ART. IX.—*Descriptions of New Genera and Species of Starfishes from the North Pacific Coast of America;* by A. E. VERRILL.

[Brief Contributions from the Museum of Yale University, No. LXX.*]

THE species here described were mostly received from the Canada Geological Survey; from the Provincial Museum of British Columbia, through Mr. C. F. Newcombe; from the U. S. National Museum; and from Prof. Kincaid, Washington State University. More detailed descriptions and illustrations have been prepared for publication in a General Report on the Starfishes of that coast, from San Francisco to the Arctic Ocean, which the writer has been engaged upon for several years, and has recently completed, but its publication may be somewhat delayed.

The littoral and shallow-water starfishes are probably more abundant on the coasts of British Columbia and southern Alaska than in any other part of the world. Of Asteriidæ alone, there are at least 40 species, besides many named varieties; of Solasteridæ six species are recognized; of Pterasteridæ seven species. A remarkable peculiarity is the number of species having six or more rays, even in groups that are commonly 5-rayed.

Solaster galaxides Verrill, sp. nov. Figures 2, 2*a*.

A broad-disked species, usually with nine or ten rays, covered above with very small crowded pseudopaxillæ, and resembling *S. endeca* in form and color.

Two typical specimens from Victoria have been received from the Provincial Museum of British Columbia. Both have nine rays. The larger has the radii 40 and 110^{mm}; ratios about 1 : 2.7. It was orange in life.

There are usually two subequal, rather long, acute, divergent furrow-spines on each adambulacral plate; only one distally. On the actinal surface the curved transverse row or comb has usually seven or eight graded spines, the two inner decidedly longer and stouter. The marginal spines are about as in *S. endeca*, but the infero-marginals are more elongated transversely, and bear a decidedly greater number of more minute spinules.

The synactinal series of pseudopaxillæ extends only to about the basal third of the free part of the ray. They are relatively smaller than in *endeca*, being here only about half the

* By an unfortunate error the Nos. LXVII and LXVIII of this series were duplicated.

size of the infero-marginals proximally. The actinal interradial areas are apparently relatively larger than in *endeca* and bear a larger number of compressed pseudopaxillæ, the larger ones similar to the infero-marginals and synactinals. They form about sixteen radial rows, the smaller one in the median rows distally. They are covered with a large number of small, rather short regular spinules.

The oral and jaw-spines are much better developed than usual. The four apical spines are very large, strong, and

FIG. 1.

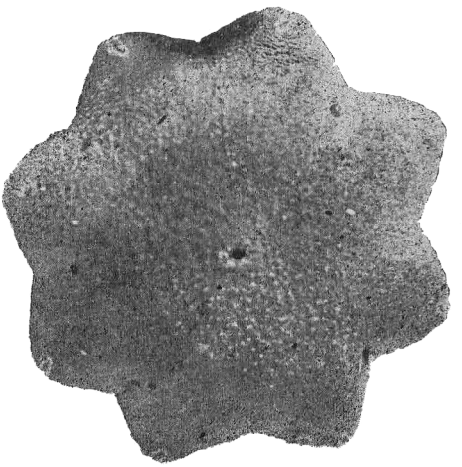

Fig. 1.—*Pteraster octaster* V. Dorsal side; $\frac{2}{3}$ nat. size.

acute. There are six graded furrow-spines on each side. The epioral spines are long and slender. They form two subparallel rows of about eight or nine graded spines. The spines in the opposed rows are often bent toward each other and interlocked. The two most adoral are distinctly larger than the others.

Solaster constellatus Ver., sp. nov. Figures 3, 4.

An 8-rayed species with a small disk and long tapered arms. Radii are 21 and 78^{mm}; ratios, 1 : 3.7.

The dorsal pseudopaxillæ are decidedly larger than in *Stimpsoni* V., which it somewhat resembles. They are stellate in form and usually, where largest, on the disk and base of rays, they have a single central and about six equally spaced and webbed marginal spinules, which are often fully expanded and nearly horizontal, producing the appearance of a six-

petaled flower; the largest ones may have seven or eight divergent spines, and the small distal ones only four or five; the supero-marginal and actinal ones are quite similar. The infero-actinal plates bear a larger number (8–12) of similar spinules. The adambulacral spines consist of a furrow-series with two or sometimes three rather short, tapered spines, and an outer comb of six or seven nearly equal, tapered spines, webbed nearly to the tips; the inner ones are usually rather longer, so that the rows are a little graded. Adoral spines strongly graded, about ten to a jaw, the apical ones unusually stout. The type is from Puget Sound (Prof. Kincaid). This is the only 8-rayed species known to me from that coast. Its large and beautifully stellate paxillæ are distinctive.

