafts although not represented, are known to have been long; also figs. 59 to 71, inclusively, in Pl. X., where the heads and fragments of their long shafts still remaining together are thus represented.

And here, directing our attention first to the furcate division of the arms, or the hexternate forms in figs. 32, 34, and 35, Pl. IX., and figs. 58, 59, 60, 66, & 68, Pl. X., we observe that, although there is great irregularity in their dividing, they are all provided with long shafts. (Again I must beg the reader to remember that these figures are not selected from their rarity, but as the best representatives that I could find of their like, which exist in countless myriads scattered throughout the deposit.) The figures, then, to which I have just alluded are very similar in character, and, together with the vase-like trifid heads, figs. 61 & 67, and the bifid ones, figs. 65 and 64, may all be varieties of their proper types respectively, produced in one species of sponge, to which I would give the name collectively of *Geodites haldonensis*, taking fig. 58 as the best representative of this group.

If, then, we make this a *Geodia*, it involves the addition of an anchor-headed spicule with extremely long shaft (as those know who have studied the existing species); and this we appear to have in figs. 62 & 63, which, although slightly differing in form, may be but varieties of one type; also a large smooth acerate spicule, like that of fig. 76: and thus we have all the spicular forms characteristic of the circumferential zone of a *Geodia*, viz.:—(1) the thick ternate head, characteristically furcated and vasiform in this instance; (2) the vasiform, trifid, extended head; (3) the anchor-like or trifid recurved head; and (4) the large acerate spicule. Add, further, to these the globular crystalloid or little siliceous ball (Pl. IX. figs. 55 & 56) (found abundantly in this deposit) for the crust, together with the large acerate and acuate spicules (figs. 76 & 77, Pl. X.) for the interior, and we have, with the exception of the minute stellates &c. (also usually found in the existing species of the Geodidæ, but which, for reasons above given, we cannot expect to find in this deposit), all the spicular combination which belongs to a *Geodia*, except that, I think, there is no existing species known in which the arms of the ternate head are furcated and also spread forwards, instead of horizontally and more or less recurved.

Such a condition may be seen, so far as the furcation goes, in Schmidt's *Stellettæ* and *Ancorinæ* (Spong. Adriat. Meeres, Taf. 3 & 4, 1862); but here, again, the bifurcations are not prolonged, but *recurved*.

Fig. 69, which is hexternate, is, with its varieties, also a very common form in this deposit; and here the arms *are* spread out horizontally or laterally, and the furcations somewhat recurved, as in *Stelletta* &c. For this and its like, then, I would propose the name of *Stellettites haldonensis*; albeit it is not certain that this spicule, too, might not have been connected with a crust of siliceous balls and a spicular combination in other respects like that just mentioned, when it would become a *Geodites*, the absence of the siliceous balls being Schmidt's distinction. But, then, his *Stelletta discophora* has a crust of little siliceous disks, which are but a more depressed form of the siliceous balls; and so the future may furnish a species of *Geodia* with the hexternate or furcate spicule of *Stelletta* and the siliceous balls of a *Geodia*, in which case the genera of Schmidt's groups of Ancorinidæ and Geodidinæ would come together.

Lastly, we come to the simple ternate or trifid head of the long-shafted spicules, of which three kinds at least, with their varieties, abound in this deposit, viz. fig. 70, which is very stout, with long shaft and three arms expanded laterally, almost horizontally, and a little recurved. In the illustration, which is taken from the most perfect one that I could find, the arm on the left side is broken off square, and the other two, which were about equal in length, broken or rounded off by attrition. Fig. 36, Pl. IX., also belongs to the simple ternate division of the head with long shaft; but the arms are more or less straight, elongate, attenuated, and spread out at equal distances from each other, somewhat forwards. Fig. 71 is another of this kind, but frequently with very little difference between the length of its shaft and the expanded arms.

Of these the two former, viz. figs. 70 & 36, might, from the length of their shafts, have belonged to the circumferential spicular zones respectively of two different species of *Geodia*.

