

The Asteroidea of H.M.S. 'Challenger' Expedition.—Part I.
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[Read January 19, 1882.]

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PART I. PTERASTERIDÆ.

THE Asteroidea collected during the expedition of H.M.S. 'Challenger' were kindly intrusted to my care by Sir C. Wyville Thomson in the early part of the past year (1881), to report upon and describe. As might naturally be expected in a group of animals of such universal occurrence, the amount of material is very great, and furnishes additions of the highest importance to our knowledge of the geographical and bathymetrical distribution of species, of variations of form within areas of occurrence, and of growth-stages; whilst the number of species new to science is also very considerable. These circumstances, together with the fact that comparatively little has hitherto been known respecting the Asterid fauna of abyssal depths, are sufficient to indicate the interesting and important character of the collection under notice.

It is my intention to lay before this Society an account of the species obtained, with descriptions where necessary, and to present the same by instalments during the course of the preparation of the detailed Report, which will ultimately form a part of the Official Report of the Voyage now in process of publication. In the issue of the proposed preliminary lists I shall not feel called upon to adhere rigidly to the sequence in which families or genera are classified by systematists. The parts will more probably be issued as soon as my examination of special groups is completed; and this, for obvious reasons, will be determined in a great measure by conveniences of study and comparison. By this means I hope to be able to lay more speedily before specialists an outline of the results of the Expedition as far as the Asteroidea are concerned, and thus render them available for general consultation and reference. All questions of anatomy, development, variations, and general deductions will be reserved for the Report above mentioned.

Fam. PTERASTERIDÆ.

Synopsis of Genera included therein.

Ambulacral spines forming transverse combs. Spines united by web.	Supradorsal membrane with muscular fibrous bands. Actino-lateral spines forming a free independent lateral fringe; not merged in the actinal floor.	Muscular bands not reticulated. Membrane usually containing spicules.	PTERASTER.
		Muscular bands regularly reticulated. No spicules in membrane.	
	No muscular fibrous bands in the supradorsal membrane. Actino-lateral spines merged in the actinal floor. No lateral fringe.	Paxillæ-spinelets (15-30), long and hair-like, protruding freely through the membrane. Ambulacral spines part horizontal. 1 pair of secondary mouth-spines; united by web to mouth-spine series.	MARSIPASTER.
		Paxillæ-spinelets (5 or 6) short, robust, not protruding. Ambulacral spines perpendicular. 3 pairs of secondary mouth-spines, free and independent.	
Ambulacral spines not forming transverse combs. Spines independent, and not united by web.	Nidamental cavity spacious. Supradorsal membrane well-developed. Muscular fibres present. Spiracula present. Spinelets of paxillæ short, not protruding through, but supporting, the membrane.		HYMENASTER.
	Nidamental cavity aborted. Supradorsal membrane rudimentary. No muscular fibres. No spiracula. Spinelets of paxillæ fascicular, protruding a great portion of their length naked through the membrane.		
			BENTHASTER.

Hitherto this family has been represented by a very limited number of forms, only nine species being on record. Eight of these belonged to the genera *Pteraster* and *Retaster*; and the ninth was the type and solitary representative of *Hymenaster*, a genus established by Sir Wyville Thomson for a remarkable Asterid discovered during the cruise of H.M.S. 'Porcupine.'

Thirty-four species of Pterasteridæ have been obtained by the 'Challenger,' only two of which were previously known. Of the thirty-two new species, three belong to *Pteraster*, four to *Retaster*, and the remarkable number of twenty to *Hymenaster*, a genus which is now found to possess a world-wide distribution in deep waters. The remaining five species are representatives of

three new genera, viz.:—*Marsipaster*, two species; *Benthaster*, two; and *Calyptraster*, one.

Note on Terminology.—For the sake of brevity and to avoid verbose repetition, several terms are employed in the following descriptions which have not previously been used in their present special signification. The introduction of these terms is necessitated by structural peculiarities in the forms comprised in the family Pterasteridæ, several of which have hitherto been unobserved, whilst others have been ignored or passed over by previous systematists. The application of the terms will, in most cases, be self-evident. The following is a brief definition.

The *supradorsal membrane* is the veil-like covering or external independent tissue whereby the dorsal nidamental cavity is formed. The membrane is supported above the true dorsal surface of the animal by the *paxillæ*, which consist of a long columnar pedicel surmounted by a "crown" of fine, more or less elongate spinelets. In the majority of forms belonging to this family, fine muscular fibrous bands extend between the tips of the spinelets, and constitute a more or less regular fibrous network; and the general tissue of the dorsal membrane which fills in the interspaces or meshes is usually perforated by small contractile pores, styled *spiracula* by Sars. A large aperture occurs in the supradorsal membrane, situated over the centre of the disk and opening directly into the dorsal cavity, to which it affords the common means of ingress and egress; it is named the *oscular orifice*. This aperture may be closed by five more or less regular fan-like valves, or simply by a number of webbed or papillose spinelets. A number of small apertures open into the nidamental cavity on the actinal surface of the Starfish, an aperture being situated at the base of each of the long actino-lateral spines and close up to the adambulacral plate. There is consequently an opening into the cavity on either side of the furrow corresponding with each segment of the ray; hence these are spoken of as *segmental apertures*. The openings are guarded, and can be closed, by a small spinelet or papilla articulated on the adambulacral plate, and termed the *aperture-papilla*. In some genera these appendages are partially hidden in the actinal membrane, and are free on one side only; in others they are perfectly free, and covered with a more or less expansive investing membrane of their own. The long spines articulated on the body-frame close to the adambulacral plates, and which form the lateral or marginal web in