Pteraster octaster Ver., sp. nov. Figure 1.

Disk large and plump; margins well defined by points of actino-marginal spines; rays eight, short, about as wide as long, subacute; the ambulacral grooves turn up but little at the tips. Radii of the largest example, 20 and 30^{mm}.

Dorsal surface covered with a thick membrane through which the tips of the spinules show but little as pretty uniformly scattered points; in alcohol they form the apex of small, low, conical, fleshy elevations. Central oscule small, in alcohol inconspicuous, its short spines covered by a soft membrane. Ambulacral feet large, in two rows.

Adambulacral spines form combs of five or six spines, of which the innermost is much smaller and more slender than the rest, which are rather stout, tapered, subacute, divergent; the outer ones longer; the outermost appressed to the surface. Epioral pair of spines long and rather stout, tapered, translucent distally. The interradial areas are narrow, with rows of long, stout, imbedded actino-marginal spines, the ends of which project a little at the margin of the disk. Four specimens were sent to me by the U. S. National Museum. Three were from Bering Island, collected by Dr. Stejneger and Mr. N. Grebnitsky in 1888. One was from Kamchatka, collected by N. Grebnitsky.

This is the only *Pteraster* known which has more than six rays and is therefore easily recognized.

Pteraster hebes Ver., sp. nov.

Disk plump and relatively large, the five rays being very short and blunt, with the ambulacral grooves and plates turned upward and reflexed upon the upper surface nearly to the base of the rays, or about even with the shallow interradial angles. Radii, 22 and 28^{mm}. The central dorsal oscule is well devel-

oped, surrounded with slender webbed, projecting spines in five groups of eight to ten each. The dorsal surface is covered with a multitude of crowded slender spinules, which project above the marsupial membrane and give almost the appearance of velvet pile, but in some places they form more or less evident divergent stellate clusters of twelve to twenty spinules. Seen from within these spinules are slender, 2 to 3^{mm} long, very divergent, supported by slender columnar paxillæ. The

FIG. 5.

Fig. 5.—*Atlasterias Rathbuni* V. Dorsal view; $\frac{1}{2}$ nat. size.

ambulacral grooves are broad and shallow. The ambulacral plates are somewhat bilobed at the inner ends and distally are somewhat imbricated. The adambulacral spines are long and slender, about five or six in a transverse row, of which the two inner ones are very small and slender, not half as long as the outer ones, of which there are three or four, about 3·5^{mm} long. The appressed actino-marginal spines are distinctly longer and about twice as stout and blunt proximally, but distally, on the upturned part, where they are crowded, they become about equal in length to the adambulacrals and scarcely

longer; those near the interradial angles are flattened and enlarged distally; the valves at the peractinal pores between their bases are very acute, small, and slender.

Departure Bay, Br. Columbia, 23 fathoms, mud and sand, 1908 (C. H. Young), Canada Geological Survey.

Hippasteria spinosa Ver., sp. nov.

Very similar in form and size to *H. phrygiana* of the N. Atlantic, but thickly covered with large, tapering, acute spines, usually one to nearly every dorsal plate and 1 to 3 on each marginal. Many of the plates also have large elevated bivalve pedicellariæ, but not so wide as in *phrygiana*.

Departure Bay, British Columbia, 18 fath. (H. C. Young), Canada Geol. Survey; Puget Sound (Prof. Kincaid).

Tosia arctica Ver., sp. nov. Figures 8, 8*a*.

Pentagonal with short obtuse rays. Disk thick; margins rounded. Radii 31 and 48^{mm}.

Dorsal plates, when granules are removed, are mostly elliptical or rounded, well spaced; granules are angular and coarse, and those of adjacent plates are in contact in alcoholic specimens, so that the plates mostly appear hexagonal or pentagonal; there are usually 6 to 8 marginal and one central granule on the larger plates; some have, also, a bivalve pedicellaria about equal to a granule in size. Marginal plates not very large, closely and coarsely granulated; the distal ones become less regular, partly rounded, and small. Plates of lower side uniformly coarsely granulated. Adambulacral plates have two short, thick furrow spines and five or six on outer part, often with a pedicellaria of similar size.