But the prevalence of fig. 71 and its varieties, chiefly in size, so nearly resemble the stout spicules with which an existing species, viz. *Dercitus niger* (Annals, Jan. 1871), is densely charged, that I do not think that a more appropriate appellation can be assigned to it than that of *Dercites haldonensis*.

The existing type grows on the rocks at Budleigh-Salterton, and is a black variety of *Hymeniacidon Bucklandi*, Bk., = *Pachastrella Bucklandi*, Sdt.

We now leave the spicules of the ternate system, and go to that large *acerate* form whose middle and ends are represented in Pl. X. fig. 76, *a a*, which, with the exception of *Dercitus niger* (which is peculiar in this respect), is the characteristic body-spicule of all the known Pachytragiæ; and hence its great abundance of different sizes in the Haldon deposit is easily understood. It is smooth, acerate, fusiform, and for the most part stout and slightly curved, as shown in the figure, which otherwise represents the average size of the largest specimens.

The same remarks apply to the *acuate* spicule, whose large and small ends are given in fig. 77 *a*, but with this exception, that the acuate form is somewhat smaller and less abundant in the existing species as it is in the Haldon deposit. It seems also to be but a modification of the body-spicule, in which one half is shortened and enlarged at the expense of the length of this half, the blunted extremity varying also in form from that of being simply rounded in fig. 78 to pin-head-like inflation as in fig. 77.

Here, then, we also come upon the characteristic form of the spicule in *Donatia*, Gray (*Tethya lyncurium*), and its like; but, as before stated, in the absence of the large stellates peculiar to the existing species, the acuate spicule alone is a useless indication.

Lastly, we arrive at the smaller spicules of the deposit, represented in Pl. IX.; and beginning with fig. 43, we at once recognize its bihamate pointed form, which association leads us to connect with the Esperiadæ. But where are the little anchorate spicules which in the existing species always accompany it in a still more minute form? These also are absent, and, from their minuteness and delicate forms, may have disappeared under the destructive and dissipating influences before mentioned. Still, for future reference, this spicule must also be named; and hence I would call it *Esperites haldonensis*.

It is six times as large as that of the great branching *Esperia* of the deep sea, from which I have been kindly provided with a small portion for reference by Dr. Carpenter; and this, again, possesses the largest bihamate of any existing species with which I am at present acquainted. Yet the fossil specimen is C-like, more or less contort, and in all other respects, as will be seen by the figure, exactly like the bihamate of the present day. It was first brought to my notice by Mr. Vicary, who found it in the Haldon deposit, after which I obtained several myself in specimens of this deposit. They are all about the same length, viz. 1-37th of an inch, while those of the deep-sea species only average 1-222nd of an inch; so that while the former can be well seen with a simple lens of low power, the latter can only be seen with the $\frac{1}{4}$-inch combination of a microscope.

Still larger is another but sigmoid contort form of this (?) spicule, viz. fig. 79, of which one specimen only has been found, and that, too, by Mr. Vicary, in the Haldon deposit. Its gigantic size, being 1-17th of an inch long, and of proportionate thickness, makes one almost doubt its identification with the bihamates. However, as it is, so it is represented in the figure, where its remarkable size and form show that it should also have a name for distinction's sake. Hence we will call this *Esperites giganteus*.

It is impossible to confound the bihamate spicule of a sponge with that of an echinoderm, since the latter, as in *Echinus sphæreus*, to which Dr. Bowerbank alludes (Brit. Spong. vol. i. p. 44), is not only vastly more minute than our smaller fossil specimens, but differs from the bihamates of sponges generally in being calcareous instead of siliceous, more or less crooked, and provided with a little point in the middle of its convex side, by which, as is wont with these spicules, it is attached to the flesh of the echinoderm. I need hardly add that the spicules of the Spongiadæ are free.