Pteraster, and support the whole actinal floor in *Hymenaster*, are designated the *actino-lateral spines*. Finally, in the armature of the mouth-plates distinction is made between (1) the *mouth-spines proper*, which are situated upon the horizontal margins of the plates, and which are usually directed over the actinostome; and (2) the *secondary* or *superficial mouth-spines*, which are borne upon the surface of the plate, and usually stand perpendicular to its plane—these latter spinelets being also frequently larger and more robust than the mouth-spines proper.

PTERASTER, *Müller & Troschel*.

Species enumerated.

<i>P. militaris</i> (O. F. Müll.), Müll.	<i>P. rugatus</i> , n. sp.
& Trosch.	<i>P. stellifer</i> , n. sp.
<i>P. affinis</i> , E. A. Smith.	<i>P. semireticulatus</i> , n. sp.

PTERASTER MILITARIS (O. F. Müll.), *Müll. & Trosch.*

Station 49. Lat. 43° 3' N., long. 63° 39' W. Depth 83 fms.; bottom temperature 1°·8 C.; gravel, stones.

PTERASTER AFFINIS, *E. A. Smith*.

Pteraster affinis, *E. A. Smith*, *Ann. & Mag. Nat. Hist.* (1876), vol. xvii. p. 108; *Trans. Venus Exped., Zool. Kerguelen Is.* p. 6, pl. xvi. fig. 5.

Station 149. Royal Sound, Kerguelen Islands. Depth 25 fms.

PTERASTER RUGATUS, n. sp.

Marginal contour subpentagonal, interradial angles scarcely indented, the lesser radius being in the proportion of 68·4 per cent.; $R=9\cdot5$ millim., $r=6\cdot5$ millim. Interradial margin rounded, extremities of the radii slightly upturned, exposing the end of the furrow. Dorsal profile rounded, not high, tapering but little towards the extremities of the radii. Abactinal surface flat or slightly convex. Lateral fringe very slightly produced beyond the margin of the test.

Supradorsal membrane subcorrugated, not reticulated. Paxillæ-spinelets fine, about 5 or 6 in number; tips slightly protuberant, and producing a slight papillate appearance on the dorsal surface; no regularity of arrangement perceptible. Membrane indurated with minute spicules averaging ·03–·04 millim. in length—small, irregular and angularly branching bodies, sub-

dendriform in appearance, fairly well spaced. The spiracula are rather large, not numerous, and are irregularly placed.

Ambulacral furrows narrow, uniform in breadth till near the extremity, not petaloid. Ambulacral suckers in regular simple pairs. Ambulacral spinelets short and rather robust, 3 to 4 in each comb, 3 only on the outer part of the ray. Innermost spine nearly as long as the others, or, if a small inner one is present, it is so aborted as to be invisible without dissection. Web remarkably thick and fleshy, subsaccular over the spinelets, passing off from the outermost spine with a long gentle sweep far out on to the lateral fringe.

Mouth-plates each bear on their margin about three rather short, robust mouth-spines webbed together. Secondary superficial mouth-spines one on each plate, perpendicular to the plane, longer than any of the other spines, exceedingly thick, triangular, translucent, sharply pointed, and covered with a thick fleshy investment.

Aperture-papillæ large, prominent, subtriangular. Actinolateral spines directed horizontally, comparatively long, especially in the interbrachial space. Web rather thick and fibrous.

Colour, in alcohol, greyish white.

Station 150. Lat. $52^{\circ} 4' S.$, long. $71^{\circ} 22' E.$ Depth 150 fms.; bottom temperature $1^{\circ} 8 C.$; rock.

PTERASTER STELLIFER, n. sp.

Marginal contour stellato-pentagonoid, interradial angles slightly indented, the minor radial proportion being 67.6 per cent.; $R=34$ millim., $r=23$ millim.

Radii very broad at the base, and tapering to a fine extremity, which is slightly recurved, margins of the rays not curved outward. Dorsal surface depressed and flatly convex. Lateral fringe scarcely extending beyond the margin. Actinal surface flat.

Supradorsal membrane rather thick, regularly papillose in appearance, not reticulated, composed of closely interlacing fibrous tissue. Paxillæ numerous and closely placed, with crowns of usually six spinelets radiating round a central one; expansion of spinelets slight, all uniformly protuberant. The tips of the spinelets elevate the membrane into little conical papillæ, which, in consequence of the regularity of the crowns of the paxillæ, have the appearance of forming six-rayed stars with a central papilla, raised slightly in relief above the general superficies.

The crowns are closely placed, the interspaces rather deep; and the stars often appear to overlap. A more or less distinct lineal arrangement of this ornamentation may be observed upon the rays, although here and there irregular paxillæ-crowns, with fewer or more minute spinelets as the case may be, are interspersed. The "stars" diminish in size as they proceed outward on the ray. Spiracula small and rather widely spaced. Oscular orifice small; spinelets of the valves short and crowded.