Bering Island (N. Grebnitsky, 1889). U. S. Nat. Mus. Type.

Asterias (*Pisaster**) *papulosa* Ver., sp. nov.

A very large 5-rayed species, with a high, swollen disk and long tapered rays. Radii of a medium-sized specimen, 42 and 210^{mm}; ratios, 1:5; rays, 45^{mm} broad at base, 43^{mm} high. A larger specimen is 660^{mm} broad.

The dorsal spines are few, short, thick, tapered, subacute; they form simple median radial rows; others are irregularly and

* This subgenus, or perhaps more correctly genus, first indicated by Müll. and Tr. (type *P. ochraceus*), has monacanthid adambulacral spines and remarkably large sessile denticulate pedicellariæ, and usually, in the adult, numerous rows of actinal plates and spines. *P. papulosus* is an exception, as to the last character. It includes, also, *P. fissispina*, *P. confertus*, *P. Lutkeni*, *P. capitatus*, *P. brevispina* and *P. giganteus*, all described by Stimpson from the N. P. coast.

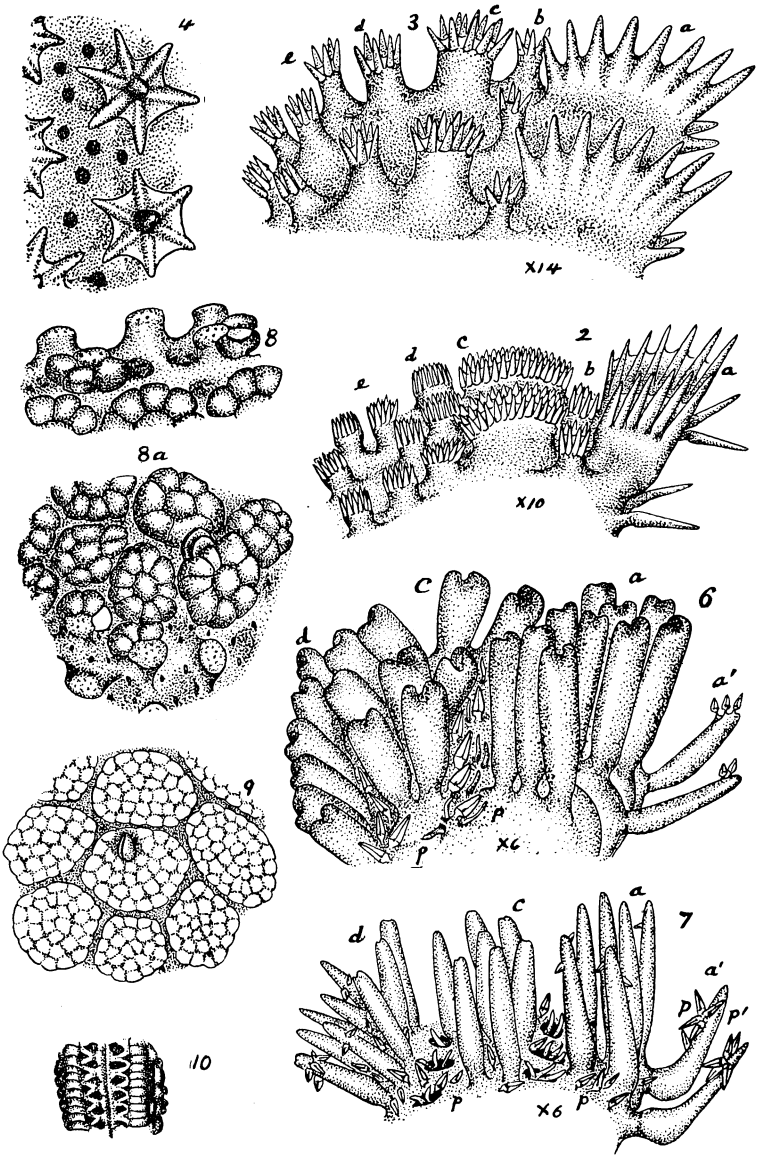

Fig. 2.—*Solaster galaxides* V. Profile view of adambulacral spines (*a*) ; peractinals (*b*); marginals (*c*, *d*); and abactinals (*e*); × about 14 times.
Fig. 3.—*Solaster constellatus* V. Lettering as above ; × about 10.
Fig. 4.—The same ; some of the abactinal pseudopaxillæ expanded, and papular pores ; more enlarged.
Fig. 6.—*Allasterias Rathbuni* V., var. *anomala ;* lettering as in fig. 2 ; *a'*, furrow spines ; *p*, *p*, major pedicellariæ and papulæ. × about 6.