Next come figs. 46 and 47, which are as abundant in the Haldon deposit as they are remarkable for their beauty: these are moniliform, cylindrical, slightly diminishing towards the end, and slightly curved; they vary in thickness and in the number of their moniliform inflations, which seldom exceeds eight; but in fig. 46 there are nine, the end one of which on one side, having been apparently broken off, has been restored. Fig. 47 is another form of the same spicule, which is thicker, more obtuse at the ends, and has only six moniliform inflations: they vary somewhat in size also, and many are fragmental; but the more perfect form seems to be that of fig. 46. I know of no sponge possessing spicules like these; at the same time, being so abundant, and remarkable for their beauty and the peculiarity of their form, they demand specific distinction. Hence we will call this spicule *Monilites haldonensis*.

Fig. 54 appears to be an eroded state of the same spicule, unless it was one like that figured by Dr. Bowerbank (Brit. Spong. pl. 11. fig. 244).

Again, there is another moniliform spicule, much smaller than the foregoing, which is represented in figs. 44 and 45. This, however, is not linear like the last, but apparently quadriradiate. I say "apparently," because I am not quite certain that in some instances one ray would not be found to be longer than the rest, in which case it would belong to the ternate-shafted spicule represented in fig. 71. All its rays are moniliform, straight, and pointed, with such symmetry as to make it, although very small, a beautiful object. I also know of no existing sponge that possesses a spicule like this, for which I propose the name of *Monilites quadriradiatus*.

Fig. 47 is a very common form in this deposit, about the same size as *Monilites haldonensis*, but differing from it chiefly in being smooth instead of moniliform. It varies much in thickness and a little in length below that of the figure; but possessing no peculiarity referable to any existing sponge, no further notice of it is necessary, except that it is remarkable for its multiplicity, and originally may have formed the smaller spicule of one of the Coralliospongiæ, as a similar spicule, although a little less in size than the one figured, abounds in *Discodermia polydiscus* (Schmidt's mounted specimen of *Corallistes polydiscus* in the British Museum).

As this spicule is a simple or smooth analogue of *Monilites haldonensis*, so there is a simple one of *M. quadriradiatus*, which I have not figured, but which is equally plentiful with the latter in the Haldon deposit, and therefore equally deserving of notice.

Figs. 48, 49, and 57 are all abundant, but with no character to associate with any existing species in particular. Although small, they are much larger than most of the spicules of existing shore Sponges, excepting the Pachytragiæ.

Figs. 50, 51, and 52 are respectively peculiar in form, but, apart from the sponges to which they belonged, are of no specific value. Their figures are introduced here as representatives of a great variety of the same size which exist in the Haldon deposit. In fig. 52, which is the smallest spicule with definite form that I have found, we seem to have a capitate ray of one of the minute hexactinelled ("floricomo-hexradiate," Bk. B. S. pl. 8) spicules in the Coralliospongiæ; but this is all that can be said for it. In some instances it is as probable that the minute spines or projections of a spicule may have been obscured by chalcedonic union into one mass, as that the solvent influence may have carried them off altogether.

Last, although far from being the least important, are figs. 55, 56, which represent one of the globular crystalloids or siliceous balls of the crust of a *Geodia*. Perhaps, from its specific value and great abundance, it is one of the most interesting forms in the deposit. That represented in figs. 55, 56, which give its lateral and upper profiles respectively, is the average size of the largest, and shows that it is somewhat depressed or a little less in diameter vertically than it is laterally, also that it possesses the usual hilous depression below.

These little balls not only form the crust of the existing Geodidæ, but are scattered more or less throughout the whole structure of these sponges, where they present as many sizes as phases of development, which may thus be followed from the youngest to the most matured state (see their structure &c. 'Annals,' 1869, vol. iv. pls. 1 & 2). They are therefore exceedingly numerous; and, further, in the existing species, they somewhat differ in their globular forms and in the markings or pattern on the surface of the matured ones.

Hence it is not suprising that they should be very abundant and be present of different forms and sizes in the Haldon deposit; but the pattern on their surfaces is so obscured by the minute botryoidal crystallization of the chalcedony before mentioned, that I have only met with one instance in which the presence of a few tubercles bore indication of the original appearance; and these were too indistinct to be of any specific value.

