ing its presence than has heretofore been employed becoming obvious when, as shown by me in the case of *Gromia* (and as I believe will be found to be the case in every one of the naked Rhizopods which have hitherto been relegated to the lowest order of that group of organisms chiefly on account of being supposed to be deficient in this organ), it is almost certain that the error has arisen from the extreme difficulty, often encountered, of rendering the nucleus visible. The superiority of the method I am about to describe consists in its being simple, easy of application, and sure.

During some experimental trials I was making on the effect of a galvanic current passed through the water on slides containing living *Amœbæ* and other organisms, which generally resulted in their being instantaneously killed without rendering their internal organization more distinct than it was before, it occurred to one of my sons to try the effect of ordinary frictional electricity. The result proved most gratifying; for although, as in previous cases, the *Amœbæ* were instantly killed, their entire bodies were at the same time burst up, so to speak, into a homogeneous-looking mass of granular particles, the nucleus, however, in every instance forming a conspicuous object in the midst of these. So marked was this result that in some perfectly clean gatherings of *Raphidiophrys elegans*, so numerous that each field of the microscope was simply crowded with them, but in none of which a nucleus could be previously discerned, the instant the discharging knobs communicating with a single small Leyden jar were applied on opposite sides of the glass cover, and of course in contact with the water between the cover and slide, the effect I have described was produced in every one of them. The only precaution that has to be attended to is not to employ too powerful a discharge.

VI.—*Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia, continued.* By H. J. Carter, F.R.S. &c.

[Continued from vol. xvii. p. 516.]

Order VIII. CALCAREA (*continued*).

Observation.

Following Polèjaeff's arrangement the Sycones will be inserted here, that is before the Leucones, as the radial chambers in the simplest and most typical forms, ex. gr. *Grantia ciliata*, Bk. (*Sycandra ciliata*, H.), appear to be closely allied

in structure to the tubulation of the Ascones, where the latter begin to present "parenchyma," inasmuch as the radial tube of *Grantia* is solely composed of a spicular skeleton consisting of a single layer of small radiates, whose interstices are tympanized by sarcode plentifully traversed by pores, and whose intervals are filled with parenchyma supporting the young ova &c., with Häckel's "intercanal system." Indeed the amount of parenchyma in *Clathrina ventricosa* far exceeds that to be found in any of the Sycones, as will be seen hereafter, and thus, as before stated, in this respect it more nearly approaches Häckel's Leucones (ex. gr. *Leucaltis floridana*) than any of the Sycones.

9. *Sycandra Ramsayi*, von Lendenfeld.

Sycandra Ramsayi, von Lendenfeld, Proc. Linn. Soc. New South Wales, vol. ix. pt. 4, p. 1097.

This sponge, which has been well described and illustrated by Dr. R. von Lendenfeld (*op. et loc. cit.*), is easily recognized by its comparatively large size and the closeness of the hairy surface, which has been so much worn away in my specimens that it now looks like a "shoe-brush" or the coat of a "clipt" horse. The tufts of spicules with which it is covered are so close together that the surface instead of being granulated by them, as in *Grantia ciliata*, is continuously uniform, so that the whole, including the long stout peristome, has when dry a glistening silky appearance; still, by pushing aside the tufts, the usual pore-areas may be seen between them which also respectively cover their radial chambers on the outside; but this is not shown in Dr. Lendenfeld's illustration (*op. cit.* pl. lxvi. fig. 37). Internally the holes of the cloaca, although honeycomb-like in appearance, are almost circular, and so generally in apposition that it is only here and there that any "intercanal" space for the parenchyma can be seen between them; their margins are sparsely echinated with the fourth ray of the quadriradiate, which is comparatively short, and the radial chambers extending outwards from them are long and skeletally "articulated" with characteristically small, thin, triradiate spicules of much the same size, but for the most part sagittal in form. The minute acerate spicules from the base of the tufts represented by Dr. Lendenfeld form part of the medium of attachment between the tufts and the elongated shafts of the triradiates at the outer end of the radial tube; these are sinuous and larger

at one end than the other, which is lance-pointed *, altogether about 13 by $\frac{2}{3}$-6000th in. in their greatest dimensions—in short they form Häckel's "Stäbchenmortel," and are what I have proposed to call "mortar-spicules." Of the terminations of the long acerates of the tufts I know nothing, as they are all broken off except a few of the shorter ones, which are *simply* pointed. The most complete specimen of this species in Mr. Wilson's collection is much compressed, about 1 in. long and $\frac{3}{4}$ in. broad; with a large peristome of glistening, silky, fine acerates now arranged conically, altogether about 3-24ths in. in diameter at the base and 5-24ths in. long, which, of course, is the diameter of the mouth.

10. *Grantia subhispida.*

Individualized. Sacciform, elongate, somewhat pyriform, diminishing in size abruptly towards the free and gradually towards the fixed end. Surface presenting a checkered appearance owing to the presence of lines crossing each other spirally and obliquely upwards, at the intersections of which a tuft of long projecting spicules is situated, and in the intervals a cribrate, stelliform area, arched outwards. Pores in the dermal sarcode stretched over these cribriform areas, in short the holes of the cribriform structure itself. Vent large, single, terminal, subcircular or twisted, like a slit nostril; surrounded by a palisading of long linear spicules, leading into a cloaca which corresponds in shape to that of the specimen, and whose surface is scattered over with holes separated by a thick spicular framework; holes not superficially sphinctered, but presenting two or more sphinctered openings *within* the margin belonging to the internal structure. Wall composed of radiating cylindrical chambers in juxtaposition, whose skeletal structure is "articulate," tympanized with sarcode, pierced by the usual pores of intercommunication, and more or less accompanied by parenchymatous or intercameral intervals; outer ends of the chambers respectively covered by the spicular tufts and cribriform areas, and their inner ends opening in pairs, within the holes of the cloaca respectively, as before stated. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of two forms, viz. one long, fine, linear, straight and simple, pointed at each end, arranged parallelly to each other around the mouth; the other much stouter, curved, simple or lanceolate at one end, chiefly

* When the word "lance" is used with reference to the form of the end of a spicule, it must be understood to mean lozenge-shaped or conical as the case may be.

arranged around the external ends of the radial chambers to which they belong. 2, triradiates, varying in size and shape according to their position, that is from an equiangled to a sagittal form in which the arms are much expanded. 3, quadriradiates, whose fourth arm is short, curved towards the mouth, and projects into the cavity of the cloaca. No. 1 in its thin form is confined to the peristome, and in its stouter one to the tufts on the surface of the body, mingling also with the proximal ends of the peristome-spicules; no. 2 chiefly to the spicular skeleton of the radial chambers, which is thus "articulate;" and no. 3 chiefly to the cloaca, where its fourth arm thickly echinates the surface and circular holes of this cavity. Size of largest specimen, of which there are two, $1\frac{1}{4}$ in. long by 4-12ths in. in greatest diameter, which, the specimen being pyriform, is towards the free end; vent or mouth about $\frac{1}{6}$ in. in its greatest diameter.

Obs. This species, although closely allied to *Grantia ciliata*, differs from it in several particulars, viz. first in the pore-areas being much more circularly defined, arched outwards, and presenting a stelliform appearance; secondly, in the radial chambers being of the same size throughout, while in *Grantia ciliata* they widen outwards; and thirdly, in two or more openings of these chambers opening *inside* the holes of the cloaca respectively, while in *Grantia ciliata* each chamber has its appropriated opening in the cloaca, and each is sphincter ed by a sarcodic diaphragm. The smaller specimen is charged with ova about 1-400th in. in diameter when dry, which possess the germinal vesicle and *now* are evidently *on the surface* of the radial chambers as much as in the parenchyma, where they are also present.

With reference to the position of the ova, they *must* be developed *ab initio* from the surface of the chamber or tube in *some* instances, as in the *Clathrinæ*, ex. gr. *C. osculum* &c., where the internal surface of the tubular thread of which it is composed is plentifully charged with them; since here there *can* be no "parenchyma," for there is no place for it.

11. *Grantia compressa*, auct.

The specimens of this species have grown on a small feathery *Fucus* in much the same condition as they grow here (Budleigh-Salterton, S. Devon).

12. *Grantia compressa*, var. *fistulata*.

The only difference between this and the usual compressed form of *G. compressa* is that it is tubular; it grows in a bunch contracted to the point of attachment, in which the individuals

are about 1 in. long by 1-16th in. in diameter, singly or bifurcated.

13. *Sycothamnus alcyoncellum*, H.

Sycothamnus alcyoncellum, H., Kalkschwämme, Atlas, Taf. lviii. fig. 5.

Easily recognized by its hollow, cylindrically-branched, coral-like form, checkered on the surface by spirally-intercrossing lines extending round the cylinder, with holes at the points of intersection. There is nearly as much as would fill a half-pint cup of this, all of which is in a fragmentary condition, wherein the naked and peristomed varieties (*S. arboreum*, H., fig. 7) appear to be mixed. In some of the "mortar-spicules" which Häckel describes in his text-book but does not represent in the 'Atlas,' the lanciform ends are serrated, like those of his *Leucandra saccharata* (Taf. xxxviii. fig. 13).

14. *Teichonella labyrinthica*, Carter.

Teichonella labyrinthica, Carter, 'Annals,' 1878, vol. ii., p. 37, pl. ii. figs. 6–10.

There are several specimens of this species, respectively complete and fragmentary, which enable me to modify to a certain extent what I stated formerly respecting it, inasmuch as the less involuted specimens show that it is goblet-shaped in general form and *not* simply "vallate," like *T. prolifera* (*op. et loc. cit.*); also that a *quadri*radiate forms part of its spiculation; hence these additional facts render it necessary that it should be relegated to the vicinity of *Grantia compressa*, where its generic name might be changed from "*Teichonella*" to "*Grantia*." It was the absence of the lower part and the imperfect state of the specimen generally that led me in the first instance to call it "vallate." As the structure of the stem has not already been noticed, it may be here stated that it consists of a solid, cylindrical, somewhat compressed mass of spicules, chiefly fine triradiates with very long shafts, and echinated with large, long, curved, fusiform acerates on the surface, which are partly free and partly imbedded in the general fabric. The largest specimen is $2\frac{1}{4}$ in. high, not including the stem, and 3 in. across the brim of the head when involuted; while the maximum thickness of the wall, which is towards the base, is 3-24ths in., diminishing gradually towards the border. The stem, which is somewhat contracted near the middle, is an inch long and about $\frac{3}{8}$ in. thick, expanding upwards into the wall of the head and downwards upon the object on which it has grown. One cannot help seeing in the compressed form of the involuted folds of the

head, which altogether is only $1\frac{1}{2}$ inch in its shortest diameter, while its longest, as above stated, is 3 inches, another character of *Grantia compressa* and its varieties.

The crater- or basin-like form, together with the arrangement of the excretory canal-system, causes this sponge to be very analogous in these respects to *Carteriospongia*, Hyatt, among the Keratosa, wherein the openings of the latter on each side of the wall being opposite each other, causes the specimen to present a cribriform appearance when placed between the observer and the light.

Observation.

We have now to leave that portion of Mr. Wilson's collection in which the typical form of the "radial chamber," viz. that in *Grantia ciliata*, which consists of an unbroken cylinder extending directly across the wall from the cortex to the cloaca, is replaced by a *sub*radial structure, in which the typical radial parallelism is more or less lost by the addition of large holes of intercommunication, more or less equal in diameter to the chambers themselves, which thus introduces a branching structure that is better seen in the vertical or horizontal section of the specimen than in the tangential one of the wall, in which the ends of the chambers appear to be almost as regular and as much in juxtaposition as they would be in *Grantia ciliata*. Hence the calcareous sponges presenting this "subradial" structure will be generically termed "*Hypograntia*" under the following diagnosis:—

Hypograntia.

Calcareous sponges in which the typical or radial structure of *Grantia ciliata* is more or less diverted from its parallelism by the addition of large holes of intercommunication between the chambers.

15. *Hypograntia infrequens* (incertæ sedis).