distantly scattered; distally somewhat in rows; also in ten small clusters around the disk. Papular areas very large, with very large dermal groups of minor pedicellariæ, and also large wreaths around the spines. Large wedge-shaped denticulate dermal major pedicellariæ are numerous. A simple upper row of marginal spines like the dorsals; infero-marginals much stouter, two to a plate; two regular simple rows of similar stout actinal spines, with many large denticulate pedicellariæ between them. Adambulacral spines long and slender in a very regular simple row. Large clusters of major pedicellariæ of various sizes, large and small, are attached within the ambulacral grooves. Vancouver I. (Prov. Mus., B. C.); British Columbia (Canada Geol. Survey), and Puget Sd. (Prof. Kincaid, type).

Allasterias Ver., gen. nov. Type *A. Rathbuni* Ver.

Remarkable for the arrangement of the adambulacral spines, in several series, of which one is deeper within the groove on alternate plates. Disk rather large, areolate. Dorsal ossicles numerous, but small, arranged, both on the disk and rays, in a reticulate manner around the papular areas, which are numerous, and bear large groups of small papulæ. Spines numerous, arranged irregularly, or placed around the papular areas, but usually forming a median radial series. Upper marginal plates rather large and stout, so as to form an angular margin, each bearing several spines larger than the dorsals. Lower marginals not close to the adambulacrals, bearing in the type two or three spines, longer than the upper ones. Actinals rudimentary or lacking.

Allasterias Rathbuni Ver., sp. nov. Figures 6, 7.

Rays five, broad at base and rapidly tapering to acute tips. Radii, 25 and 100^{mm}; ratios, 1 : 4. Small major pedicellariæ are abundant all over the dorsal and lateral surfaces.

The whole dorsal surface is conspicuously areolate or reticulate, the areolations mostly 1·5 to 2^{mm} broad. The dorsal spines are very small and numerous, sometimes almost like round or capitate granules, being scarcely higher than thick,

Fig. 7.—The same, var. *nortonensis;* lettering as in fig. 6. × 6.

Fig. 8.—*Tosia arctica* V. Some of the dorsal interradial plates with granules removed; 8*a*, the same, some of the larger radial plates with granules and a pedicellaria; others bared of granules and showing papulæ: much enlarged.

Fig. 9.—*Tosia granularis*, dorsal radial plates, magnified the same as fig. 8*a*.

Fig. 10.—*Asterias* (*Leptasterias*) *macropora* V. Under side of ray of 5-rayed Alaska specimen, with spines removed, showing large size of ambulacral pores; × about 2.

but in other examples clavate or partly acute; they are arranged in single rows on all the ossicles, so as to form a border around the papular areas; toward the sides of the rays they are distinctly longer and mostly clavate or subacute.

The upper marginal spines form a wide band of small crowded spines, five to ten or more on a plate. They are larger and longer than the dorsals, and two or three times as long as thick, mostly cylindrical or clavate, sometimes gouge-shaped. Below this band there is a broad intermarginal channel with large papular areas and numerous rather large, pointed major pedicellariæ. This channel rapidly widens at the bases of the rays.

The lower marginals form a double row, mostly two to a plate; they are similar to the upper ones, but longer and mostly more clavate, often with gouge-shaped tips. Between the upper and lower marginals, at the bases of the rays, a short intermediate row of ossicles is sometimes interpolated.

Major or forficulate pedicellariæ are usually everywhere abundant, scattered over the surface, between the dorsal, marginal, and actinal spines, and especially on the lateral channels and interradial areas. The larger ones are compressed, rather large, lanceolate or acute-triangular, with a sharp or acuminate apex. Those that are scattered on the dorsal surface are much smaller, unequal in size, but similar in form, though less acute.