Ambulacral furrows narrow, straight, not petaloid, converging gradually towards the extremity. Suckers arranged in simple pairs. The borders formed by the transverse combs of ambulacral spinelets rather broad. Each comb with 5 spinelets, comparatively short, the innermost one diminutive, not half the length of the others, and placed aboral to them on the plate, the comb being thus curved round aborally at the margin of the furrow; the spine next to the outermost is usually the longest. Web moderately thick and semitransparent, rather deeply incurved between the spinelets, somewhat thickened round them, and slightly sacculate over their extremities; continued from the outermost spine of the comb far out on the actino-lateral spines.

Segmental apertures rather large and conspicuous for this genus. The papilla is comparatively large, and free on its aboral side only, forming a regular semicircular lip, the remainder of the papilla being entirely hidden in membrane.

Mouth-plates short, but widely expanded laterally, rising by a gradual slope into a high and angular median keel, and forming a prominent peak aborally. Each plate bears one moderately robust secondary superficial spine placed rather nearer the anterior margin of the plate than the middle. These spines are shorter than the mouth-spines proper, and are covered with a thick investing-membrane slightly sacculate at the extremity. Five mouth-spines are situated on the horizontal margin of each plate, the innermost the longest, the next slightly smaller, and the outer three much smaller. Each of the spines is covered with a moderately thick subsacculate investing membrane; and no web is developed, except in one single abnormal instance, where a secondary spine is united with the inner or first mouth-spine proper.

The first or most adoral transverse ambulacral combs of two neighbouring rays touch one another at their bases behind the aboral peak of the mouth-plates, but are not joined together.

The actino-lateral spines are long, delicate, closely placed, and

extend to the margin of the actinal surface; the web faintly rounded over their extremities and slightly festooned between. The spines are horizontal in their disposition, forming a flat ventral surface to the disk; and the fringe extends very slightly beyond the margin; and the spines diminish to quite microscopic proportions at the extremities of the ray.

Colour, in alcohol:—The actino-lateral spines, the ambulacral spines, the mouth-plates, and the mouth-spines are all of a delicate rosy-pink colour; and this, seen through the semitransparent light-flesh-coloured investing tissue, gives an exquisitely beautiful appearance to the underside of the Starfish. The general colour of the dorsal area is a pinkish white, verging on flesh-colour.

Station 311. Lat. $52^{\circ} 50' S.$, long. $73^{\circ} 53' W.$ Depth 245 fms.; bottom temperature $7^{\circ} \cdot 7 C.$; mud.

PTERASTER SEMIRETICULATUS, n. sp.

Marginal contour substellate; interradial angles well indented, the minor radial proportion being 57 per cent.; $R=14$ millim., $r=8$ millim. The sides of the rays slightly and gracefully curved outwards, the tips naturally upturned and incised, bringing the extremity of the ambulacral furrow on to the dorsal area. Dorsal profile rather high and bombous over the disk, tapering off rather steeply to the extremity of the rays. Actinal surface slightly concave.

Supradorsal membrane marked out with conspicuous reticulated lines of membrane, although no regular divisional fibres or independent tendinous network can be made out—the fibres present being fine, and only distinguishable when highly magnified. Paxillæ moderately long, with the spinelets radiating well outwards, about 6 to 8 or even more in number; the corrugated membrane which they support lying thick and baggy over their tips, and forming the regular lines and cross lines whereby the character above noted is produced. None of the spinelets are more prominent than the rest; and although a central one appears to be normally present in the centre of the mesh, this is very frequently absent towards the end of the rays. The membrane is semitransparent, and contains no spicules; 6 to 10 large-sized, irregularly disposed spiracula occur in each mesh-like area.

Ambulacral furrows moderately wide and sublanceolate; the sucker-feet more or less alternate, and showing distinctly a ten-

dency towards quadruple arrangement. Ambulacral suckers moderately long and slender, each comb having 3 to 4 (or occasionally 5) spinelets, the innermost not more than one third of the size of the next spinelet, and placed in advance of, or aboral to, the rest of the comb; the outer spinelet usually rather longer than the others. The web-membrane is semitransparent, moderately indented, and, after passing from the outermost spinelet of the comb, is attached to the web of the actino-lateral spine, slightly in advance of the actino-lateral spine belonging to its own ambulacral plate—the spinelet hanging right over the terminal piece of web, which does not reach far out as in *P. rugatus*. A rather long saccular prolongation of the web-membrane occurs at the tip of each of the ambulacral spines. Towards the extremity of the rays the combs sometimes show a tendency to separate into component spines, each being still clothed with membrane. The aperture-papillæ are somewhat jawbone-shaped, the thickened extremity being directed adorally.

The mouth-plates bear 4 to 5 spines on each side, long, and stouter than the ambulacral spines, both series being webbed together, the outer spine being sometimes very small and rudimentary. The secondary superficial spines are small, not so long as the innermost mouth-spines, but rather more robust. In one or two plates of the specimen under notice there is a single irregular secondary spinelet, smaller than and accompanying those just referred to. The first ambulacral comb after the mouth-plate series has its web continued on to the aboral extremity of the mouth-plate; hence these two combs meet.