Individualized. Pyriform, sac-shaped, bent upon itself, peristomed. Colour whitish yellow outside, ferruginous within. Surface even, uniformly composed of large triradiates, fixed in their position by sarcode charged with minute mortar-spicules. Pores in the structure last mentioned. Vent single, terminal, circular, surrounded by the peristome, leading into a narrow cylindrical cloaca, corresponding in shape with that of the specimen; holes in the cloaca small, tolerably regular both in size and approximation, each provided with a sarcodic sphincter, like those of *Grantia ciliata*;

surface and holes of the cloaca thickly echinated with the fourth arm of quadriradiates curved towards the mouth. Structure of the wall consisting of radial chambers, most evident on the cloacal side, where they are defined by the long shafts of triradiates, whose heads are against the cloaca and whose shafts, directed perpendicularly outwards, abut upon the cortex, which consists of several layers of tolerably large triradiates, and is thus very thick; chambers uniformly pierced by pores alone until arriving at the cortex, where their continuity is broken up by the presence of large holes of intercommunication, which are continued to the pore-areas of the surface through a similar structure in the midst of the cortex. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of two forms, viz. that common to the peristome in general and that of the surface, the latter minute and sinuous, with one end enlarged and lanceolate, in short the "mortar-spicule," about 28 by 1-6000th in.; 2, triradiates, also of two forms, both large, viz. those which compose the cortex, which are more or less regular, and those whose long shafts define the radial portion of the chambers, where they average 115 by 12-6000ths; 3, quadriradiates, with large, ensiform, curved fourth arms. No. 1 is confined to the peristome and surface; no. 2 to the cortex and interior of the wall, where the heads of the "long shafts" rest against the cloaca; no. 3 to the surface of the cloaca, where the fourth arm, which is stout, ensiform, and curved towards the mouth, *profusely* echinates the whole surface. Size of specimen about 6-12ths in. long by 2-12ths in. in its greatest transverse diameter.

Obs. The structure of this specimen so gave way that it became crushed under the knife while making the section; thus the wall and cloaca together became separated from the cortex. This in part might have been occasioned by decomposition, as indicated by the ferruginous colour of the inner portion; but it may be here stated that it is very likely to occur where the spicules are large and thick, on account of the little resistance then afforded by the sarcode; hence the advantage to be gained by imbedding the portion in paraffine, when the spicules are so firmly kept in their natural position that during the section they cannot swerve from it. There is enough present, however, in my section to show that there is still a portion of the typical radial chamber left in this species, and that it is "inarticulate;" while the thickness of the cortex, exceeding that of any other specimen in the collection, is very remarkable.

16. *Hypograntia hirsuta.*

Individualized; solitary or social. Sacciform, cylindrical, elongate, diminishing towards the free end, which is provided with a long peristome, also towards the fixed one, which is contracted to the point of attachment; covered with a hairy coat of long spicules, which together with the peristome when dry gives the whole a glistening silky appearance. Colour light grey. Surface overspread with tufts of acerate spicules in the midst of circular cribriform areas, which are more or less arched outwardly. Pores identical with the holes of the cribriform structure, which are comparatively large. Vent single, terminal, leading to a cloacal cavity corresponding in shape with the specimen, a little wider in the centre than the wall, which is comparatively thick; abundantly echinated with the fourth arm of the quadriradiate; holes of the cloaca large, irregular in size and distance apart, being more or less separated by the interspaces which the varying breadth of the superficies of the cavity presents; showing within the margin, which is profusely echinated, segments of one or more circular sphincter-ed openings which belong to the structure of the wall. Structure of the wall consisting of subradial chambers, *i. e.* only partly radial, arising from the radial form being more or less diverted from parallelism by large holes of intercommunication, besides the usual pores, especially in the outer and inner sides of the wall, where, in the former, they simulate the "subdermal cavities," and in the latter "subcloacal" ones also; opening in more or less plurality just inside the holes of the cloaca, as above stated; skeletally composed of small radiates, *i. e.* "articulated." Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates of two forms, viz. one thin, smooth, straight, long, silky about the mouth, and the other thicker, curved, and disposed in tufts about the body; 2, triradiates varying from regular to irregular or sagittal; 3, quadriradiates, the same, of which the fourth arm may average 20 by 2-6000ths. No. 1 confined to the peristome and tufts of the surface respectively, where the latter in combination forms a cone over the outer part of its chamber; no. 2, chiefly confined to the wall-structure and the surface respectively, where, in the latter, their rays support the cribriform sarcode, arching over the ends of the chambers which are not occupied by the "tufts;" and no. 3 to the cloaca, where the fourth arm thickly echinates the surface and margins of the holes of this cavity, as before noticed. Size of largest specimen (for there are several) about 9-12ths in. long, exclusive of the peristome, and 5-12ths

in. in greatest diameter, that is in the middle; cloacal cavity 3-24ths in. in diameter in the middle.

Obs. At first sight this looks very much like *Sycandra Ramsayi* from its hairiness; but when examined minutely it is found to present the structure above stated, which allies it almost as much to the Leucones as to the Syconcs, hence the wall-structure is a mixture of both. The sarcode of the chambers is plentifully beset with ova, which appear to be in the last stage of segmentation.

17. *Hypograntia sacca*, von Lendenfeld, sp.

Grantessa sacca, v. Lend. *op. et loc. cit.* p. 1098, pl. lx. fig. 41, and pl. lxiii. fig. 42.

Individualized. Specimen large, pyriform, compressed to flatness, sacciform, somewhat bent upon itself, free and open at the small end, which is truncate and bears the remains of a peristome that has been broken off, so that, at first sight, it appears to be naked or without one; convex at the large end, where the point of attachment was by the most prominent part. Colour sponge-brown. Surface consisting of cribriform sarcode densely charged with small radiates, through which project a number of glistening cones consisting of long acerates; pores of the cribriform structure large, averaging about 1-207th in. in diameter, or just half the size of the holes in the cloaca; cones irregular in form, of different sizes, and at various distances apart, averaging about 1-415th in. in diameter at the base, and 1-207th in. from each other; but all broken off in the specimen, so that their length cannot be ascertained. Pores in the cribriform structure as just stated. Vent single, terminal, amounting in the compressed state of the specimen to a mere slit about 5-12ths in. long; furnished with a peristome, which has been broken off close to the lip; leading into a large cloacal cavity, which, on account of its compressed form, measures 1½ in. in its greatest diameter; thickly scattered over with subcircular holes averaging 1-60th in. in diameter, or twice that of the "pores," as before stated, arranged for the most part in groups of three and four together, at variable distances apart, depending on the breadth of the intervening skeletal structure of the cavity; presenting *within* their borders one or more openings of the wall-structure; scantily echinated with short spines, that is the fourth arm of quadriradiates. Structure of the wall, which when compared with the diameter of the cloaca is very thin, not being more than 1-16th in., much the same as in *Grantia hirsuta*. Ends of the chambers of the wall-structure externally covered by the cribriform sarcode and the cones respectively. Spicules of three kinds, viz. acerate, triradiate,

and quadriradiate :—1, accrates, long, thin, cylindrical, glistening, silky in both peristome and cones, but, owing to the friction to which the specimen has been exposed, all, as before stated, broken off so short that their dimensions in length cannot be given, although, as usual, the length may be assumed to have been considerable. Dr. v. Lendenfeld estimates it (*l. c.*) at "2–3 millim.," say about 5-48ths in. long. 2, triradiates, comparatively small, regular, and irregular or sagittal, and of variable size. 3, quadriradiates, which are very scanty. No. 1 confined to the peristome and cones, those of the latter spreading out tent-like over the outer ends of their chambers, and sinking deeply into the parenchyma; no. 2 to the wall and its limiting layers, viz. that of the surface and that of the cloaca, uniformly and comparatively small throughout; and no. 3 to the surface of the cloaca and margins of the pores on the surface where the scanty presence of the curved fourth arm indicates that of the quadriradiate itself. Size of specimen, whose sides are closely approximated, 2 in. long, by $1\frac{1}{2}$ in. in its widest diameter.

Obs. Although this species, in its dead state, is so much compressed, it is doubtful how far this would be the case when living undisturbed in its habitat. As it appears to be the same species as that described by Dr. R. v. Lendenfeld (*l. c.*), I have adopted his specific name for it. The surface in a dried specimen affords a beautiful object for the microscope, and altogether is so strikingly characterized that it only needs to be studied once to be unmistakably recognized thereafter.

The smaller specimen of this species, for there are two, appears to be in a better condition than the large one, inasmuch as it is stouter, though still somewhat compressed, and plentifully charged with ova, in apparently the "planogastrula" stage, situated chiefly on the *surface* of the chambers; but without any traces whatever of the small granuliferous spermatic-like cells seen where the ova are *not* in such an advanced stage of development. It is about an inch long and half an inch its longest diameter, containing a large crustacean in the cloaca quite ready, when living, to devour the embryos as they were discharged from the parent.

18. *Hypograntia extusarticulata.*

Agglomerated. Specimen consisting of a large bunch of long and short, more or less inflated, cylindrical sacs, with conotruncated ends; growing irregularly out of each other towards the base, all scantily peristomed. Colour whitish yellow on the surface, sponge-brown within. Surface even,

composed of uniformly cribrated sarcode densely charged with "mortar-spicules" and small triradiates, giving it a rough compact aspect. Pores, the holes of the cribriform structure, all tolerably uniform in size. Vents single, terminal, circular, at the end of each of the individuals; each provided with a short peristome, and each leading into its own cloaca, which corresponds in shape to the form of the individual, but is so much broader than the wall that the latter looks like a mere shell; holes numerous, small and great, but still tolerably uniform, permitting more or less of the openings of the wall-structure to be seen within them, according to their size; separated by the skeletal structure of the cloaca, which consists, like the surface of the body, of small triradiates, but with *no* "mortar-spicules." Wall thin, about 1-30th in. in diameter, consisting of subradial chambers like those of *Grantia hirsuta*, but more broken up in their parallelism by the large holes of intercommunication; covered by the pores of the surface externally, and opening, as before stated, into the holes of the cloaca internally; mixed in their skeletal structure, which consists of the "articulated" form *externally*, and the "inarticulated" one *internally*, but all comparatively small; thus the inner radiates of the "inarticulated" portion, which are the largest, have their sagittal heads fixed in the cloaca, while their shafts extend outwards horizontally to about the middle of the wall. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, long and short, the former fine, cylindrical, straight, and similarly pointed at each end, and the latter short, minute, more or less sinuous, fusiform, and lance-pointed at one end, about 15 by $\frac{3}{3}$-6000th in.; 2, triradiates, regular and irregular, comparatively small throughout, the larger, as before stated, on the inner side of the wall, where their shafts average 60-6000ths in. long; 3, quadriradiates, also regular and irregular in their triradiate portion, provided with a thick, curved, fourth arm. No. 1, in its two forms, is confined to the peristome and cribrate sarcode respectively, where the latter, which are the "mortar-spicules," mingle (as is the wont of the dermal acerate when present) in a larger form with the proximal ends of the peristomes; no. 2 is common to the wall and its limiting layers on each side, viz. the cloaca and the cortical layer on the surface of the body; no. 3 is chiefly confined to the surface of the cloaca, where its fourth arm, which projects into the interior of this cavity, is thick and curved, but not plentiful. Size of specimen, which, being an agglomeration, is of course very irregular, about 2 in. long by 1 in. thick; the largest individual of the bunch about $1\frac{1}{2}$ in. by 5-24ths in. in its greatest dimensions.

Obs. As in the two foregoing species so here, there are subdermal and subcloacal dilatations of the wall-structure into which the chambers of the latter open in more or less plurality.

19. *Hypograntia intusarticulata.*

Agglomerated. Specimen consisting of one large individual with several small ones growing out about the base, all without peristomes, the former cylindrical, truncate. Colour whitish yellow. Surface uniformly even, composed of cribriform sarcode densely charged with mortar-spicules and small radiates, so as to completely exclude the sarcode itself, which is thus faced by a minute hispid reticulation. Pores, that is the interstices of the reticulation, large, varying in size under 1-360th in. in diameter. Vent terminal, circular, without peristome, leading into a narrow cylindrical cavity, which, after a short distance, becomes wider and irregular in form as it extends into the smaller individuals; holes of the cloaca subcircular, very irregular both in size and distance apart, corresponding with the width of the spicular or skeletal framework of the cavity; presenting within their margins respectively from one to four openings in connexion with the chambers of the walls. Structure of the wall like that of *Grantia hirsuta* &c., viz. consisting of subradial chambers intercommunicating with each other by large holes as well as the usual pores; partly "articulate" and partly "inarticulate" in the composition of their skeleton, that is the small radiates occupying the *inner* third and the larger ones, through their long shafts, the *outer* two thirds of the wall. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, minute, sinuous, thicker towards one end than the other, viz. that which is lance-pointed, about 16 by $\frac{2}{3}$-6000th in., in short the "mortar-spicule;" 2, triradiates, regular and irregular or sagittal, of two sizes, viz. one small and the other large, with long shafts averaging 60 by 3-6000ths in., and arms about half this length; 3, quadriradiates scanty. No. 1 is confined to the surface, where, together with small radiates, it acts as the mortar-spicules of the dermal reticulation; no. 2, viz. the triradiates, in their smaller size, occupy the "articulated" portion of the parenchymal chambers, and the large ones the "inarticulated" part, where their heads are fixed in the cortex and their long shafts traverse the outer two thirds of the wall perpendicularly to the surface; no. 3, the quadriradiates, are chiefly confined to the surface of the cloaca, where the fourth arm, which is large, projects into the interior with its curve towards the mouth of this cavity. Size of specimen,

which is rather compressed, $\frac{3}{4}$ in. long by $\frac{1}{3}$ in. in its greatest transverse diameter.