The type specimens are from Maloska (Prof. Kincaid). Specimens of varieties have also been sent from St. Michael's Island (L. M. Turner), 1873, No. 3821; Norton Sound (M. Murdoch), 1883, No. 7621, U. S. Nat. Mus. *A. amurensis* (Lutk.) is probably an allied species. Dedicated to Mr. Richard Rathbun of the National Museum.

Variety *anomala* V., nov. Figure 6.

This variety is remarkable for the very stout, crowded marginal and adambulacral spines, which are inflated distally and obtuse, with the tips excavate or gouge-shaped. (See fig.) Dorsal spines are small and capitate, but larger than in the type. Radii 23 and 87^{mm}. St. Michael's I. No. 3821, U. S. N. M.

Variety *nortonensis* V., nov. Figure 7.

This differs from the type in having the dorsal spines longer and more acute, and the infero-marginal and actinal spines longer and more tapered. Norton Sound (Murdock). No. 7621.

Asterias (*Urasterias*) *forcipulata* Ver., sp. nov.*

A very large species, allied to *U. Linckii*. Rays long and slender, gradually tapered; length of ray, 325^{mm}; breadth, 28^{mm}; disk small. Dorsal skeleton weak, with large papular areas nearly concealed by vast numbers of unusually large minor pedicellariæ.

The dorsal plates are small, three or five-lobed or stellate, each of the larger ones usually bearing a rather long tapered subacute spine; these are well spaced and form about five irregular or indefinite rows. The spines are surrounded by wreaths of the large minor pedicellariæ, but these also occur in larger clusters scattered over the integument between the spines. Large major pedicellariæ are also scattered over the back; these are stout, ovate-lanceolate, with obtuse tips, which are usually strongly denticulate.

On the sides of the ray and separated from those above by a wide papular band there is a row of small, mostly four-lobed marginals, usually bearing a single long spine. They are connected to those above and below by weak transverse bars, leaving large papular areas between. The spines are rather longer and larger than those of the dorsal surface. Between these and the adambulacral spines there is a single row of stouter spine-bearing plates, the infero-marginals; each corresponds to five or six adambulacrals. Most of these bear two long, tapered spines, usually blunt and somewhat flattened or sulcate at the tips, rather larger than the upper marginals, usually 7 to 8^{mm} long. Between their bases there are often scattered large and strong, denticulate, major pedicellariæ, similar to those of the back, but mostly stouter and more obtuse; with these are some that are much smaller, lanceolate, and subacute. The large pedicellariæ also occur on the naked spaces below, both on the papular areas and on the adambulacral plates. There are also some small synactinal ossicles connecting the peractinals with the adambulacrals, but not bearing spines. The adambulacral spines form two regular close rows, two on each plate; they are slender, tapered, mostly flattened, subacute, about 5 to 5·5^{mm} long. The ambulacral pores are large and form four rows.

The dorsal minor pedicellariæ are remarkable for their great size and abundance; in life they probably nearly conceal the whole upper surface and spines, and are borne on slender pedicels.

Departure Bay, Brit. Col., 18 fath., gravel (C. H. Young, 1908), Canada Geol. Survey.

* The subgenus *Urasterias* is now proposed for this species, with *U. Linckii* and *U. panopla* Str. of the Arctic. It is characterized by the absence of spiniferous actinal plates, weakness of dorsal skeleton, great size and abundance of both kinds of pedicellariæ. Type *U. Linckii*.

Asterias polythela Ver., sp. nov.

Rays six, stout, of moderate length, rounded and with a firm skeleton. Radii 20 and 80^{mm}; ratios, 1 : 4.

Dorsal surface appears rough and rugged. It bears an irregular number of large, stout, round spines, arranged without order, except that in a few places two or three may stand in a median series; elsewhere they may be grouped, 2 to 5, near together, or stand singly. These spines stand on raised central bosses of the plates; they are constricted somewhat at base and then abruptly enlarged below the middle; the terminal part is regularly tapered or somewhat acorn-shaped or nipple-shaped, longitudinally finely grooved, ending in a blunt apex. They are 2 to 4^{mm} high and 1·5 to 2^{mm} in diameter. Scattered over the whole surface are many small, unequal, short, acorn-shaped and capitate spines, mostly from 2 to 4^{mm} in diameter. The large and small spines are all surrounded by close wreaths of small minor pedicellariæ; clusters of these are also attached to the skin, so that the surface appears to be almost covered with them.