The largest as to size and general shape, viz. that figured, bears a greater resemblance to those of *Geodia Thomsonii*, Sdt. (Atlan. Spong. Faun. Taf. 6. fig. 13), than to any other existing species with which I am acquainted.

There is hardly a large spicule in the deposit to which one or more of these little balls are not adherent; so that, as before stated, this must be regarded as accidental, and arising from their having been thrown together promiscuously at the time the deposit was formed.

It has, however, been necessary to add one of them to the combination of spicules before mentioned to complete the complement of *Geodites haldonensis*; and for this purpose we may take the largest size, or that figured in figs. 55 and 56. Of course the combination is conventional and provisional; but it is necessary, under the circumstances, for future reference.

Before concluding, we have to advert to a structural peculiarity in many of these fossil spicules, which finds its illustration in fig. 75, Pl. X., and to which I have before alluded as an unusual enlargement of the axial canal. Here it will be observed that the axial canal is extremely wide, and the wall of the spicule therefore very narrow, also that the former has in it the end of another spicule and several grains of sand: *a* is the wall, *b b* the dilated canal, *c c*, grains of sand, and *d* the point of a spicule.

This fragment, which represents part of the shaft of a ternate-headed spicule, is an illustration of what is frequently met with in the Haldon deposit, and, by the presence of the grains of sand, shows that this condition of the spicule was not produced during fossilization, but must have existed from the beginning.

It seems to derive explanation, however, from what I have particularly noticed in the deciduous spicules, both fragmental and entire, of the spiculo-arenaceous sponges and those in the head of *Squamulina scopula* (Annals, 1870, vol. v. pl. 4), viz. that most of them have unusually wide canals, insomuch that I have often thought that this arrest of development (for spicules appear to be formed endogenously rather than exogenously) in many instances had led to their being thrown off (like dead feathers) from the sponges in which they had thus become useless; and floating about, rather than sinking at once or becoming fractured and destroyed like the more solid ones, they had thus been more easily captured by those organisms which make use of such elements for building up their habitations. But be this as it may, the axial canals of the deciduous spicules, both entire and fragmentary, in the spiculo-arenaceous sponges and the head of *Squamulina scopula* are for the most part unusually large.

Concluding Remarks.

In accounting for the Haldon deposit geologically, with reference to the fossil spicules of the Spongiadæ which it contains, we have to consider whence the sand of which it is composed was derived, to what kinds of the Spongiadæ the fossil spicules in it belonged, in what kind of climate these sponges probably lived, what kinds of the Spongiadæ are not represented in the deposit, and, lastly, by what agency its elements were brought together.

These queries can be soon answered.

In the first place, the sand, coming from the disintegration of older rocks, was probably of shore origin. Then, the kinds of Spongiadæ to which the fossil spicules contained in it belonged (at least those which can be recognized) are the Pachytragiæ and the Coralliospongiæ, including the Euplectellidæ, the former of which now grow in the marginal zone of the sea, and the latter in the zone immediately following it,—that is to say, the Euplectellidæ at the Philippine Islands in 10 to 24 fathoms (Cuming, *apud* Bowerbank, *l. c.*) and the Coralliospongiæ in 98 (*Sympagella nux*, Sdt.) to 700 (*Aphrocallistes Bocagei*, Wright): none of those referred by M. de Pourtales to Dr. Schmidt were found below 450; and *Aphrocallistes Bocagei* was also found by Dr. W. Thomson in 700 fathoms. The Pachytragiæ appear to be world-wide in habitat, and the Coralliospongiæ confined to the warmer latitudes and the equatorial region of the sea. No spicules of the Calycispongiæ (Kent) or deep-sea sponges, such as *Hyalonema*, *Holtenia*, &c., have been found in this deposit, the materials of which must have been brought together by strong tidal currents.