20. *Hypograntia medioarticulata.*

Individualized. Pyriform, sack-like, peristomed, turned to one side at the fixed or small end, pear-like. Colour grey. Surface uniformly even, consisting of cribriform sarcode densely charged with mortar-spicules and small radiates, in short, exactly like that of *H. intusarticulata*. Pores, that is the holes of the cribriform structure, also about the same size, viz. varying under 1-360th in. in diameter. Vent single, circular, surrounded by a peristome; leading into a narrow cylindrical cavity, corresponding in shape with that of the outward form of the body, that is being widest above, where it is a little less in diameter than the maximum thickness of the wall; surface of the cloaca presenting large subcircular holes separated from each other by a thick and densely spiculated framework, sparsely echinated with thick curved spines (the fourth arm of the quadriradiate), more or less covered with a thin layer of sarcode which spreads itself in a cribriform state all over the surface of the cloaca, where it is best seen under the microscope in a dried condition. Structure of the wall in general like that of *H. intusarticulata*; also partly "articulate" and partly "inarticulate," but with the small radiates or articulate skeleton occupying the *middle* portion, the larger ones with their long shafts the *outer* half, and the smaller ones of this kind the *inner* quarter of the wall. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates of two forms, viz. the long, thin, cylindrical, glistening one of the peristome, and the other, the mortar-spicule, varying in size under 22 by 1-6000th in., more or less straight, *without* lanciform end; 2, triradiates, small and large, regular and irregular or sagittal, the large ones with straight shafts averaging 60 by 4-6000ths in. and arms about half this length; 3, quadriradiates, in which the fourth arm is comparatively stout and long. No. 1, in its longest form, is confined to the peristome, and in its shortest, viz. the mortar-spicule, to the dermal reticulation; no. 2, the triradiates, in their smallest size, occupy the "articulated," and the larger ones the "inarticulate" portions of the chambers, where their heads are fixed in the cortex and cloaca, and their long shafts traverse the outer and inner parts of the wall respectively, perpendicular to its sides; no. 3, the quadriradiates, chiefly in the surface of the cloaca, where the fourth arm projects into the interior and is more or less covered with the sarcode which, in a cribriform condition, lines the

cavity throughout, as before stated; also in a minute form echinating the interstices of the dermal reticulation, to which it thus imparts an additional hispid character. Size of specimen about 5-12ths in. long, and 2-12ths in. in its greatest diameter.

Obs. This specimen is remarkable for presenting the delicate sarcodic network over the surface of the cloaca which seems to occur occasionally (see Häckel's representation of *Leucetta pandora*, 'Atlas,' Taf. 22. fig. 3 *b*), sometimes, as in this case, occupying the whole of the cavity with its clathrous structure; also for the large size but sparse distribution of the fourth arm of the quadriradiate over the cloaca. Although like the foregoing species in many respects, it differs from it in general form and in the possession of a peristome.

In the last three species the "articulated" portion of the radial chamber is on the outside, the inside, and in the middle respectively, while the other portions respectively are supplied by the so-called "*in*articulated" skeletal structure.

Observation.

Still following the structure of the "wall" for arrangement, it becomes necessary to separate those species which present *no trace whatever* of "radial chambers" from those which do, although in a modified form, such as those last mentioned. Hence they will be generically named "*Heteropia*," in reference to the holes in the sarcodic structure of the wall, which here is traversed by the shafts of more or less large triradiates unaccompanied by smaller ones.

HETEROPIA.

Calcareous Sponges in which the wall is simply composed of sarcode supported on large sagittiform triradiates, whose heads are fixed in opposite sides of it respectively, and whose long shafts, extending perpendicularly across it, more or less overlap each other*.

21. *Heteropia polyperistomia.*

Individualized, social. Globular, elongate, rather bent upon itself, presenting six or more small, conical, glistening peristomes scattered over the body, which is otherwise echinated with thick, club-shaped, much curved, acerate spicules directed forwards. Colour grey-brown. Surface consisting of a rough, uneven, reticulate structure composed of the arms

* A similar structure is represented by Häckel in his illustrations of *Sycilla* (Atlas, Taf. 43. figs. 6, 9, and 10); but to say that it is composed of "Radial Tuben" appears to me to be a stretch of imagination.

of radiate spicules intercrossing each other, through which the curved sickle-shaped acerates project. Pores in the interstices of the dermal reticulation. Vents in plurality, scattered over the surface, at least six in number, each provided with a conical, glistening peristome, which contrasts strongly with the grey colour of the body, and all opening into a single cloaca, which is narrow, corresponding in shape with that of the specimen; in width about the same as the thickness of the wall; holes of the cloaca large and subcircular, separated from each other by variable distances in proportion to the width of the intervening spicular framework of the cloaca, presenting *within* their borders respectively one or more circular openings which appertain to the structure of the wall. Structure of the wall no longer presenting any trace of radial chambering beyond the parallelism of the long shafts of sagittal triradiates which successively following each other chiefly from within outwards traverse a simply clathrous cancellated sarcode, the shafts of the larger or inner triradiates being met by those of the smaller ones descending from the surface. Spicules of two kinds, viz. acerate and triradiate:—1, acerates of two forms, viz. one thin, straight, cylindrical, glistening, and silky, sharp pointed at each end; and the other thick, unequally fusiform, that is the outer portion being thicker than the inner one, and so curved in the outer part as to be almost sickle-shaped, about 150 by 2-6000ths in.; 2, triradiates, small and large, the latter averaging 100 by 6-6000ths in. in the shaft, and 40 by 4-6000ths in. in the arms respectively, which are spread out in a sagittal manner. No. 1, in its thin form, confined to the peristomes, and in its thick one to the surface generally, where it is curved towards the mouth, the larger or free end externally and the other attenuated and imbedded halfway through the wall; no. 2, the triradiates in their smaller forms chiefly confined to the spicular structure of the surface and that of the cloaca respectively, and the large ones to the wall, where the largest, whose measurements have been given, have their heads in the cloaca and their shafts directed outwards to meet the smaller ones which come from the surface. No quadriradiates were seen. Size of specimen 7-12ths in. long, by 5-12ths in. transversely. Two smaller ones growing from the base give the "social" character.

Obs. This specimen may be recognized by the number of small glistening peristomes scattered over the surface, the presence of the large sickle-shaped acerates of the surface, and the absence of the quadriradiate.

22. *Heteropia patulosculifera.*

Agglomerated. Specimen consisting of a large bunch of inflated sac-like individuals of different sizes irregularly growing out of each other, more or less conical, and opening respectively by, for the most part, large mouths indistinctly peristomed. Colour whitish yellow outside, sponge-brown within. Surface consisting of cribriform sarcode *without* mortar-spicules, knitting together triradiates, both regular and irregular, of tolerably uniform size, which is rather small; echinated, especially towards the mouth, with large, curved, fusiform acerates, sublanciform at the *free* end. Pores, the holes of the cribriform sarcode, small and large mixed, the latter about 1-280th in. in diameter. Vents single, terminal, more or less large as the free end of the individual is more or less conical, each provided with a short peristome, and all leading to a more or less general cavity which is rendered irregular in form by its branch-like extensions into the different individuals of the mass; far exceeding in size the thickness of the wall, which is thus reduced to a mere shell-like thinness; holes in the cloaca numerous, tolerably uniform in size and distance apart, each presenting one or more sphincter ed apertures under the common level of the cloacal layer; these belong to the wall-structure, and thus simulate subcloacal cavities. Wall very thin, as before stated, compared with the bulk of the individual and the largely dilated cloacal cavity, about 1-40th in. in diameter, consisting of empty sinuous canals in juxtaposition, intercommunicating by pores and large holes respectively, the latter giving it a clathrous appearance; "holes" of intercommunication larger immediately under the pores of the dermis, simulating "subdermal cavities," and the same under the cloaca; skeletal structure chiefly composed of large triradiate spicules with long shafts, whose sagittal heads support the cortex on one side and the cloaca on the other, while their shafts more or less overlap each other horizontally in the intervening space. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates of two forms, viz. one thin, long, straight, cylindrical, similarly pointed at each end, and the other thick, curved, fusiform, and lanceolate at the free end, measuring about 140 by 10-6000ths in.; 2, triradiates of different sizes, large and small, regular and irregular, the largest sagittal much exceeding the rest in dimensions, being about 90 by 6-6000ths in. in the shaft, with arms respectively about half this length; 3, quadriradiates, similar in size in their triradiate portion to the small triradiates, with the addition, of course, of the fourth arm. No. 1, in its finer form, is confined to the peristome,

and the stouter one with lanciform end to the surface, the latter also mingling (as before stated to be the wont of the surface acerates) with the proximal ends of the peristome spicules; no. 2, the triradiates in their largest size occupying the position mentioned; and no. 3, the quadriradiates, mixed with the small triradiates, in the cortex and the cloaca respectively; in the latter, the fourth arm is short, small, and so sparse as to be hardly noticeable. Size of specimen, which of course, from its composition, is very irregular, about $1\frac{1}{2}$ in. each way.

Obs. On the surface of the cloaca may be seen small holes about 1-1000th in. in diameter, which appear to be pores like those of the surface, as I have before stated; and here I would observe again that if the differences in form, position, and size of the spicules respectively in a Calcareous Sponge are to be severally noted, it must be done in a special description of the species itself, which would thus become far too elaborate for practical purposes, so that, in a Handbook of Sponges generally, some medium course must be adopted to attain this object.

23. *Heteropia macera.*

Agglomerate. Consisting of several individuals united together, whose form separately would be cylindrical, sacciform, and peristomed. Colour whitish yellow outside, sponge-brown within. Surface even, uniformly consisting of moderately large triradiates fixed in position by cribriform sarcode. Pores, the holes of the cribriform structure, which are very distinct but not particularly large. Vents of the individuals respectively terminal, circular, and each provided with a peristome, leading into a general cloacal cavity, which is narrow and cylindrical at first, but afterwards becomes wider than the wall of this cavity as it spreads itself out into the cloacal dilatations of the rest of the individuals in the mass; holes of the cloaca large generally, but still variable in size and distance apart, corresponding with the variable width of the skeletal structure of the surface of the cloaca. Structure of the wall like that of the last species described, viz. *H. patulosculifera*, that is, consisting of horizontal intervals defined by the long shafts of sagittal triradiates which, coming from opposite sides of the wall, overlap each other, while the intervals, which are chiefly composed of sarcode, intercommunicate with each other by large holes in addition to the usual pores. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates, of three forms, viz. that usually composing the peristome, among which proxi-

mally may be found shorter ones with lanciform ends; minute ones or mortar-spicules, both straight and sinuous, the latter with lanceolate ends, varying under 30-6000ths in. long, with which the cribriform structure of the surface is more or less charged; and, lastly, large and much curved fusiform acerates about 180 by 15-6000ths in., echinating the surface chiefly towards the mouth; 2, triradiates, of the surface generally, moderately large, regular and irregular, or sagittal; and of the wall much larger, where their shafts vary under 150 by 12-6000ths, with each of the arms a little less. No. 1, respectively, in its thin form confined to the peristome, in its minute one to the surface, where, in combination with the cribriform dermal sarcode, it fixes in the triradiates of this part; and the stouter form chiefly to the region of the mouth, where its much curved and thickened portion, which is outside, is directed towards this aperture, and its attenuated one sunk deeply into the *wall* of the specimen. No. 2, triradiates, to the dermal and cloacal surfaces and the wall; in the latter, their long straight shafts overlapping each other, as in the foregoing species, divide the structure into horizontal intervals, while their arms are much spread out sagitally under the spicular layers of the surface and of the cloaca. Size of largest group, for there are two specimens each consisting of several individuals of different size agglomerated, 2-3rds in. high by $1\frac{1}{2} \times \frac{1}{2}$ in. horizontally.