The actino-lateral spines are of moderate length and slender; the fringe extending a short distance free beyond the margin of the test, and directed horizontally or in the plane of the ventral surface.

Colour, in alcohol, greyish white.

Station, "off Marion Island." Depth 50 fms.

RETASTER, *Perrier*.

Species enumerated.

R. verrucosus, n. sp.

R. peregrinator, n. sp.

R. gibber, n. sp.

R. insignis, n. sp.

RETASTER VERRUCOSUS, n. sp.

Marginal contour moderately indented in the interradia, which

are angular and not rounded; outline of the rays gracefully curved outwards. The lesser radius in the proportion of 59.5 per cent.; $R=47$ millim., $r=28$ millim. Dorsal profile moderately high and rounded, tapering gradually to the extremity of the rays, which are slightly upturned and expose the ambulacral furrow on the dorsal area. Actinal surface flat.

Supradorsal membrane very regularly and uniformly reticulated. The paxillæ have long pedicels, and bear a crown of about 15 spinelets, nearly as long as the pedicel. The central spinelet is very much more robust and longer than any of the rest, and stands perpendicular, rising in the centre of the mesh, whilst the others, which are slender and delicate, radiate round it and outwards to the fibrous bands that form the outline of the mesh. The median spinelet is much more prominent than any of the others; and the thick fleshy cap formed upon it by the dorsal membrane imparts a very conspicuous papillate appearance to the Starfish, assuming in large old specimens almost a semituberculate character of great regularity and evenness of disposition. In large, fully-grown specimens the whole membrane becomes very thick and wrinkly, rendering it difficult to trace the radiating bands; in moderate-sized specimens, however, they may be clearly distinguished without removing the epidermis. From the central spinelet 6 to 8 secondary muscular fibres radiate up to the main fibres of the mesh; they are of considerable thickness, and leave only narrow interspaces, in which four or five small spiracula occur.

Ambulacral furrows very broad and petaloid in outline, with sucker-feet arranged in quadruple series. Transverse combs of ambulacral spines numerous and closely placed, with five moderately long and robust spines, the uniting web being thick, fleshy, and with long saccular prolongations extending beyond the tips of the spines. The ambulacral spinelets are nearly equal in length, except the innermost, which is shorter and more delicate. Each alternate row is somewhat retired from the furrow-margin; and in these combs the innermost spinelet is very much smaller than its companions, in some cases almost aborted; and this spine is usually placed rather in advance of its row.

Mouth-plates with long mouth-spines, 4 on each plate, all the eight webbed together, not radiating apart, but forming a narrow scoop-like fan, the inner three spines on each plate about equal in length, the outermost spine very small and short. The secon-

dary or superficial mouth-spines (one on each plate) not longer than the mouth-spines, scarcely if at all stouter, subcylindrical and not pointed, covered rather thickly with membrane.

Actino-lateral spines completely hidden in a very thick fleshy membrane, which extends as a saccular prolongation beyond their extremities, forming an aborted lateral fringe that projects slightly beyond the margin of the disk and rays.

Colour, in alcohol, varying from light warm brown to purplish grey.

Station 313. Lat. $52^{\circ} 20'$ S., long. $68^{\circ} 0'$ W. Depth 55 fms.; bottom temperature $8^{\circ} 8$ C.; sand.

RETASTER PEREGRINATOR, n. sp.

Marginal contour not greatly indented, the lesser radius being in the proportion of 65.85 per cent.; $R=41$ millim., $r=27$ millim. Interradial angles subangular or faintly rounded. Radii short, thick, blunt and rounded at the extremities, which are slightly upturned. Dorsal profile bombous and rather high. Actinal area flat or subconvex.

Supradorsal membrane thick and regularly reticulated. Paxillæ with a crown of 5 to 10 spinelets, one directed to the centre of the mesh, the rest expanded very slightly; six radiating fibrous bands pass from the central spinelet to the mesh-fibres; and the interspaces include 2 or 3 large spiracula. All the spinelets are uniformly protuberant, and that only to a slight degree; they are rather closely placed; and the whole dorsal area is thickly covered with rather fleshy wrinkly skin, presenting a somewhat spongy and subpapillose appearance, and a slightly scabrous feeling to the touch. The primary meshes are not very distinctly marked out superficially; and the hexagons consequently appear to overlap or run into one another in many cases. Oscular orifice small and inconspicuous.

Ambulacral furrows broad and more or less petaloid, the closely placed and prominent transverse spine-combs adding greatly to the appearance of breadth. Sucker-feet arranged in quadruple series. The combs of ambulacral spines are broad, a feature further enhanced by their method of arrangement. Each alternate comb has usually two spines less: in this way combs of 7 to 8 spinelets alternate regularly with combs of 5. The larger combs radiate well over the furrow, whilst the smaller ones, on the other hand, are considerably retired from the margin; the

innermost spine standing perpendicular, or even directed slightly outwards. Hence, when seen from above, the smaller combs appear to have little more than one half, or at most two thirds, the space of the larger combs. In the larger combs the innermost spine is smaller and shorter than the rest, frequently not more than half the length. In the smaller combs the innermost spine is much smaller still, often quite aborted and apparently absent. The other spines are nearly equal in length; and both combs are uniform with one another in this respect. The combs are thickly webbed, and have large and elongate saccular extensions developed over the extremities of the spinelets.