It follows, then, that, the sand being of shore origin, the Pachytragiæ and Coralliospongiæ living in the marginal and following zones of the sea respectively in warm latitudes, while tidal currents requisite to drift into one and the same deposit such coarse materials are also chiefly confined to these regions, the deposit was formed rather nearer the shore than the deep sea, and in a climate much warmer than our present one.

Again, the sandy nature of the deposit, and the absence of all fossil spicules like those of the deep-sea sponges, contrast forcibly with the "oozy calcareous mud" of the region in which the latter live, which is also stated to be literally "crammed" with their deciduous remains.

Thus, geographically, geologically, and structurally, the deep-sea sponges so differ from the Coralliospongiæ that separating them for classification becomes absolutely necessary; and hence Mr. Kent, who is practically acquainted with both groups, has most advisedly instituted the appropriate name of Calycispongiæ for the former (Monthly Microscopical Journal, Nov. 1870).

The delicate though long spicules of the deep-sea sponges, held together only, as before noticed, by equally delicate sarcode, also contrast forcibly in structure with the rigid, silicified, keratose fibre of the Coralliospongiæ. But if rigidity alone be here considered, it may very properly be observed that in this respect the long, thick, twisted spicules of which the "glass rope" or stem of *Hyalonema* is composed has no parallel among any of the Spongiadæ.

Nor is it less true that this long stem, supporting a calyciform sponge upon its upper extremity, thus prominently differs from its companions *Holtenia* and *Pheronema*, whose sessile or stemless bodies are not only kept in contact with the mud, but partially imbedded in it by a beard of long spicules, far more delicate than those forming the stem of *Hyalonema*.

To this it might be added that a parasitic polype, first named by Schultze *Palythoa fatua* (Annals, 1867, vol. xix. p. 160), usually appears, according to Dr. W. Thomson's observation, on the stem of *Hyalonema* "before it is an inch long, and sometimes earlier." After which we know, by the specimens of the "glass rope" which are much above a foot in length, that the polype not only covers the greater part of them, but the *upper* end also, thus proving that in the "struggle for life" it has caused the calyciform head of the sponge to fall off, and has thus appropriated the stem.

Hence it becomes a matter for consideration how far the difference between the stem of *Hyalonema* and the beard of *Holtenia* arises from the presence of the polype upon the former.

The origin of parasites is involved in obscurity, as much as their modification of structure is often evident—for instance, the gall on oak-trees. And as this modification is to suit their own purposes, and the habit of a polype is for the most part to grow on a hard substance and live in clear water, may not the *Palythoa fatua* have compelled the sponge, in "the struggle for life," on either side, to elongate its stem, and thus reciprocally to produce the modifications which cause it so to differ from the beard of its companions *Holtenia* and *Pheronema*, which have no parasite? In short, might not the stem of *Hyalonema* have been the same as the beard of *Holtenia*, had not the former been accompanied by a parasite? If so, then Dr. Gray's separating the sponge at the top from it, and giving it another name (*Carteria*) is perfectly reconcilable; for the stem would then be a joint production of *Hyalonema Sieboldii*, Gray, and *Carteria*, Gray, with the latter name for the sponge alone,—thus retaining in *Hyalonema Sieboldi*, as Schultze has very properly observed, the name of the celebrated Japanese traveller who, so far as we know, sent the first specimens to Europe (Annals, *l. c.*).