Obs. In this species that peculiar form of the sagittal triradiate is well developed wherein the shaft, which is, as usual, straight and cylindrical, is accompanied by a vertically flattened state of the two arms; so that *in situ*, that is on the lower and inner part of the peristome, where this form of the triradiate is particularly evident, the shaft is seen to be in a line with the spicules or palisading of the peristome, while the flat arms are spread out sagittally across them—thus acting, like the cross bar of a paling, in keeping flat and in position the lower ends of the palisading.

24. *Heteropia compressa.*

Agglomerate. Specimen in form massive, compressed, irregular, consisting of variously elongated conical processes projecting irregularly from the general mass; peristomed. Colour white outside, sponge-brown within. Surface even, consisting of cribriform sarcode, knitting together tolerably large triradiates with more or less uniformity; triradiates rather elevated in the centre. Pores, the holes in the cribriform structure, averaging about 1-900th inch in diameter, among which are scattered others (? excretory) full three times

as large. Vents single, terminal, peristomed, at the ends of the conical processes respectively; all leading into a general cloacal cavity, which is thus rendered wide, irregular, and compressed, in accordance with the form of the specimen; holes in the cloaca numerous, of different sizes and distances apart, the largest more or less sunk into the wall-structure, showing *within* again the openings of the chambers of the latter; surface of the cloaca smooth, or, if echinated, it is with one of the projecting arms of a triradiate, as there are no quadriradiates. Wall comparatively thin, composed of largely cancellated sarcode traversed by equally large triradiates, whose shafts, coming from opposite sides, cross it entirely, and whose widely spread-out arms support the structure of the surface outside and the spicular layer of the cloaca within respectively. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates, for the most part long, thin, straight, and cylindrical; 2, triradiates, regular and irregular, of two sizes, small and large, the latter far exceeding the other in this respect, averaging for the shaft 225 by 22-6000ths in., with wide-spread arms of nearly the same length, so that it approaches an equiradiate form. No. 1 confined to the peristome, where the shorter spicules are intermixed with the longer ones which are broken off; no. 2 to the surface of the body, the cloaca, and the wall-structure; those of the cloaca towards the mouth furnished, as usual, with *flat* arms, which, sagittally expanding across the inner ends of the peristome-spicules, bind the latter down to a common level, as before stated, like the cross bars of a paling, while the shaft, which may be insignificantly short and round, is directed perpendicularly backwards. Size of specimen 1 inch high by $1 \times \frac{1}{2}$ inch horizontally.

25. *Heteropia pluriosculifera.*

Agglomerate. Specimen in form irregularly triangular, rather compressed, consisting of three individuals or lobes, each of which is provided with a peristome; growing on a small branch of a *Fucus*. Colour whitish yellow externally, sponge-brown within. Surface uniformly composed of moderately large triradiates bound together by cribriform sarcode. Pores or interstices of the cribriform sarcode large. Vents single and terminal, situated on the prominent parts of the lobes respectively, each furnished with a peristome; leading to a common cloacal cavity, corresponding in shape with that of the specimen, but much wider than the wall, which, being only 1-33rd inch thick, looks also in this case like a mere shell

to it; holes in the cloaca numerous, variable in size and distance apart in proportion to the breadth of the intervening skeletal structure of this cavity; subcircular and presenting within respectively from one to four openings which belong to the structure of the wall. Structure of the wall like that of the foregoing species of *Heteropia*. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates of two forms, viz. one long, straight, thin, and cylindrical, and the other slightly curved, stouter, and fusiform, the latter varying in size under 255 by 9-6000ths in.; 2, triradiates, small and large, the latter far exceeding the others in size, averaging 85 by 5-6000ths in. in the shaft, with arms 30 by 5-6000ths in. No. 1 in its thinner form is confined to the peristome, and in its stouter one echinates the surface generally, where its inner part, which is most attenuated, is deeply sunk into the wall, and its outer part, which is thicker, curved towards the plurality of mouths respectively; no. 2 in its smaller and more regular form is chiefly confined to the skeletal structure of the surface and cloaca, and the larger ones to the interior, where their straight long shafts, coming from opposite sides of the wall, overlap each other, as in the foregoing species. I saw neither quadriradiates nor mortar-spicules. Size of specimen about 4-12ths in. high by 7-12ths horizontally in its greatest diameter.

26. *Heteropia erecta.*

Agglomerate. Specimen erect, compressed, contracted towards the point of attachment, consisting of several individuals of different sizes sprouting out obliquely upwards from the general mass in conical forms, each provided with a peristome. Colour whitish yellow outside, sponge-brown within. Surface even, uniformly composed of moderately large triradiates, held in position by cribriform sarcode. Pores in more or less defined areas of the cribriform sarcode, bounded by the intercrossing arms of the dermal triradiates; large generally, but presenting two sizes, viz. one the most numerous, about 1-830th in. in diameter, and the other about 1-276th in., the latter scattered irregularly amongst the former. Vents single and terminal, at the ends of the conical individuals respectively, each furnished with a peristome, leading after a short distance from a narrow cavity in each conical portion to a general one much wider than the walls of the former, which are about 1-24th in. thick; holes in the cloaca very variable in size and distance apart, the latter corresponding in width

to that of the skeletal layer of the cavity which separates them; subcircular, presenting *within* respectively from one to four or more openings which belong to the wall-structure, so that each of these holes in the cloaca is the aperture of a subcloacal dilatation or cavity. Structure of the wall like that of *H. compressa*. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates of two forms, viz. one thin, straight, cylindrical, fine, silky, and the other stout, fusiform, and much curved, averaging 240 by 18-6000ths in.; 2, triradiates, viz. those of the surface, which are moderately large, regular and irregular or sagittal, and those of the wall, which are very large and long-shafted, averaging 120 by 6-6000ths in., and the arms only a little less, so that this spicule also is very nearly equiradiate. No. 1 in its thin form is confined to the peristome, and in its stouter one echinates the surface chiefly towards the mouth, where its outer portion, which is the largest, is much curved, and the curve directed towards the mouth, while the other or more attenuated one is deeply sunk into the wall of this part; no. 2, the triradiates, in their smaller and more regular forms, are confined to the surfaces both of the outside of the specimen and the cloacal cavity, while the larger and less regular ones are confined to the interior of the wall, where their straight long shafts, coming from opposite sides, overlap each other, and their sagittal arms support the structure of the surface and that of the cloaca respectively. No quadriradiates or mortar-spicules were seen. Size of specimen, which is compressed, 9-12ths in. high by 5-12ths in. in its greatest diameter.

Obs. I notice here, as in other instances, that the most dilated spaces of the wall are under the surface and the cloaca respectively, thus presenting *subdermal* and *subcloacal* cavities. The physiology of all this, and much more too, will by and by have to be explained before the nature of the sponge is fully elucidated.

27. *Heteropia spissa.*

Agglomerate. Specimen triangular, rounded, each angle formed of the outer part of a conical individual connected with a common centre; growing upon a small branch of a *Fucus*. Colour whitish yellow. Surface even, composed of cribriform sarcode, fixing in a number of triradiates of different sizes, some of which are very large, and many with one arm projecting beyond the common level, especially towards the mouth. Pores consisting of the holes in the cribriform sarcode, which for the most part are uniform in size, viz. 1-830th in. in diameter, but here and there double this width.

Vents single, one at the end of each conical lobe, each provided with a peristome, and all leading to a dilated central cavity or cloaca, whose holes are variable in size and distance apart, corresponding to the breadth of the skeletal layer of this cavity between them; subcircular, and presenting *within* respectively from one to three or more openings which belong to the wall-structure. Structure of the wall, which is about 1-23rd in. thick, like that of the foregoing species, but with the sagittal radiates still larger. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates of two forms, viz. one long, thin, straight, cylindrical, and the other minute, short, and also straight, averaging about 14 by $\frac{1}{3}$-6000th in.; 2, triradiates, of different sizes and different degrees of irregularity, sagittal and otherwise, the largest averaging 225 by 27-6000ths in., with arms respectively about 150 by 8-6000ths in. No. 1 is confined to the peristome in its long thin form, and in its short minute one sparingly to the cribriform sarcode, where it constitutes the mortar-spicule; no. 2, viz. the triradiate, in its smaller form, which is still comparatively large, is confined to the structure of the surface and that of the cloaca, where, in the former, one ray often projects in such a manner that, if not carefully examined, it may be mistaken for a large acerate directed towards the mouth, and the other form, which is much more sagittal, to the wall, where its shafts stretch across this part from opposite sides, and thus overlap each other, while their arms support the skeletal structures of the surface and cloaca. Size of specimen about $\frac{1}{2}$ inch in its widest diameter.

Obs. The chief characters of this specimen are its large triradiates, whose projecting arms on the surface seem to replace the large curved acerates usually found there; also the absence of quadriradiates, and therefore of echinating spines, on the surface of the cloaca.

[To be continued.]

VII.—*Professor E. Ray Lankester's Memoir "Limulus an Arachnid," and the Pretensions and Charges founded upon it.* By Professor Carl Claus.

In a recently published article, in the April number of this Journal, entitled "Professor Claus and the Classification of the Arthropoda," Prof. E. Ray Lankester has taken upon himself to bring a series of heavy accusations against me, and asserts that I have borrowed from his *Limulus*-memoir of the year 1881 the views expressed by me upon the classification of the Arthropoda, on the occasion of a communication upon the heart of the Acarina, which appeared in the 'Anzeiger

XV.—*Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia, continued.* By H. J. Carter, F.R.S. &c.

[Continued from p. 55.]

Order VIII. CALCAREA (*continued*).

Observation.

We now come to Calcareous Sponges wherein the spicules and sarcode apparently do not present any definite arrangement like that of the foregoing species, but, on the contrary, one in which both are apparently mixed together confusedly, so as to form a cancellated mass, which is traversed by a branched system of excretory canals identical with that of the non-calcareous sponges, the former representing the parenchyma and the latter the channels of the excretory system.

To this structure the name of "*Leuconia*" was given by Dr. Bowerbank in 1864 (Mon. Brit. Spong. vol. ii. p. 2), ex. gr. *L. fistulosa* (*Leucandra fistulosa*, H.), and the same name will be adopted here.

Häckel put these sponges into his second family under the name of "*Leucones*," which he has divided into genera; but at present I can only give my attention to the species *in Mr. Wilson's collection*, under the general title of "*Leuconia*," and leave others to divide them into genera hereafter when a complete history of the calcareous sponges shall be produced.

Since describing the last of the Ascones ('Annals,' 1886, vol. xvii. p. 512), viz. *Clathrina ventricosa*, wherein the amount of parenchyma far exceeds that observed in any of the Sycones, as before stated (*suprà*, p. 35), this structure has not presented itself to anything like the extent of that characterizing the sponges about to be noticed, although the excretory canal-system may be easily homologized throughout. Hence the following diagnosis under the "heading" before mentioned, viz.:—

Leuconia.

Calcareous sponges in which the parenchyma is almost equal in amount to the excretory canal-system, which traverses it in all directions by repeated subdivision, until one is as infinitely divided as the other. Canals poriferous throughout.

28. *Leuconia fistulosa*, var. *australiensis*.