Mouth-armature resembling that of *R. verrucosus*. Mouth-spines 8 to 10 in number, 4 or 5 on each plate, both series webbed together, forming a narrow scoop-like fan. Secondary superficial mouth-spines, one on each plate, thin, cylindrical, not tapering, no longer than the mouth-spines, covered with membrane.

Actino-lateral spines of moderate length, reaching up to the margin of the test; hidden in membrane, of which a saccular but not indented prolongation extends beyond the extremities as a fleshy marginal fringe. Segmental apertures of the dorsal chamber very large and elongate, situated well within the transverse combs, and quite hidden thereby.

Colour, in alcohol, purplish grey.

Station 149. Off Christmas Harbour, Kerguelen Islands. Depth 120 fms.

RETASTER GIBBER, n. sp.

Marginal contour substellate, interradial angles acute, not rounded. Minor radial proportion about 50 per cent.; $R=28$ millim., $r=14$ millim. Radii 5, well rounded, tapering continuously from the angle to the extremity, with sides rounded, tumid, and curving over on to the actinal area as in *Echinaster*. Dorsal profile high, gibbous, rounded. On the actinal area the mouth and surrounding portions are deeply sunken.

Supradorsal membrane with reticulated fibrous bands, marking it off into square or rhomboid meshes of great regularity. In the centre of each, 3 to 4 paxillæ-spinelet-tips are visible; and other spinelets radiate to the mesh-fibres, one (or occasionally two) spiracula being situated in the interspaces. The white fibres of the meshes form a conspicuous feature; and the slightly

protrusive tips of the spinelets impart a granulose appearance to the dorsal area, the whole being covered with a thin fleshy membrane. The oscular orifice is small, closed by a number of sub-papillate spinelets, rather longer, more prominent, and more robust than those of the paxillæ proper.

Ambulacral furrows narrow and deeply sunken. Ambulacral combs quite within the furrow and below the level of the test, with 3 to 5 spinelets, which are short, rather robust, webbed together,—the membrane being very slightly indented and with a slight knob over the end of each spinelet. Ambulacral suckers completely hidden by the overarching combs.

Mouth-plates deeply sunken; mouth-spines longer than the ambulacral spines, 3 on each plate, the whole six being webbed together into a continuous comb. Each plate bears one large isolated secondary or superficial spine, longer than the mouth-spines, very robust, covered with a thick membrane, except at the tip, which is translucent and sharply pointed.

Segmental apertures elongate and narrow; papillæ free on the aboral side only.

Actino-lateral spines very short and robust, almost hidden within the furrow, of which they appear to form the sides, and only protrude a short way beyond the level of the test, standing nearly perpendicular to the plane of the ray, and in some parts showing a tendency even to arch over the furrow slightly. This disposition, together with the aborted character of the fringe, imparts a feature very different from that usually presented by this structure in *Pterasteridæ*. In the immediate angle, near the peristome, the actino-lateral spines are somewhat longer, and are laid over upon the rounded surface of the interbrachial area, their web being continuous and forming a smooth fleshy triangular area leading up to the mouth-angle.

Colour, in alcohol, yellowish or greyish white.

Station 311. Lat. $52^{\circ} 50'$ S., long. $73^{\circ} 53'$ W. Depth 245 fms.; bottom temperature $7^{\circ} 7$ C.; mud.

RETASTER INSIGNIS, n. sp.

Marginal contour stellate, five-rayed. Interradial angles well rounded. Minor radial proportion 44.4 per cent.; $R=45$ millim., $r=20$ millim. (in another example $R:r$ as 70:31). Rays very slightly tapering, obtusely rounded at the extremities. Dorsal surface moderately convex, rays uniformly rounded from the

margin. Under surface flat or subconcave, somewhat impressed round the actinostome.

Supradorsal membrane very conspicuously reticulated. Paxillæ-spinelets prominent, arranged in regular lines, joined by fibres forming large uniform rhomboid meshes, which are rendered still more distinct by the lines and the investment of the spinelets being of a dark purple or black colour, whilst the dorsal membrane generally is ashy white. The meshes are filled in with a closely and regularly reticulated tissue, the interspaces of which are small, equally spaced, and each punctured with a minute spiraculum. The opposite angles of the rhomboid areas are usually joined by fibres rather more robust than the rest, forming a right-angled cross in the centre, and marking off the reticulated area of the mesh into four more or less easily distinguishable sections. There are 80 to 100 or more spiracula in each mesh. The spinelets that stand at the angles of the meshes protrude more than the others, and appear like well-developed thornlets springing from the general surface. Oscular orifice small and constricted, the spinelets of the pseudo-valves slightly prominent, their extremities tipped with the same dark colour as the lines of reticulation above mentioned.