There are other sponges which have a parasitic polype on them besides *Hyalonema*. Thus, Schmidt (Adriat. Spong. 1862, Taf. 6. figs. 2 & 3) gives figures of two Halichondroid, erect, branching species, viz. *Axinella damicornis* and *A. verrucosa*, each characterized by pin-like and acuate spicules, and on each of which there is a social parasitic polype imbedded in its proper cortical layer. But in the British Museum there are several specimens of a flat Halichondroid amorphous sponge (*Reniera*?), whose reticular fibre is charged with small acerate and slightly curved spicules, and on whose upper surface are plentifully scattered solitary polype-heads about 1-12th of an inch in diameter (in the dried state). These, which have been likened by Dr. Gray to the parasitic genus *Bergia* of Michelotti (P. Z. S. 1867, pp. 239 & 514), are imbedded alone, that is, without cortical layer, in the surface of the sponge. Their disks are charged with sand and deciduous spicules, entire and fragmentary, of different kinds; and so far, with their other polype-structure, they differ from the sponge in which they are imbedded; but beyond this they are directly continuous with the structure of the sponge, which thus evidently serves the purpose of a cortical layer or cœnosarc, and so stands in relation to them as the root-stock of a fruit-tree to its graft, there being as much difference between them and the sponge as between the insect which forces the oak to supply the "gall" and the oak-tree itself, so far as separate organization goes. What the modifications of the sponge-structure immediately around the polype-head may be, I am not prepared to state; but it is reasonable to infer that these are such as would not have been there, had the polype-head not been present: hence the *Palythoa fatua* with its social polypes and cortical layer may make use of the sponge-stem of *Hyalonema*, and thus, to meet the circumstances of the case, occasion the modifications in it above mentioned.

Returning to the habitat of the deep-sea sponges and the Coralliospongiæ respectively, we observe that they occasionally mingle; but while the former are chiefly confined to the most retired depths of the ocean, the habitat of the latter tends in the opposite direction.

Not only, however, do the deep-sea sponges and the Coralliospongiæ mingle, but there is one of the Pachytragiæ, viz. *Stelletta* (*Tisiphonia*) *agariciformis*, Sdt., = *Wyville-Thomsonia Wallichii*, Wright, which exists on a reef in the Gulf of Florida, in 178 fathoms, and was happily recognized by Dr. Wallich in "soundings" of the Atlantic Ocean brought up from a depth of 1913 fathoms.

All honour, then, be to one who, so far back as "October 1860," secured this little, wee young specimen, not more than 1-12th of an inch in diameter (Quart. Journal. Microscop. Sc. No. 37, Jan. 1870, pl. 2. fig. 1) for the future advancement of our department of science! It has even been suggested to me by Dr. Gray (to whose kind assistance much of this communication is due), and not without reason, that *Tethya muricata*, Bk. (Brit. Spong. vol. i. p. 25, and figs. 304 and 305), may probably be the same sponge.

Lastly, I would add that Schmidt (Atlant. Spong. Faun. 1870, p. 20, Taf. 2. figs. 16–20) reproduces several figures from fossil remains in the Cretaceous system, which, from their triaxial and "lattice-form" characters, he associates with the living species of "*Farrea*, *Aphrocallistes*, and *Dactylocalyx*." And, as far as the minute triaxial or hexradiate spicules go, he is right in considering them allied to these genera; but when instances of the silicified fibre are given as evidence of the "hexradiate" plan of their structures generally, it will be seen, as our figures show, that this is any thing but regular, and that the ternate division of the large spicules of the circumference, which alone we have had for our guidance, is the most constant plan, and the one least subject to complex modification.

The hexradiate form of the minute spicules answers very well for the character of Schmidt's general grouping under the term "Hexactinellidæ;" but when we come to divide the Sponges of the deep sea from the Coralliospongiæ, other definitions are required; hence the acceptableness of Mr. Kent's term of "Calycispongiæ" for most of the former. The remains of such sponges may be found in those deposits of the Cretaceous system which, from their subtleness, may be assumed to have been formed in deep seas, but not in such as bear the characters of the Haldon deposit.

Not so with the Coccoliths of the deep sea (to me calcareous, solitary, unicellular Algæ), which so abound in the

Laminarian zone at Budleigh-Salterton that it is impossible to examine microscopically a portion of Sponge, Echinoderm (visceral contents), or Compound Ascidian without seeing several of them. They, but for their delicate nature, would, it may therefore be assumed, have been as numerous in the Haldon deposit as they are in the deep sea and in the Chalk, which they might have contributed to form just as much as, if not more than, the other minute organisms found in it; for the coccolith is but a Melobesian cell (*Melobesia unicellularis*, mihi), which, like the arborescent *M. calcarea* on the south coast of Devon, may form beds of many miles in extent, entire as they die or fragmental as they pass out in a comminuted state from the alimentary cavities of the lower animals (e. g. *Ascidia arachnoïdea*, Forbes), which feed upon their protoplasmic contents most voraciously. Hence, too, perhaps their pelleted grouping in the form of coccospheres, if these are not their sporangia.