Individualized. Specimen long, straight, sacciform, and so flatly compressed that the sides are in close approximation; suddenly contracted at the free end to 6-16ths inch, while the rest of the body generally is 10-12ths inch in diameter; provided with a peristome (whose spicules are broken off so shortly that the mouth looks as if it were *naked*); convex at the large end, where it was attached by the most prominent part to the object on which it grew. Colour sponge-brown. Surface consisting of cribriform sarcode charged with sagittal triradiates and densely traversed by more or less long flimsy acerates, arranged in thin, broken, indistinct lines, apparently without any uniformity. Pores, which are the holes of the cribriform sarcode, comparatively small in size. Vent single, terminal, occupying the free end of the specimen, which is truncate, compressed to a narrow slit; surrounded by a peristome; leading into a large cloacal cavity corresponding in shape with that of the body, which is slightly contracted in the centre; scattered over with holes of different sizes and different distances apart, some very large and deeply sunk into the internal structure, others very small and shallow, all showing *inwardly* a variable number of openings, which belong to the excretory canals of the wall-structure; surface of the cloaca, its holes and deep depressions, all echinated with the short and curved fourth ray of quadriradiates. Structure of the wall, which, compared with the width of the cloaca, is very thin (not being more than 3-24ths inch in diameter), composed of cancellated sarcode traversed by the canals of the excretory canal-system, which, repeatedly branching, subdivide the whole almost infinitely: supported on small triradiates, which appear to have no definite arrangement. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of different lengths and different sizes, the longest and finest chiefly confined to the peristome (but for the most part broken off, so that their original length cannot be ascertained); some, viz. the stoutest, which remain entire, fusiform, bent at the extremity, and much shorter than the rest, averaging 150 by 12-6000ths inch. 2, triradiates, regular and irregular, of different sizes and forms, chiefly sagittal. 3, quadriradiates, of much the same size, which is rather small. No. 1 in its finest and longest forms chiefly characterizes the peristome, but is equally spread all over the body together with the shorter and stouter ones, all mixed up in a matted more or less shaggy mass, so that when dry the whole surface glistens from the silky flimsy nature of

the *fine* spicules; no. 2 equally present in the wall-structure and its outer and inner layers, viz. that of the surface and that of the cloaca respectively; no. 3 is chiefly confined to the cloaca, where its fourth ray, which is short and curved, thickly echinates not only the general surface of this cavity, but the circular margins of the holes and the surface of the canals within them respectively. Size of specimen $3\frac{1}{2}$ inches long by 10-12ths inch in its widest diameter.

Obs. One cannot help seeing in this specimen the Australian representative of the British *Leuconia fistulosa*, Bk.,= *Grantia fistulosa*, Johnston, of which the type specimen is in the British Museum; nor can we help seeing in the excretory canal-system a close approach to that of the non-calcareous sponges.

29. *Leuconia hispida.*

Individualized. Erect, conoglobular, compressed, contracted towards the base, peristomed. Colour whitish yellow on the outside, sponge-brown within. Surface thickly echinated with comparatively thin fusiform acerates, held together rather confusedly in indistinct groups by cribriform sarcode, which in the intervals often presents defined areas. Pores, viz. the holes of the cribriform sarcode, of different sizes, varying under 1-451st in. in diameter. Vent single, circular, terminal, on the summit, provided with a peristome about 1-16th in. in diameter, leading into the cloacal cavity, which becomes three times as wide, corresponding in form with that of the specimen; holes in the cloaca very variable in size and distance apart, the latter depending on the width of the cloaca-skeletal structure between them; presenting *within* their border from one to four or more circular openings, which belong to the excretory canals of the internal structure; thus every hole in the cloacal surface is tantamount to that of a subcloacal vent; surface of the cloaca and margins of the holes respectively thickly echinated with the long curved fourth arms of quadriradiates. Structure of the wall, which is thick, cancellated, traversed by the canals of the excretory system, supported skeletally on smallish triradiates. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:— 1, acerates, of two forms, viz. one long, thin, straight, cylindrical, silky, and the other slightly curved, stouter, and fusiform, the latter averaging 200 by 4-6000ths in.; 2, triradiates, all apparently about the same size, which is comparatively small, regular and irregular, with the arms in different degrees of sagittal expansion; 3, quadriradiates, numerous. No. 1,

in its thin form, is confined to the peristome, and in its stouter one to the surface, where it is indistinctly grouped into tufts between the cribriform areas; no. 2 to the structure of the wall generally; and no. 3, the quadriradiates, to the surface of the cloaca, where its fourth arm, which is long and curved, thickly echinates the surface. Size of specimen 7-12ths inch high, not including the peristome, by 5-12ths inch in its greatest transverse diameter, being rather compressed.

Obs. This species is closely allied to *Leuconia fistulosa*, var. *australiensis*, in most respects.

30. *Leuconia echinata.*

Individualized and social. Pyriform, wide above, narrow below, where it is contracted and turned on one side towards the point of attachment; peristomed; thickly echinated with large, much curved acerates. Colour whitish yellow outside, sponge-brown within. Surface composed of cribriform sarcode in the midst of small radiates; echinated with the acerates mentioned. Pores, the holes in the cribriform sarcode, most of which are comparatively small, while the rest, scattered here and there, vary under 1-166th inch in diameter. Vent single, circular, terminal, surrounded by a peristome, leading into a sacciform cloacal cavity corresponding in shape to that of the specimen, a little wider in its widest part than the thickness of the wall; holes in the cloaca subcircular, large and wide apart, each sphinctered by cribriform sarcode, whose interstices are circular and in more or less plurality, varying in diameter under half that of the subjacent hole; surface of the cloaca moderately covered with thick curved spines, viz. the fourth arms of quadriradiates. Structure of the wall cancellous, supported on the rays of large triradiates, and traversed by the canals of the excretory system. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates of two forms, viz. one long, straight, thin, cylindrical, silky, and the other thick, fusiform, much curved, and very thick, the latter averaging 450 by 18-6000ths in.; 2, triradiates of different sizes and different degrees of irregularity, the smallest and most regular on the surface, the next in size on the surface of the cloaca, and by far the largest of all, whose shaft may be 102 by 18-6000ths and arms respectively 150 by 18-6000ths, confined to the wall-structure; 3, quadriradiates, in which the fourth arm is thick and curved. No. 1 is confined to the peristome in its fine straight form, and in its curved and stout one thickly echinates the surface, where its outer part, which is the largest and most curved, is directed

towards the mouth and its inner one directed backwards, to become sunk into the structure of the wall; no. 2, the triradiates, are disposed as before mentioned; and no. 3 is chiefly confined to the surface of the cloaca, where its fourth arm, which is thick, moderately long, and curved towards the mouth, plentifully echinates the surface of this cavity. Size of specimen about $\frac{1}{2}$ inch high by $\frac{1}{3}$ inch in its widest part.

Obs. The spiculation in this small pear-shaped species generally is, with the exception of the radiates in the surface, comparatively large, and the cribrated sarcode stretched across the holes of the cloaca, although unusual in the calcareous sponges, is not uncommon at the vents of the *non*-calcareous ones. In one small specimen, for there are several of different sizes, the peristome is as long as the body of the sponge itself, which is 3-24ths inch, showing that the matured size of the spicules may be independent of that of the sponge.

The next form to be described is very much like this, but, in addition to the large curved acerates of the surface, possesses *cones or conical spines* formed of a great number of fine spicules like those of the peristome interspersed between them.

31. *Leuconia erinaceus.*

Individualized and social. Specimen pyriform, sack-like, wide above, where it is furnished with a peristome, narrowed to the point of attachment below. Colour whitish yellow outside, sponge-brown within. Surface-sarcode cribriform or reticulate, knitting together the radiates of this part, which are small; echinated with two kinds of spines, viz. one conical, composed of a great number of fine, long, glistening spicules like those of the peristome, and the other consisting of a single, thick, sickle-shaped acerate, interspersed among the glistening white cones. Pores the holes of the cribriform sarcode. Vent single, terminal, circular, provided with a well-marked sarcodic sphincter, surrounded by the palisading of the peristome, which is somewhat everted; leading into a narrow cloacal cavity about half the width of the wall in its greatest diameter, which part is opposite the greatest diameter of the specimen, diminishing afterwards towards either end; covered with a sarcodic membrane presenting circular holes which are opposite those of the cloaca; holes of the latter wide and circular, but variable in size and distance apart, permitting the terminal openings of the canal-system in plurality to be seen *within*. Wall consisting of cancellated sarcode traversed by the canals of the excretory system; supported on a skeletal structure consisting of regular and

irregular triradiates with long shafts, especially on the outside, where they extend inwards from the other two arms which are fixed in the spicular structure of the surface. Spicules of two kinds, viz. acerate and triradiate; no quadriradiates:—1, acerates of two forms, viz. one fine, long, straight, cylindrical, and glistening, and the other stout, much shorter, fusiform, and sickle-shaped; 2, triradiates, regular and irregular, with long shafts but not particularly large. No. 1 in its fine form is confined to the peristome and the composition of the conical spines of the surface, which are about 200-6000ths long, 300-6000ths apart, and 90-6000ths in. in diameter at the base, where their spicules are sunk into the outer part of the wall; and the other or stout form, which consists of a *thick acerate* that is much shorter than the "cones" and curved towards the mouth, plentifully scattered among them, where its largest portion is outside and the other or more attenuated one is sunk into the outer portion of the wall-structure; no. 2, the triradiates, occupy the position mentioned, including the surface of the cloaca, which possesses *no* quadriradiates, and therefore presents *no* spines or "fourth arms" on its surface. Size of largest specimen, for there are several, about $\frac{1}{2}$ inch high by $\frac{1}{4}$ inch in its greatest diameter.

Obs. This is a very remarkable species on account of the glistening cones, composed of spicules like those of the peristome, which are scattered over the surface in the midst of large sickle-shaped acerates which do not glisten, and therefore by their colour, as well as by their form, produce a mixture and a contrast which renders this sponge unmistakable; while the cones from their prominence, whiteness, large size, pointed ends, abundance, and almost perpendicular arrangement on the surface so remind one of the echination of a "hedgehog," that the latin name of this animal has been used for its specification. The cloaca here also is covered with a delicate layer of clathrous sarcode.

32. *Leuconia nivea*, var. *australiensis*.

Individualized or agglomerated. Globular, sessile, and solitary, or massive, agglomerated, flat, and spreading. Colour whitish outside, sponge-brown within. Surface consisting of cribriform sarcode, more or less charged with mortar-spicules, knitting together large, more or less sagittal triradiates, with centre so much *elevated* that they present a tripod-form, whose extended arms thus bind down the surface to a common level. Pores, the holes of the cribriform structure more or less grouped into distinct areas, which occupy the intervals between

the arms of the triradiates. Vent single and terminal in the individualized solitary forms, in plurality in the flat ones, in which they are more or less uniformly scattered over the surface in a papillated state, about $\frac{1}{6}$ inch apart, each furnished with a minute peristome, which consists of *mortar-spicules* like those that fringe the pores of the dermal cribriform sarcode; leading in the globular forms into a regularly formed cloaca corresponding in shape with the specimen, and into irregularly branched canals in the flat ones; holes of the cloaca of different sizes and different distances apart, the largest more or less sunk into the internal structure, and all affording outlets to a variable number of excretory canals; surface of the cloaca, together with that of the holes and their subsequent extensions respectively into the internal structures, thickly echinated with small spines, viz. the fourth arms of the quadriradiates. Wall composed of cancellated structure, that is the parenchyma, traversed by the canals of the excretory system, supported on a skeletal structure composed of small triradiates. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, minute, sinuous, and lanceolate at one end, about 14 by $\frac{1}{2}$-6000th in.; 2, triradiates, of two sizes, viz. those of the wall-structure, which are small and more or less regular, and those of the surface, which are large, averaging 105 by 9-6000ths in. in the shaft, with arms respectively a little less; 3, quadriradiates, with long expanded arms and very short spine or fourth ray. No. 1 is confined to the cribriform sarcode of the surface and to the peristome, where in the former it acts as a mortar-spicule; no. 2 chiefly to the structure of the wall and the surface respectively, as before stated; and no. 3 to the surface of the cloaca, where the spines or fourth rays are so small and short that they can only be seen laterally. Size of globular form about 4-12ths inch high and 3-12ths inch in diameter horizontally; the flat form is merely a fragment about an inch in diameter and 1-24th inch thick.

Obs. With the exception of trifling differences, the Australian species in its *flat* form is almost identical with the British one called *Leuconia nivea*, Bk. (*Leucandra nivea*, H., Atlas, Taf. xxxix.)—that is, there are no quadriradiates like those represented by Bowerbank (Mon. vol. iii. pl. v. fig. 8), and the elements of the surface in *L. nivea* appear to be much more confused and indistinct, while they are beautifully defined in the Australian form; but in other respects the latter appears to be so nearly allied to the British one that it can hardly be considered more than a variety of it.

33. *Leuconia Johnstonii*, var. *australiensis*.