Ambulacral furrows narrow, straight, and sunken—their apparent depth being further increased by the position of the prominent fringe of the actino-lateral spines, which stands vertical on either side of the furrow. Ambulacral spines 5, united together by a web; three standing on the margin of the plate parallel with the furrow, the next (more adoral) placed more outwards and away from the furrow, and the fifth more outwards still. The innermost (*i. e.* aboral) spine is very small, each succeeding one in the comb increasing in length; all are comparatively short, delicate, and tapering. The membrane that unites the spinelets is very fine, semitransparent, and deeply festooned between the spinelets, and is continued from the outermost spine of the comb on to the adjacent actino-lateral spine. The small spines placed on the margin detract very slightly from the general transverse aspect of the combs, their smallness rendering them inconspicuous; they have, however, the peculiarity of closing the space between their own and the next aboral comb at the margin of the furrow. Aperture-papillæ small and sublan-ceolate in form, hidden in the general membrane, excepting their

aboral side, which alone is free, which closes the aperture, shutting close up to the next aboral actino-lateral spine.

The mouth and parts surrounding it are much sunken—a feature further emphasized by the deep wall of the continuous marginal fringe. Mouth-plates elongate, with their aboral extremities produced into a rather prominent peak, suggestive of that in *Hymenaster*. About five mouth-spines are borne on the outer margin of each plate, the innermost much longer and more robust than the others, all webbed together, forming an elegant marginal comb conformable to the contour of the plate. The innermost spines of the two adjoining plates stand close together, but are not united by web. On the superficies of each plate, and nearer the mouth than midway, is a long, robust, cylindrical, rapidly tapering, pointed secondary spine, standing isolate and perpendicular, covered with membrane, but with no web-attachments.

Actino-lateral spines short and robust, not more than one third longer than the outermost ambulacral spine, and tapering only very slightly. They are united by a close fibrous web, the margin of which and the tips of the spines (as well as the tips of the ambulacral spinelets in the transverse combs) are tipped with dark purple. The lateral fringe thus formed stands perpendicular on the margin of the furrow; and the spines comprising it would at first sight be thought to belong to the comb-series. The fringe of the adjacent sides of two neighbouring rays is merged together at their adoral extremity, forming a continuous fringe, which runs close past the aboral end of the mouth-plates.

Station 189. Lat. $9^{\circ} 36'$ S., long. $137^{\circ} 50'$ E. Depth 25–29 fms.; mud. Also off Booby Island.

MARSIPASTER, n. gen.

Form depressed, marginal contour pentagonoid, dorsal area flatly convex, actinal area plane. Supradorsal membrane an irregularly developed, somewhat spongiform tissue. No muscular fibrous bands. No spicules. Paxillæ with moderately expanded crowns composed of a great number of fine, long, hair-like spinelets (15–30), their extremities protruding freely through the membrane. Paxillæ invested with a well-developed membranous envelope. Ambulacral spines webbed together, forming transverse combs; spinelets more or less horizontal in position, overspanning the furrow. Mouth-plates with one secondary surface-spine, connected

with the mouth-spine series by a continuation of the web. Mouth-spines three on each plate, webbed together. Actino-lateral spines merged in the actinal floor; no independent marginal fringe.

This genus is nearly related to *Pteraster*,—from which, however, it is distinguished by the rudimentary character of the supradorsal membrane, devoid of muscular fibrous bands; by the actino-lateral spines being merged in the actinal floor; and by the absence of a marginal fringe. Furthermore, the numerous hair-like spinelets of the paxillæ protruding through the membrane give a peculiar character to the dorsal area; and the ambulacral spines, from their high position in the furrow and from their more or less horizontal direction, present a feature unknown in the other members of the group.

MARSIPASTER SPINOSISSIMUS, n. sp.

Marginal contour pentagonoid; radii somewhat produced; interradial angles widely rounded, forming a continuous curve from tip to tip. Lesser radius in the proportion of 62.5 per cent.; $R=16$ millim., $r=10$ millim. General form depressed; dorsal area slightly convex, tapering off gently to the extremity of the rays.

Supradorsal membrane very fine and thin, somewhat irregular, and forming a continuous spongiöse mass, rather than a definite membranous sheet, through which the spinelets of the paxillæ protrude freely. No specialized muscular fibrous bands present. Spiracula very few, widely and irregularly spaced.

The paxillæ have long pedicels and a crown consisting of a great number (20–30 at least upon the disk) of very fine hair-like spinelets, which radiate at a small angle from the perpendicular, crown and pedicel alike being invested with a delicate membranous tissue, the whole appendage seen in profile bearing a fanciful resemblance to an umbrella when turned inside out. The investing membrane merges into the general spongy tissue above mentioned; and a considerable length of the extremities of the spinelets protrudes free and naked. The paxillæ are numerous; and their crowns join up close together. Owing to these circumstances and to the great number of the spinelets, the dorsal surface presents the appearance of a coarse, irregular velvet pile. Ocular orifice small and quite inconspicuous; valves consisting of a flattened crown of rather more robust spinelets.

Ambulacral furrows rather broad, not petaloid, tapering towards the extremity. Sucker-feet arranged in simple pairs. Ambulacral spinelets 5, long, acicular, webbed together into transverse or obliquely curved combs, and remarkable for their position more than half within the furrow. Spines of unequal length, the innermost much smaller than any of the others, and placed somewhat in advance of, or aboral to, the series; the longest spine usually the middle one, or sometimes the second from the outside, in length nearly equal to the breadth of the furrow, across which it stretches horizontally, whilst the two outer spines radiate downward and aborally. Consequent on this position of the median spine, the spinelets which compose the outer half of the comb radiate very widely apart. The connecting web is fine and semitransparent, very deeply indented between the spinelets, the combs receiving thereby a remarkable appearance; and the web is continued from the outer spine of the comb down to the base of the aperture-papilla, and not out along the actino-lateral spine. The aperture-papilla is represented by a small conical spinelet placed on the outer edge of the adambulacral plate and between the bases of the actino-lateral spines; it is covered with membrane, that of the ventral area being stretched over it, giving it the form of a small subtriangular or conical peak.