Besides sponge-spicules in this deposit, I have seen minute bivalve shells and a few minute Foraminifera, but no remains which I could in any way identify with the calcareous spicules of Echinodermata, Alcyonidæ, Gorgonidæ, or Ascidiæ.

EXPLANATION OF THE PLATES.

N.B. All the figures in these plates, excepting 7, 8, and 9, are taken from the fossilized remains of sponges in the Upper Greensand of Haldon Hill, near Exeter, and of Black Down, near Cullompton, respectively; and *all* are drawn on the scale of 1-24th to 1-1800th of an inch, in order that their relative sizes may be seen and their measurements respectively computed by compass and rule.

The fractured ends of the shafts or branches are represented by a point or little circle within a larger one, the former being intended for the central or axial canal, and the latter for the circumference of the spicule or branch respectively.

Dotted lines indicate restored parts, where they are not intended to represent the lines of one spicule behind another.

Plate VII.

Figs. 1 & 2. Disks of *Dactylocalycites Vicaryi.*

Figs. 3–5. Disks of *Dactylocalycites polydiscus.*

Fig. 6. Disk of *Dactylocalycites Vicaryi*, lateral view, showing the shaft.

Fig. 7. Disk of *Dactylocalyx polydiscus*, Bk., after Schmidt, showing the ternate branching of the axial canal of the shaft (*a*).

Fig. 8. Disk of *Dactylocalyx polydiscus*, Bk. (*Discodermia polydiscus*, Bocage), after Bocage, showing the ternate division of the axial canal of the shaft (*a*).

Fig. 9. The same, lateral view, showing the shaft.

Figs. 10 & 11. Rectangular branching of silicified fibre like that of *Euplectella.*

Fig. 12. Canalled silicified fibre like that of *Farrea occa*, Bk.

Figs. 13–18. Knots or branching centres of silicified fibre, like that of *Dactylocalyx.*

Plate VIII.

Figs. 19–29. Fragments of silicified fibre. Figs. 19 & 24 show how small spicules are often adherent to them. Figs. 20 & 24 show how the little siliceous balls of Geodidæ are often adherent to them. Fig. 20 is an extremely common form, varying slightly in its detail, but so numerous as to be quite characteristic of some part of the silicified fibre of a *Dactylocalycites*; but whether to a particular species, or to what part of the fibre, I am equally ignorant. Figs. 25 & 26 show how small spicules are sometimes incorporated with them, as in *Aphrocallistes* &c. Fig. 20 shows a foramen (*a*) in the fibre, a very common occurrence, as may be inferred, in the silicified fibre of the Coralliospongiæ.

Plate IX.

Fig. 30. Hexternate head expanded regularly and horizontally.
Fig. 31. Hexternate head, of smaller dimensions.
Fig. 32. Hexternate head of long shaft (fig. 66), irregular.
Fig. 33. Hexternate head, stout, like the circumference-spicule of *Dactylocalyx Bowerbankii.*
Fig. 34. Hexternate head of long shaft, with blunt points, the straight lines *b a b*, *b a b*, and *b a b* showing that the branching of the axial canal, if thus carried on, would give the minute "biternate" form in *Aphrocallistes Beatrix*, Gray (Bowerbank, *l. c.*).
Fig. 35. Hexternate head of long shaft, irregular.
Fig. 36. Ternate head, with expanded, long, straight, attenuated arms, somewhat inclined forwards, and long shaft.
Fig. 37. Quaternate head, with fragment of shaft.
Fig. 38. Quaternate head of fig. 39, end view. *Gomphites Parfittii.*
Fig. 39. The same, with fragment of shaft, lateral view.
Fig. 40. Disk of *Dactylocalycites callodiscus.*
Figs. 41 & 42. Lateral and end views respectively of *D. ellipticus.*
Fig. 43. Bihamate spicule, *Esperites haldonensis.*
Figs. 44 & 45. Four-rayed moniliform spicule, *Monilites quadriradiatus*; two views.
Figs. 46 & 47. Curved moniliform spicule, *Monilites haldonensis*; two forms.
Fig. 48. Small acerate spicule.
Fig. 49. Small curved acuate spicule.
Figs. 50–52. Small spicules, more or less fragmentary or worn.
Fig. 53. Curved cylindrical smooth spicule, with obtuse ends; numerous, of many sizes.
Fig. 54. Eroded form, apparently, of fig. 46.
Figs. 55 & 56. Largest form of siliceous ball of *Geodia*; lateral and upper views respectively. *Geodites haldonensis.*
Fig. 57. Smallest form of curved acerate spicule; numerous, and of many sizes.