Individualized. Globoconical, sessile, rather compressed, open and conical above, convex and wide below, where the most prominent part becomes the point of attachment; no peristome. Colour whitish outside, sponge-brown within. Surface consisting of cribriform sarcode charged with triradiates, faced by comparatively large quadriradiates. Pores, the holes of the cribriform sarcode, varying in size under 1-200th inch (? are the largest for *ex*halant purposes). Vent single, terminal, naked, leading into a sacciform cylindrical cloaca, corresponding in shape with that of the specimen, about the same diameter in its widest part as the thickness of the wall; scantily overscattered with a few holes of widely different sizes, viz. some very large (1-24th inch in diameter) and others very small, situated at variable distances apart, and the large ones so sunk into the internal structure that they appear like diverticula of the cloaca, into which more or less of the excretory canals of the internal structure open, and thus pour out their contents before the latter enter the cavity of the cloaca itself; surface of the cloaca, together with its diverticula, entirely smooth and void of all echination, being bound down by sagittal triradiates *only*. Wall comparatively thick, consisting of cancellated sarcodic structure traversed by the canals of the excretory system, supported by a skeletal structure composed of triradiates and quadriradiates of different sizes, among which the sagittal form is most conspicuous. Spicules of two kinds, viz. triradiate and quadriradiate:—1, triradiates, of different sizes, chiefly irregular, among which the sagittal is, as just stated, the most conspicuous; 2, quadriradiates, of different sizes, which are again mostly sagittal, that of the surface, which is by far the largest, averaging 135 by 12-6000ths in. in the shaft and a little less in the arms, so that it has an *equiarmed* appearance; the arms arching upwards and outwards serve to bind down the dermal structure, and the shaft descending perpendicularly to support it from within; while thus traversing the outer part of the wall the shafts are accompanied by dilated portions in their intervals which are identical in appearance with the "subdermal cavities" of the non-calcareous sponges. No. 1 is abundant in the skeletal structure of the wall and in its limiting layers, viz. that of the surface or cortex and that of the cloaca; no. 2, the quadriradiate, is equally abundant with the triradiates in the structure of the wall, and almost exclusively on the surface of the body, but *entirely absent* on that of the cloaca, on which a curved spine or fourth arm is not to

be seen. Size of largest specimen, viz. that described (the other, which is very small, being just the opposite in point of general form), about ½ inch high by 5-12ths inch in its greatest diameter.

Obs. It is remarkable here that while the quadriradiates abound on the surface and are so large as to form a character, their *absence* is equally characteristic on the surface of the cloaca. To facilitate recognition of the *quadriradiate* on the surface it might be observed, as in the preliminary remarks, that the passage of the light *through* the centre of the head or triradiate portion invariably causes that part to present a dark *triangular* space, whose points are in the angles of the rays; while when the *triradiate* is in such a position as to show a dark area (that is when viewed laterally), this is *quadrangular*. At first sight the presence of the large quadriradiate on the *surface* causes this species to resemble the British *Leuconia Johnstonii*; but the peculiar form of the quadriradiate and its fourth arm on the cloaca of the latter, together with other minor differences, causes it to be merely a variety.

34. *Aphroceras asconoides.*

Individualized and social. Specimen consisting of a group of individuals growing from a contracted base. Individual long, narrow, tubular, sessile, somewhat compressed, diminishing in size towards the free end, which is truncate, and contracted towards the other, which is fixed; without peristome; varying in size under 1½ inch long by 3-24ths inch in transverse diameter, often putting forth a bud or small branch towards the lower part. Colour yellowish white. Surface even, glistening when dry, composed of a layer of long, slightly curved acerates, arranged longitudinally and very near together, separated only by cribriform sarcode, traversed so thickly by the *exserted* arms of *internal* radiates as to present a minutely hispid appearance. Pores, the holes in the cribriform sarcode, opening between the long acerate spicules, and in the midst of the exserted arms of the internal radiates. Vent single, terminal, naked, leading into a cloacal cavity which is tubular, corresponding with the shape of the individual; presenting *no* cloacal structure, but a number of minute circular pores in direct continuation with those of the surface, in the midst of a layer of spongozoa in juxtaposition, with which that remarkable granuliferous nucleated body called by Häckel the "Kern" (to which I have already alluded in describing *Clathrina cavata*, 'Annals,' 1886, vol. xvii. p. 502) is plentifully mixed; supported on a skeletal structure composed

of comparatively small and delicate sagittal quadriradiates, which will be more particularly described hereafter. Wall very thin, not more than 1-112th inch in diameter, consisting of only two skeletal layers, viz. an external and an internal one, the former composed of the large slightly curved acerates before mentioned, and the latter of the delicate quadriradiates just noticed, which support the soft parts of the species. Spicules of two kinds, viz. acerate and quadriradiate:—1, acerates, very large, long, symmetrically fusiform, slightly curved, sharp-pointed at each end, averaging 1-12th inch long and 25-6000ths in. in transverse diameter; 2, quadriradiates, more or less sagittal in form, with a long shaft directed longitudinally backwards when *in situ*, and the two arms expanded laterally almost perpendicular to the shaft, with the fourth arm, which is short and curved towards the mouth, directed inwardly; shaft about 90 by 1-6000th in., arm 43 by 1-6000th. No. 1 forms a single layer on the surface as before stated, and no. 2 the internal layer also before noticed, with more or less of the arms exserted between the long acerates, so as to give this part a minutely hispid appearance. At first sight the latter look like mortar-spicules or small acerates, but although they appear to serve the same purpose, they are *not* so, but what I have stated. Size of group about 2 inches in diameter at the circumference, contracted to a point at the base.

Obs. In *structure* this species is very like Häckel's *Asculmis armata* ('Atlas,' Taf. xiii. fig. 1), but of course very different otherwise. It is remarkable too that the "granuliferous nucleated cell" or "Kern" which is so characteristically abundant in the Ascones (ex. gr. *Clathrina*) should be equally abundant here.

35. *Aphroceras syconoides.*

Individualized. Long, sessile, round, cylindrical, diminishing towards the mouth, which is truncate, also towards the fixed end, which is contracted; without peristome. Colour in the dried state whitish grey. Surface consisting of cribriform sarcode, charged with mortar-spicules, more or less concealing subjacent, large, slightly curved, fusiform acerates, arranged longitudinally, parallelly, and in close approximation. Pores in lines, in the cribriform sarcode between the long acerates. Vent single, terminal, naked, leading into a cloacal cavity which is narrow and accords in shape with that of the specimen; covered with circular sphincter holes in juxtaposition and of nearly uniform size; echinated with the

fourth arm of quadriradiates, which is small, curved, and short. Wall about 1-30th inch thick, composed of "*radial chambers*" in juxtaposition, extending from the circular pores on the surface to the holes of the cloaca; supported by a skeletal framework consisting of a great number of small radiates, that is "articulated;" the whole held together by sarcode pierced by pores of intercommunication. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, of two forms, viz. one very large, long, symmetrically fusiform, slightly curved and pointed at each end, about 150 by 6-6000ths in., and the other minute, somewhat sinuous and lance-pointed at one end, 13 by 1-6000th in; 2, triradiates, more or less sagittal and comparatively small, averaging about 48 by 2-6000ths in. in the shaft and 15 by 2-6000ths in. in the arms respectively; 3, quadriradiates, with the fourth arm, as usual, much shorter than the rest, and curved towards the mouth. No. 1 in its large form is confined to a single layer on the surface, where they are arranged longitudinally parallel to each other and closely approximated, and in the minute form to the cribriform sarcode of the surface, wherein it plays the part of a mortar-spicule; no. 2, the triradiates, to the radial chambers, where their heads are inwards and their shafts directed outwards; and no. 3, the quadriradiates, which are also sagittal, to the surface of the cloaca, where the fourth arm is so short that, to be well seen *in situ*, this surface must be viewed under the microscope *laterally*. Size of specimen $\frac{3}{4}$ inch high by 7-48ths in its greatest horizontal diameter.

Obs. In general form and structure this species is very much like Schmidt's *Ute glabra* (Adriat. Spong. 1 Suppl. p. 23, Taf. iii. fig. 1), but the fourth arm of the quadriradiate is much less developed; and from Häckel's spiculation ('Atlas,' Taf. lvi. figs. 1 *a*–1 *t*) there does not appear to have been any "mortar-spicule." Again, had it been identical with the Australian species, the beauty and striking appearance of the pores on the surface in the latter (which, for the most part, are conspicuously situated in lines between the large acerates, very little less in size than the holes of the cloaca, and each terminating the external end of a radial chamber) would hardly have passed unnoticed, so that it may be assumed that, if not a variety, it must be considered a species of *Ute*. At the same time it may be as well to consider whether the species should be called "*Ute*" or "*Aphroceras*."

In 1858 Dr. J. E. Gray described and illustrated a small, branched calcareous sponge from Hongkong under the name of "*Aphroceras alcicornis*" (Proc. Zool. Soc. 1858, p. 113, pl. x.

figs. 1 and 2), of which he subsequently made a family under the name of "Aphrocerasidæ" (*ib.* 1867, p. 558); meanwhile Dr. Bowerbank described a British species under the name of "*Leucogypsia Gossei*," for which he established the genus "*Leucogypsia*" (Phil. Trans. 1862, p. 1095, pl. lxxii. figs. 3 and 4); and, lastly, Häckel in 1870 called these species respectively "*Leucandra alcicornis*" and "*L. Gossei*," which he placed in the genus *Leucandra* of his family Leucones.

Now an examination of *Aphroceras alcicornis* and *Leucogypsia Gossei* shows that they are almost identical in structure and spiculation, although very different in form; thus they, in their aggregate state, may have a plurality of vents which are all *un*peristomed, each of which may lead into a separate narrow cloaca, which may be once or twice locularly divided, and each loculus indistinctly limited by further dividing into several large canals, thus forming a step towards a simple, branched, canalicular structure without distinct cloaca, as will be found by-and-by in *Teichonella prolifera*; while the structure in which these cloacas are situated consists of cancellated sarcode permeated by the canals of the excretory system, and supported on a spicular skeleton consisting of small radiates, traversed longitudinally by large, long, fusiform, slightly curved, symmetrical acerates, more or less pointed at each end, arranged longitudinally and parallel to each other *throughout* the structure of the wall, but generally most abundant towards the surface *.

Of the fact that both of these species have been placed by Häckel in his family of Leucones there can be no doubt; nor can there be any that Dr. Gray's name, in the matter of nomenclatural priority, takes precedence of all others.

On the other hand, to Schmidt's "*Ute glabra*," which was described in 1864 (*l. c.*), Häckel, in 1870, gave the name of *Sycandra glabra*, and placed it under the genus *Sycandra* in his family of Sycones.

Thus my *Aphroceras asconoides* and *A. syconoides* (which latter is but a variety of Schmidt's *Ute glabra*), together with *Aphroceras alcicornis*, Gray, would, if relegated according to the *structure of their walls*, come under Häckel's families of Ascones, Sycones, and Leucones respectively; but if relegated according to the *striking character of their spiculation* which the large parallel acerates present, *all* would come under the

* Mr. Thomas H. Higgin, F.L.S., of Liverpool, in 1874, found a *branched* species of *Aphroceras* at Holyhead, which I have described under the name of *A. ramosa* (see Report I of the Liverpool Marine Biological Committee upon the "Fauna of Liverpool Bay and the Neighbouring Seas," p. 92, ed. Prof. W. A. Herdman, D.Sc. &c. 1886).

family for which Dr. Gray has proposed the name of "Aphrocerasidæ," and which Häckel has placed among his Leucones, as above stated.

Are we, then, to distribute these species according to the structure of the wall or according to their peculiar spiculation? for "peculiar" it is, since the acerate form that I have described is not, to my knowledge, to be found in any other calcareous sponges but the "Aphroceasidæ." I must leave this for future observation to decide, while for the present their descriptions may remain where they are.

It is possible that here and there one of the large acerates may have a lanciform end or vary a little in its symmetrical form; but these are accidental occurrences.

Here I might add that, as this form of acerate spicule is identical with one which is very common among the *non*-calcareous sponges, and the "Aphrocerasidæ" are the only ones in which it occurs among the calcareous sponges of the present day, so it may be assumed, in a fossil point of view, as Zittel has done, that a calcareous sponge did exist in the Cretaceous age, in which the only spicules were of this form, that is without radiates; and hence Zittel has instituted for his third family of fossil calcareous sponges the name of "Pharetrones," which, until this assumption can be proved, must remain, as Prof. Sollas has described and illustrated it, under the name of *Pharetrospongia Strahani*, among the *non*-calcareous sponges, or those possessing *siliceous* spicules of this form alone (Quart. Journ. Geol. Soc. 1877, vol. xxxiii. p. 242 &c. pl. xi.).