The marginal and actinal rows of spines are pretty regular and smaller than the dorsals. The upper marginals stand mostly one to a plate proximally and two to a plate distally. They are shaped somewhat like the large dorsals and nearly as long, but only about half as thick. The lower marginals are about as long, but stouter; they stand either one or two to a plate. A short row of smaller spines is interpolated between the upper and lower marginals proximally. The peractinal spines are like the lower marginals proximally and form a regular row, one to a plate. The adambulacral spines are small, round, blunt, mostly two to a plate, sometimes one in certain parts, divergent and almost concealed by large clusters of small, ovate, major pedicellariæ on the inner ones, and clusters of major pedicellariæ on the outer ones; many large clusters of major pedicellariæ are attached to the inner edge of the plates within the furrow. A few much larger, blunt-ovate, major pedicellariæ with finely denticulate jaws, occur on the interradial spaces and between the proximal marginal spines.

The type was taken off the Arctic coast of Alaska by the U. S. R. S. "Corwin" in 1885, No. 16889 (U. S. Nat. Mus., No. 15820).

Asterias victoriana Verrill, sp. nov.

The type of this species is from near Victoria, British Columbia, sent by Mr. Newcombe. Radii, 20 and 95^{mm}; ratios, 1 : 4·75. Rays five, stout, rather rapidly tapered. Dorsal

skeleton conspicuously reticulated, leaving large papular areas, which are mostly rounded or somewhat elliptical, the transverse diameter the greater. The intervening ossicles are strong and prominent above the surface, as narrow convex ridges; those at the intersections and in the radial rows larger and deeply four to six-lobed, convex in the middle, with a central mammilla and pit where the spine is attached.

The dorsal spines consist of two very unequal kinds. The larger ones are few in number and are widely scattered, except in the median radial line, where they form a pretty regular row; the others stand somewhat in quincunx, but may belong to about three imperfect rows on each side. These spines stand on the larger plates at the intersections of the reticulations. They are rather large, short, and thick, not much higher than broad, with enlarged, truncate or capitate tips, striated on the sides and rough on the top. They are about 1·5^{mm} broad. Between these there are many very small inconspicuous spines, arranged mostly in single rows along the narrow ossicles that form the sides of the reticulations. Some of them are acute, but most are slightly clavate with rough or spinulose tips. Both kinds are scattered irregularly on the central area of the disk.

Small minor pedicellariæ are thickly scattered over the whole surface between the spines and on the papular areas, and also form wreaths around the larger spines.

The supero-marginal spines form simple regular rows, and are much like the large dorsals in length and form, but are smaller. The intermarginal channel is well defined and of moderate width. The infero-marginal spines form a regular row, mostly simple, but frequently stand two on a plate distally. They are followed, proximally, by two pretty regular close parallel rows of actinal spines, of about the same size and shape. These three rows of ventral spines are longer than the supero-marginals and less clavate, but about as stout. They are blunt and sulcate at the tips. The first subactinal row extends only to about the end of the proximal third of the ray; on the proximal fourth there is also a simple row of synactinal spines.

The ossicles of the two marginal rows and next two actinals are thick, nearly equal in size and form, and proximally stand in four or five regular rows; the upper marginals are a little more removed, but the others are closely united in a tessellated manner, leaving only small papular pores between them. The exposed part is convex, with facets and pits for the spines. They are slightly four-lobed, but are so imbricated that they appear squarish with rounded corners, or ovate-triangular.

The synactinal ossicles are smaller, with an oblong or elliptical surface, and mostly bear a single spine; they extend only to about the proximal third of the rays.

The adambulacral spines stand two on a plate, or else in certain parts one and two alternately, thus forming two or three crowded rows. They are unequal, not very slender, the inner ones slightly tapered, the outer ones stouter, blunt, as long as the ventral spines, but more slender. They increase somewhat in length and thickness toward the mouth.

The two apical preoral spines are rather stouter and shorter than the adorals; their side spines are about half as long and more slender. The epioral spines are like the adorals.

The adoral carina is rather thick and stout, composed of three pairs of contingent plates beyond the epiorals, the third pair bearing two spines.

Major pedicellariæ of moderate size occur among the ventral spines and on the lateral and dorsal surfaces, but are not numerous. They are compressed, lanceolate or acute-ovate, with sharp tips.