Mouth-plates of moderate length, with widely expanded lateral flanges. Keel along the line of junction prominent, forming a well-developed peak aborally, hidden beneath the tissue of the ventral membrane, produced into a point adorally. On either side of this, and placed on the horizontal margin of the plates, are three mouth-spines, webbed together, about equal in size with the ambulacral spines, but rather more robust, the innermost spine on each plate longest, and the other two decreasing in series. Immediately behind the three mouth-spines stands a small secondary superficial mouth-spine, about the same size as, or smaller than, the innermost mouth-spine, with which it is connected by a continuation of the web; the pseudo-comb being thus bent upon itself at a sharp angle, gives a very striking character to the armature of the mouth-plates. The ambulacral spines that form the comb belonging to the first adambulacral plate have their bases arranged in a semicircular curve, and the spines radiate at equal distances apart and are directed downwards and adorally, the middle spine being longest. The spines are all webbed together; and a continuation of the tissue from

the outermost spine is attached to the prominent posterior or aboral portion of the median keel of the mouth-plates, and there coalesces with the web of the corresponding comb of the neighbouring ray, thus forming an elegant compound pair of fans that arch over the aboral peak of the plate.

Actino-lateral spines rather short and robust, not extending, or only to the very slightest degree, beyond the margin. They are united by a fine semitransparent membrane, slightly indented between the tips, which also forms the actinal floor of the test. Probably in this species there is no free extension of the lateral or marginal fringe, such as occurs in more shallow-water forms, but unfortunately the preservation of the specimens in this portion of their structure is imperfect. For the same reason it is difficult to determine with accuracy the number of actino-lateral spines, but probably about 20 to 22 were present: 17+ may be counted in natural position; the sixth from the mouth appears to have been the longest.

Colour, in alcohol, brownish grey.

Station 286. Lat. $33^{\circ} 29'$ S., long. $133^{\circ} 22'$ W. Depth 2335 fms.; bottom temperature $0^{\circ} 8$ C.; red clay.

MARSIPASTER HIRSUTUS, n. sp.

Marginal contour substellate, interradial angles well indented, the lesser radius being in the proportion of 60.2 per cent.; $R=13.5$ millim., $r=8.5$ millim. Radii broad at the base, bounded by lines running direct from the arm-angle, with little if any curve or rounding. Dorsal area moderately convex, radii slightly upturned at the extremities.

Supradorsal membrane a fine, irregular, and somewhat spongiose tissue continuous over the whole area, through which the extremities of the spinelets of the paxillæ protrude freely. No definite membrane; no muscular fibrous bands. Paxillæ with long robust pedicels bearing 10 to 15 fine, long, acicular spinelets; investing membrane of the crown merging into the general supra-dorsal tissue; the naked tips of the spinelets which pass through the tissue giving the surface a somewhat hirsute or prickly appearance. Spiracula comparatively large, very few in number, and very widely spaced. Oscular aperture inconspicuous; valves formed of spines similar to the rest of the paxillæ, and with no specialized external characteristics.

Ambulacral furrows broad and straight, not petaloid. Sucker-

feet arranged in simple pairs. Ambulacral spinelets 5, forming transverse combs. The two innermost spines much smaller than the rest, and standing parallel with the furrow, rather in advance of, or aboral to, the other three, which are disposed across the broad adambulacral plate, articulated on more or less definite tubercles, and forming a series at right angles to the furrow. The middle spine is longest. The whole series webbed together with membrane deeply indented between the radiating spinelets, but not nearly so much as in *Marsipaster spinosissimus*.

Mouth-plates broad, having wide lateral expansions, and with an elevated ridge along their line of junction, developing a prominent peak aborally and a rounded point inward. The armature consists of three long, robust mouth-spines placed on the horizontal margin of each plate, the innermost spine largest and longer than the ambulacral spinelets, the outermost less than half its size, and sometimes accompanied by an additional diminutive spinelet. The inner spines stand well away from the adoral point of the united mouth-plates, which becomes in consequence rather conspicuous. Immediately behind or aboral to the mouth-spines proper is a single superficial or secondary mouth-spine, smaller than the long mouth-spines. The three mouth-spines of each plate are webbed together by a semitransparent membrane deeply indented between; and the secondary spine is united to the innermost spine by a continuation of the web. The long, innermost spines are directed towards the centre of the mouth, where they almost meet, the other spines radiating slightly outward from this. The first, or most adoral, comb-series forms a widely expanded semicircular fan, the web being continued and attached to the prominent aboral peak of the mouth-plates.

Actino-lateral spines robust, but short; character of the fringe destroyed, probably more or less distinct along the rays; spines not reaching to the margin in the interbrachial angle, but merged in the membrane of the ventral floor. The margins of the rays and disk are well rounded and regularly covered with the intrapaxillar tissue continuous from the disk; indeed the greater part of the ventral portion of the interradiial space is thus provided.