The next species that will be described, as hitherto it has only been named, is of the same type as *Aphroceras*, but possesses a form of the triradiate spicule which is so peculiar that it has been actually identified with one in a fossil calcareous sponge of Jurassic age, and is therefore also of much palæontological interest. It is that to which I have alluded in my preliminary remarks under the name of *Lelapia australis* ('Annals,' 1886, vol. xvii. p. 440).

36. *Lelapia australis*, Gray.

Lelapia australis, Gray, Proc. Zool. Soc. 1867, p. 557.

Individualized. Cylindrical, with enlarged free end bent upon itself and elongated transversely, hammer-like. Colour whitish yellow. Surface even, presenting a number of large long acerates like those of the foregoing species, imbedded longitudinally at variable distances apart, being more or less obscured

superficially by the presence of a dermal layer of small acerates and mortar-spicules. Pores indiscriminately scattered over the surface. Vent single, at one end of the transversely elongated head, which is more acuminated than the other, where it is furnished with a short glistening peristome, leading into a cloaca that extends in a cylindrical form, increasing in size from the base to the head, where, corresponding with the hammer-like form of this part, it divides into two portions, one of which leads to the closed, and the other to the open end; surface of the cloaca presenting throughout several subcircular holes of different sizes and distances apart, each of which is furnished with a sphinctral diaphragm of sarcode, and the whole sparsely echinated with the fourth arms of quadriradiates, which are very short. Wall composed of cancellated canaliferous sarcode, like that of the genus *Heteropia*, traversed in its *entirety* longitudinally and abundantly by the large acerate spicules at various distances apart, which are crossed perpendicularly *at intervals* by bundles of small thin tricurvates which possess the peculiar form that will be mentioned hereafter, and extend from the surface on one side to the cloaca on the other. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, consisting of those which belong to the peristome, the body, and the surface respectively; 2, triradiates, divided into those which belong to the surface and the cloaca respectively; and 3, quadriradiates, which appear to be very few in number on the cloaca, confined to the surface of the latter and that of the body. Acerate of the peristome long, straight, cylindrical, thin, glistening, sharp-pointed at each end, averaging 300 by $1\frac{1}{2}$-6000th in.; that of the body, including the wall and the surface or cortex, also long but thick, almost equally fusiform, slightly curved and more or less sharp-pointed at each end, averaging 330 by 18-6000ths in., and that of the surface minute, straight, and lance-pointed at one end, in short the "mortar-spicule;" all three forms equally abundant in their several localities. Triradiates of various forms and sizes, according to their position, viz. those on the surface small and those in the cloaca large, the latter sagittal with very long and almost straight arms expanded perpendicularly to the shaft, which is very short and straight, apparently reduced in size inversely to that of the arms, the latter becoming *flattened vertically* towards the commencement or proximal end of the peristome, where, by extending perpendicularly across its spicules while the reduced shaft is directed as perpendicularly backwards, they act, as before stated, in securing the position of this palisading like the cross bars of a row of pales. Quadri-

radiates small on the surface, where they are mixed up with the mortar-spicules &c., and scanty on the cloaca, where in their triradiate portions they accord in size and form with the sagittal triradiates of the latter, but with the addition of the fourth arm, which is comparatively short and scantily echinates the interior of the cavity. With reference to that peculiar form of triradiates, whose position has before been stated, and which is of so much palæontological interest here, it may be observed that it is two-pronged fork-like, in which two of the arms are projected forwards parallel to each other and closely approximated, while the third or shaft is prolonged backwards in the opposite direction, altogether resembling a "tuning-fork," in which the arms are smooth, round, and pointed, about 60 by 1-6000th in. in their greatest dimensions, with one arm a little longer than the other, while the shaft, which may be a little longer and double the thickness, is smooth, round, and also pointed, about 75 by 2-6000ths. In their natural position they lie parallel to each other, with their shafts *outwards* and their forks directed towards the cloaca in bundles "at intervals," as before stated, while it should be added that there are *no* other spicules in the skeletal structure of the wall but the large long acerates and these crossing bundles, hence the clathrous structure of the simple sarcode becomes very evident, simulating that of the genus *Heteropia* rather than that of a *Leuconia*, which, on the contrary, is charged with radiates throughout and thus thickened. They are also to be found among the peristome-spicules towards their lower part. Size of specimen $\frac{3}{4}$ in. high by $\frac{1}{4}$ in. in diameter horizontally; breadth of head transversely about $\frac{1}{2}$ in.

Obs. It is impossible to compare the above description with that of Häckel's *Leucortis pulvinar* ('Kalkschwämme,' vol. ii. pp. 164–166) without seeing that the two are closely allied, and that, but for the absence of the quadriradiate, the minute acerates or "mortar-spicules," and the peristome in his illustrations (Taf. 29), one would have been inclined to say it was the same. The "peristome-spicule," however, is mentioned in the description, but the shape of the large thick body-acerates being *sinuous* (*cf.* illustrations), instead of simply curved, is not the same; so that altogether it is necessary to give our species a different designation; and as this has been done by Dr. Gray both generically and specifically for the original two-pronged fork-like spicules figured by Dr. Bowerbank, which also came from S.W. Australia, as noticed in my preliminary remarks (*l. c.*), we may fairly assume that they came from this species, and so I have

adopted Dr. Gray's name. Häckel's "connective variety," viz. *Leucandra pulvinar* (p. 164), is said to present the quadriradiate; but as no other part of the spiculation is mentioned, we must assume here that it was the same as that of his typical species "*Leucortis pulvinar*."

I have already alluded to the fork-like spicule as being interesting, because it has been discovered in a fossilized Calcisponge from the "Cretaceous" (*l. c.*); but the largest and most perfect that I could find in the mounted slice of *Sestrostomella rugosa*, in which it was first noticed by Dr. Hinde, who kindly lent it to me for examination, is not quite half so large as the largest that I have been able to see in *Lelapia australis*, added to which the shaft was lanceolate at the end in the fossil as in that of *Leucetta pandora*, represented by Häckel (Taf. xxiii. &c.), and not simply pointed like all those that I have seen in *Lelapia australis*; but we know that position may influence these trifling differences, and even those two figured by Dr. Bowerbank (*op. et loc. cit.*) are not alike in this respect, the shaft in one being simply pointed and in the other inflated before the end or lanceolate.

It is remarkable too that the two arms *without* the shaft should bear considerable resemblance to the forcipitous flesh-spicule in the genus *Forcepia* among the siliceous sponges (*Halichondria forcepis*, Bk., Mon. B. Sp. vol. iii. pl. xliii. fig. 13), wherein also the arms are long, parallelly approximated, and of *unequal* length. In one it is the arms of a triradiate and in the other a bent acerate.

Observation.

We have now come to species of *Leuconia* in which the typical form of the "cloaca" no longer exists, and this was initiated by the division and indistinctly circumscribed condition of these cavities in *Aphroceras alcicornis* and *Leucogypsia Gossei*; there is no longer any peristome, and both this and the cloaca in the following species will at last be found to disappear altogether, when the excretory canals, which hitherto have ended in a cloacal dilatation and peristomed vent, will be found to open directly on the surface without the intervention of either.

37. *Leuconia multifida.*

Agglomerated. Specimen sessile, massive, compressed, irregularly undulating on the margin, which is thus divided into five more or less conical and projecting portions, each provided with a mouth, but *no* peristome. Colour whitish

yellow outside, sponge-brown within. Surface consisting of lace-like cribriform sarcode charged with mortar-spicules, and knitting together tolerably large triradiates, that is wide with thinnish arms, more or less uniform in size. Pores, the holes in the cribriform structure, averaging 1-400th in. in diameter, mixed with larger ones four times the size, which often appear to have been produced by disruption of the sarcodic partitions between the smaller ones. Vents single, terminal, naked, one upon each conical projection, each leading into a cloaca, which is narrow, ending in a general one that is broad, irregular, and compressed like the specimen; holes of the cloaca circular, irregular in size and distance apart, leading inwardly to one or more openings which belong to the excretory canals of the internal structure. Walls as indistinctly defined internally as the cloacal cavity is irregular, and, owing to the compressed form of the specimen, presenting a greater thickness of the cancellated structure in one direction than the other, so that, for want of definition, it *can* only be considered "wall" in name; cancellated structure consisting of parenchyma traversed by the canals of the excretory system, supported by a spicular structure which is composed of radiates of different sizes, but mostly large, irregularly distributed, and so far apart as to cause the sarcodic portion just under the cribriform structure of the surface to present dilatations similar to the subdermal cavities of the non-calcareous sponges. Spicules of two kinds, viz. acerate and triradiate:—1, acerate, minute, sinuous, with one end lance-pointed, averaging 15 by $\frac{1}{2}$-6000th in.; 2, triradiates, regular and irregular, of different sizes, averaging 117 by 8-6000ths. No. 1 is confined to the cribriform sarcode of the surface, where it forms the mortar-spicule; no. 2, the triradiates, about the same size, both on the surface and in the wall structure, only a little stouter in the latter; thinnest on the surface of the cloaca, where, as usual, they present long, expanded arms and short shafts respectively. Size of specimen $\frac{1}{2}$ in. high by 10-12ths × 3-12ths horizontally.

Obs. There is nothing very striking in this species to distinguish it from the following except the absence of quadriradiates and the larger size of the staple spiculation, that is the spiculation of the parenchyma, which, of course, renders this structure less compact than where the spicules are smaller and more numerous. It is charged with ova about 13-6000ths in. in diameter, bearing the germinal vesicle and accompanied as usual by granuliferous cells about 4-6000ths in. in diameter, which may be spermatic—easily recognized as the spongozoa are not half this size—measurements which

could not have been made had not the specimen been in a favourable state for such observations.

The words "large" and "small," tolerable" and "moderate," &c., with reference to the size of the spicules, have been used for convenience; but they are all indefinite terms, which are only rendered satisfactory when accompanied by actual measurements. Still, it should be remembered that when they are used the magnifying-power should be the same for all, otherwise what is small at one time may appear large at another, and *vice versâ*.

38. *Leuconia lobata.*

Specimen massive, sessile, lobate, presenting two or more apertures of unequal size, not peristomed. Colour whitish yellow. Surface even, compact, chiefly consisting of mortar-spicules and small radiates, interspersed here and there with a large one which belongs to the internal structure. Pores not conspicuous. Vents two or more, naked, of different sizes, leading into a single, irregular, and indistinctly defined cloacal cavity, whose surface is scattered over with holes of different sizes, more or less sunk into the internal structure and in direct continuation with the large ends of the canals of the excretory system; echinated throughout with the fourth arm of sagittal quadriradiates, which is minute. Internal structure cancellous, traversed by the canals of the excretory system, which end in the diverticula of the cloaca already mentioned. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, accrates, minute, sinuous, lance-pointed at one end, about 13 by $\frac{1}{2}$-6000th in.; 2, triradiates of two sizes, viz. small and large, the rays of the latter generally averaging 105 by 9-6000ths in.; 3, quadriradiates of three sizes, the largest of which is of much the same size as the larger triradiates. No. 1, which is confined to the surface, is the "mortar-spicule;" no. 2, the triradiate, in its small size is confined to the surface, where it is mixed up with the mortar-spicule, and in its larger one to the structure of the interior, extending here and there also to the surface; no. 3, the quadriradiates in their smallest size are mixed up with the triradiates and mortar-spicules of the surface, in their largest size they belong to the parenchyma, where they are mixed up with the triradiates of this structure, and in their thin sagittal form to the surface of the cloaca, where, as usual, the arms are very long, almost straight, and expanded perpendicularly to the shaft, which is comparatively short and straight, averaging 16 by 3-6000ths, while the arms average 60 by 4-6000ths; the fourth arm, which is shorter still, not only echinating the

surface of the cloaca, but also extending into the canals of the internal structure. Size of specimen $\frac{3}{4}$ in. in height by 1 in. in diameter.

Obs. The compactness and consequent whiteness of the structure in this species contrasts strongly with that of *Leuconia multifida*, if the presence of the quadriradiates did not absolutely make the distinction.