Plate X.

Figs. 58–68. Shafted spicules, *Geodites haldonensis.* Fig. 58. Typical form, hexternate head extended, vase-shaped. Fig. 59. Irregular form. Fig. 60. Regular form, smaller. Fig. 61. Trifid, extended cup-shaped. Fig. 62. Trifid, recurved, anchor-shaped. Fig. 63 The same, a little varied in form. Figs. 64 & 65. Bifid spicules (varieties?). Fig. 66. Hexternate, vase-shaped, closely allied to the type form, fig. 58 (for end view see fig. 32). Fig. 67. Trifid extended, cup-shaped head, with curved shaft. (This curved kind of shaft is so common and so remarkable that it also is very characteristic of *Geodites haldonensis,* if not deserving of a different specific denomination.) Fig. 68. The same as the last, with quadrifid head, furcated irregularly; variety.

Fig. 69. Hexternate head; stout spicule.

Fig. 70. Ternate expanded head; large spicule. *Stellettites haldonensis.* This spicule shows a very common occurrence in the deposit, viz. the bare extension of the axial canal (*a*), in solid petrifaction, without the walls of the spicule.

Fig. 71. Ternate head; arms straight, pointed, expanded laterally and forwards; shaft and arms very much alike in many varieties; numerous, of many sizes. *Dercites haldonensis.*

Fig. 72. Quaternate head, contracted, with long shaft; lateral view. *Gomphites parviceps.*

Fig. 73. The same, end view.

Fig. 74. Lateral view of *Gomphites Parfittii.*

Fig. 75. Portion of long shaft, to show the enlarged state of the axial canal, which is frequently present in these fossil spicules: *a*, wall of spicule, very thin; *b b*, axial canal, much enlarged; *c c*, grains of sand in it; *d*, end of spicule in it.

Fig. 76. Specimen of the large, fusiform, smooth, slightly curved, acerate spicule common in the deposit: *a a*, the pointed ends. This kind of spicule is very abundant, entire and fragmentary, of all sizes. The figure represents the average largest size, viz. about 1-5th of an inch long. The limits of the plate are not sufficient to allow of the spicule being represented in its entire length, and therefore the middle portion and two ends only have been delineated. The same remarks apply to the following spicule.

Fig. 77. Large fusiform acuate spicule, average large size, about 1-9th of an inch long.

Fig. 78. Smaller acuate spicule.

Fig. 79. Large contort bihamate spicule, *Esperites giganteus.*

XV.—*On a New Species of* Marginella *from South Africa.* By F. P. Marrat.

[Plate XI. fig. 13.]

Marginella Keenii, Marrat, n. sp.

Shell conically ovate; spire short; whorls four, rounded, blunt at the apex; colour orange-buff, somewhat translucent; columella with four sharply raised plaits; outer lip thickened, smooth within.

Hab. South Africa.

I have named this shell after my friend Mr. Keen, of Edge Lane, Liverpool, to whom the specimens (six in number) belong, and whose collection of *Marginellæ* is considered to be the finest in England.

100 Edge Lane, Liverpool.