39. *Leuconia compacta.*

Specimen massive, sessile, lobate, lobes round, furnished with a plurality of small naked vents, growing on and enveloping the small stems of a Fucus. Colour whitish, opaque. Surface even, consisting of cribriform sarcode cementing together into compact structure small, more or less regular triradiate and quadriradiate spicules of uniform size and appearance, thickly echinated with very large and much curved acerates. Pores, the holes in the cribriform structure, uniformly small, about 3 to 6-6000ths in. in diameter. Vents in plurality, of different sizes, scattered irregularly over the surface, the largest on the most prominent parts of the lobes respectively; all without peristome, that is naked, leading into narrow, irregularly defined, cloacal cavities, which branch off into the substance of the body or parenchyma, where they become almost infinitely subdivided; surface of the cloacal cavities, together with the canals entering them, slightly echinated with the fourth arm of quadriradiates. Structure of the wall, or rather body as it may be termed (for these distinctions *now* begin to disappear), compact, consisting of parenchyma infinitely divided by the branching and rebranching of the excretory canal-system, as just mentioned; supported on a skeletal structure consisting of small triradiates and quadriradiates like those of the surface. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, large, stout, unsymmetrically fusiform, much curved, averaging 180 by 21-6000ths; 2, triradiates, regular and irregular, uniformly small, arms averaging 30 by $4\frac{1}{2}$-6000ths; 3, quadriradiates, about the same size, but with the fourth arm, as usual, much shorter than the rest. No. 1 thickly echinates the surface, where the thicker half, which is much curved, is free, and the thinner one is sunk into the substance of the body, with whose spicular structure in size also it forms a great contrast, as may be learned from the measurements above given of the acerates and radiates respectively; nos. 2 and 3 are uniformly distributed throughout the body, in which the surface of the cloacal dilatations and the large canals respectively are sparsely echinated with the fourth ray

of the latter. Size of specimen about $\frac{3}{4}$ in. in diameter each way.

Obs. This species in the structure of the body (for, as before stated, there is no differentiation now into cortex and wall, and very little between the excretory canal-system and the cloaca) is very much like *Teichonella prolifera*, from which, however, it not only differs in general form, but in the presence of the large, stout, curved acerates instead of large quadriradiates on the surface as in the latter, and in a slight tendency to a cloacal termination of the excretory systems, wherein the typical form of the cloaca is becoming lost in the enlargement of its holes and their branching off into the canalicular structure of the interior.

40. *Leucaltis floridana*, H., var. *australiensis*.

Specimen massive, without particular form, looking as if it had grown over some marine rubbish, stems and stuff of some kind in a floating or unfixed state; lobed irregularly; lobes, where existing, conical, compressed, with or without a mouth, but with no peristome. Colour dirty yellowish brown. Consistence firm, hard, especially in the dry state. Surface rough and harsh to the feel, from the projecting rays of *large* triradiates plentifully mixed with the smaller ones, or staple size of the body, presenting here and there low gentle elevations in tolerable uniformity, and also here and there a tract of granulated appearance, consisting of small conical or tent-like forms about 1-40th in. in diameter, 1-100th in. high, and 1-40th in. apart. Pores, as usual, in the reticulation of the surface. Vents numerous, large and small, scattered irregularly over the surface, the larger ones only leading into genuine cloacas, the others into simple dilatations of the structure; surface of the cloaca smooth, rendered very uneven by large and small holes, at wide but variable distances apart, deeply sunk into the body-structure through wide infundibular depressions which finally end in openings of the canals of the excretory system, echinated apparently as much by the arms of triradiates as by the fourth arm of quadriradiates. Structure of the body consisting of densely cancellated parenchyma traversed by the branches of the excretory canal-system, supported on a skeletal fabric composed chiefly of small radiates plentifully mixed with very large ones, undefined either by a cortical layer externally or a cloacal one internally. Spicules of three kinds, viz. acerate, triradiate, and quadriradiate:—1, acerates, very minute, thin, straight, cylindrical, about 100-6000ths in. long by 1-6000th in. in diameter; 2, triradiates, large and small, more or less equiradiate and equiangular, ray of the former averaging 282

by 51-6000ths, and of the latter 36 by 3-6000ths, thus the larger triradiate is eight times as large as the smaller one, which, on the other hand, is the most numerous, or the "staple spicule" of the body; 3, quadriradiates the same as the small triradiates in size, but, of course, provided with the fourth arm, which, as usual, is smaller than the rest. No. 1, the acerates, confined to the surface, where they are arranged tent-like or in a conical form, rising up from a common layer of the same kind on the surface; no. 2, the triradiates, large and small, confined to the body-structure without any evident arrangement; and no. 3, the quadriradiates, mixed with them, of the same size as the staple or small triradiates, but less numerous, also sparsely echinating with their fourth arm the surface of the larger excretory canals, as before stated. Size of the largest specimen, which is dry, rather compressed, oblong, and rounded on the projecting points, apparently produced by attrition while floating about the bottom of the sea, $7\frac{3}{4}$ in. long by $3\frac{3}{4} \times 1\frac{1}{2}$ in. in its other diameters, but very irregular.

Obs. The brown colour of this sponge, both wet and dry, its irregular form, its harsh prickly feel from the arms of the large triradiates projecting beyond the common level of the surface, together with the internal structure, which is a mixture between the cloacal and canalicular excretory systems, and its spiculation, render the species as unmistakable in itself as it is unmistakably like Häckel's *Leucaltis floridana* (Atlas, Taf. xxvi.); as, however, there does not appear to have been any of the *minute* acerate spiculation on the latter, and after much search I have been able to find only one *large* quadriradiate among the *large* triradiates, I have designated it a variety of *Leucaltis floridana*, as the heading will show.

For a calcareous sponge the great size of the largest specimen, viz. $7\frac{3}{4}$ in. long &c., may be considered very unusual. Sometimes the surface presents a reticulation of more or less broken ridges in high relief.

41. *Teichonella prolifera*, Carter.

Teichonella prolifera, Carter, Annals, 1878, vol. ii. p. 35, pl. ii. figs. 1–5.

Finally we come to this species, which simply consists of parenchymatous structure traversed by excretory canal-systems which, beginning by small branches in the interior, terminate respectively by open naked mouths at the surface; supported on a staple mass of small radiates, accompanied more or less plentifully by very large ones, which, from their much greater size, are rendered very conspicuous (see my illustrated

description, *l. c.*). Thus we have no longer any *cortical* differentiation on the surface, nor any *cloacal* cavity interiorly, but a so far simplified structure that it becomes identical with that of the common run of *non*-calcareous sponges.

There are several specimens of this sponge in Mr. Wilson's collection, all more or less like that which I have described (*l. c.*), viz. the largest averaging 3 inches high in their present state, that is after having been broken off from their base of attachment, by 5×5 horizontally, formed as usual of an erect, thick, interfolded lamina with round undulating border in which the vents are situated. When fresh these specimens are said to have presented a "greenish-slate and reddish-brown tint below," now whitish yellow throughout.

In the paper on the "Teichonellidæ," to which I have alluded, will be found another species under the name of *T. labyrinthica*, which, through Mr. Wilson's specimens, I have now found to be so nearly allied in structure and general character to *Grantia compressa*, that it has been considered desirable to remove it from the Teichonellidæ to the vicinity of that sponge, where my reasons for so doing have been more particularly stated (*suprà*, p. 38).

Parasitic Cell in Teichonella prolifera.

One of the specimens of *Teichonella prolifera* is remarkable for being densely charged with the minute nucleated cell, like the human blood-globule, which, in my paper on the Parasites of the Spongidæ ('Annals,' 1878, vol. ii. p. 165), I have described under the name of "*Palmella spongiarum*." Besides being in size and shape like the human blood-globule, it in like manner presents a *pink* tinge, whereby a white sponge, when dry, such as *Halichondria panicea*, Bk., wherein I first found it at this place (Budleigh-Salterton, Devon), becomes coloured by it; and this may account for the "reddish-brown" tint when fresh to which I have alluded. Moreover, this parasite forms half the substance of an incrusting form of an *Aplysina* covering a mussel-shell which is among Mr. Wilson's collections; and the same is the case with a specimen of *Esperia*, from S.W. Australia, which I previously possessed; so that its existence is general.

Summarily it might be stated that Mr. Bracebridge Wilson's collection of S. Australian calcareous sponges has been sufficient to lead us from the simplest structure to one which is identical with that of the ordinary run of non-calcareous sponges, and that therefore, however much it may be desired to make the former a distinct "class," these facts do not justify such a conclusion.

P.S.—Since the above was written, I have found a much larger and more typical specimen of *Lelapia australis*, Gray (to which I have given particular prominence on account of its connexion with fossil species), which by accident had been overlooked in one of Mr. Wilson's later collections from "Port Phillip Heads," and therefore take this opportunity of appending a description of it as follows:—

Lelapia australis, Gray.

Cylindrical, clavate, the largest part upwards, somewhat curved or bent upon itself, rugose longitudinally. Consistence firm. Colour dark grey. Surface even, smooth, interrupted by the projection of crooked ridges extending from the free to the fixed end, subspirally and longitudinally, in broken lengths, sometimes reduced to mere scattered tubercular points, most pronounced on the concave side towards the mouth, least so on the opposite side; largest and most continuous ridge 1-3rd in. long, 1-48th in. broad, and 3-48ths in. high. Pores plentifully scattered over the surface, not remarkably large. Vent single, terminal, represented by a narrow, elliptical opening about 1-3rd in. in its longest diameter, so constricted in the centre as to be closely approximated by an infolding of the lip on each side; provided with a peristome whose spicules here are broken off short; leading into a cloaca corresponding in shape with the specimen, that is wide above, narrowed to a point below (after which the stem becomes solid); in other respects the same as that above described. Structure of the wall, which is about 5-24ths in. thick, together with the spiculation, also much the same as above described; but with these exceptions, viz. that the large acerate spicule of the "body" appears to traverse the wall horizontally as well as longitudinally; while the "ridges" are composed of a mass of acerate spicules of different lengths and thicknesses, averaging 150 by $2\frac{1}{2}$-6000ths in., some of which are simply pointed at each end, others bent and lance-shaped at one end and simply pointed at the other, and a third bent and lance-shaped at each end; all in contact longitudinally with each other, forming a wedge-shaped mass whose narrow end or border, according to the length of the ridge (that is whether linear or reduced to a small tubercular point), is slightly sunk into the wall, and the other, whose spicules, like those of the peristome here, are broken off short, spread out into the ridges of the surface, where the cuticular layer of "mortar-spicules" banks it up on each side. In a dried fragment these masses, in the section especially, present the glistening white aspect of the peristome. Size of specimen

from end to end, across the arc of the curve, $3\frac{1}{4}$ inches; greatest diameter, which is towards the head, 1 inch; least diameter, at the fixed end, which has been broken off from the place of attachment, $\frac{3}{8}$ inch.

Loc. "Port Phillip Heads."

Obs. Besides being far larger than the specimen above described, which I always thought to be more or less deformed, this one probably presents us with the *typical* characters of *Lelapia australis*, and hence my object in appending the above description. It must also, independently of its "typical" value, be considered a large calcareous sponge as the latter generally run. The spiculation may be a trifle larger than as above described, but the ridges are an entirely *new feature*, which in their characters are alone sufficient to distinguish the species; while the large acerate spicules of the body, arranged both transversely and longitudinally in the wall, represent the large sagittal triradiates of the "inarticulate" calcareous sponge-structure; the rest of the spicules here, including that remarkable form, viz. the "fork-like triradiate," to which I have above alluded as being so interesting in connexion with the fossil species *Sestrostomella*, being dwarfed into comparative insignificance.

XVI.—*Descriptions of four new Species of Butterflies from Burmah.* By H. Grose Smith.

Papilio Adamsoni.

Upperside. Anterior wings brown-black, darker towards the base, the nervures and rays between the nervures black. Posterior wings the same colour as the base of the anterior wings, paler towards the anterior margin, crossed beyond the middle by an irregular band of five rosy-white spots, the spot nearest the anterior margin cordate, the next three conical and lunulated externally, the fifth spot at the anal angle nearly obsolete; below the band are three submarginal large spots, lunular, the innermost grey flushed with rosy carmine, the middle spot grey, less rosy, the third the same colour as the band.

Underside. Anterior wings as above, but paler. Posterior wings with the band brighter, larger, more regular and curved, containing six spots, the spot on the anterior margin nearly square, the second the largest and nearly divided by a