Colour, in alcohol, brownish grey.

Station 299. Lat. $33^{\circ} 31'$ S., long. $74^{\circ} 43'$ W. Depth 2160 fms.; bottom temperature $1^{\circ} 1$ C.; grey mud.

CALYPTRASTER, n. gen.

Form depressed, marginal contour pentagonal, dorsal area plane, actinal area convex. Supradorsal membrane very delicate, perfectly transparent. No muscular fibrous bands. Spiracula present. No spicules. Paxillæ with short robust spinelets (5 or 6 in the type species), usually flaring at the extremity, crown widely expanded, not protruding through, or even elevating, the membrane, simply supporting it. Ambulacral spines forming transverse combs; spinelets perpendicular in position, webbed together. Segmental apertures present. Aperture-papillæ not free, opening laterally only. Mouth-plates with two or three pairs of superficial secondary spines. Mouth-spines proper 2, or occasionally 3. Actino-lateral spines merged in the actinal floor. No independent lateral fringe.

This genus is established for the reception of a very elegant little form which presents certain resemblances to *Hymenaster* and certain to *Pteraster*. It resembles *Hymenaster* in the absence of a marginal fringe, and in the merging of the actino-lateral spines in the actinal floor, and resembles *Pteraster* in its transverse combs of ambulacral spines united by web-tissue. It differs from both genera in its transparent supradorsal membrane devoid of muscular fibrous bands, by the possession of three pairs of free secondary superficial mouth-spines, and by its true pentagonal form.

CALYPTRASTER COA, n. sp.

Marginal contour pentagonal, interradial angles very slightly incurved. Minor radial proportion 68 per cent.; $R=11$ millim., $r=7.5$ millim. Dorsal surface flat, or even somewhat concave in consequence of the rays being slightly curved upward; radial areas not specialized externally, the dorsal membrane forming a plane area. No marginal fringe. Actinal surface convex.

Supradorsal membrane extremely thin and perfectly hyaline, a clean specimen appearing to the eye as transparent as glass. No muscular bands present, although a fibrillar structure may be seen in the tissue under high magnification. Spiracula rather large, numerous, and uniformly distributed. Paxillæ with long pedicels, moderately delicate, evenly and equidistantly placed, usually with five spinelets, which are short in comparison with the pedicel, and rather delicate. A few of the spinelets taper a little at their extremity; but usually they are slightly flaring. The supradorsal membrane is literally supported upon the tips of these spinelets. About nine longitudinal rows of paxillæ-crowns are discernible at the base of a ray. The oscular

orifice is small but very conspicuous, in consequence of the well-developed bosses upon which the valves are articulated, and which are visible through the transparent membrane. The valves are very regular, and composed of 13 or 14 spines—the outer one or two on either side being almost aborted and hidden in the general membrane by which the whole series is webbed together, whilst the two innermost spines are longer than the others, which decrease gradually on either side and form a regular triangular fan, the base of which is articulated on the elongate boss or modified pedicel above mentioned. The bosses stand transverse and regularly central in the median line of each ray; in consequence of their breadth the distance between two neighbouring bosses is very small, and is bridged over by two or three spinelets, whilst a few short spinelets spring from the surface of the boss, and in this manner mark out a pentagonal outline round the orifice. The valves when closed lie flat over the opening, and do not form a pyramid.

Ambulacral furrows wide, lanceolate, scarcely petaloid. Ambulacral spines 4 (in a small specimen 3), of moderate length, rather robust at the base and sharply tapering, arranged at an angle of such great obliquity that, roughly speaking, the series may be described as transverse, although the innermost spine, which is somewhat smaller than the others, is usually more aboral than the rest of its series. The spines are not individually invested with membrane, but are webbed together into combs on at least the inner half of the ray. The web-tissue is extremely thin and very deeply indented between the spinelets; indeed it is only possible to make it out by means of favourable illumination. This character seems to be less general in some specimens than in others.

The aperture-papillæ are small, short, and elongately oval, more or less squamous, but often developing a small thornlet from the surface. They are more or less hidden in membrane, and free only on the aboral side.

Mouth-plates small, but rather elongate and prominent, as if compressed together laterally. Aboral extremity prominent. Adoral peak almost obliterated by the expansion of the lateral flanges. Each plate bears 3 superficial secondary spines (in a small specimen 2), not longer than the ambulacral spines, but nearly twice as robust, thick at the base, and tapering to a fine extremity. They are somewhat bowed or geniculate at right

angles to the line of junction of the mouth-plates. The anterior pair are situated at a little distance from the adoral extremity of the plates; and the second pair, which are slightly larger and rather wider apart, stand midway between them and the aboral extremity of the mouth-plates. Immediately above the anterior pair and placed on the innermost part of the lateral flanges, are a pair of mouth-spines (*i. e.* one on each plate), similar in every respect to the secondary spines just described, only slightly smaller and rather wider apart; indeed, in some specimens one is almost inclined to class them along with the secondary series. Midway on the horizontal margin of the flange is one small pointed mouth-spine; and in a large specimen a second and rather larger spinelet occurs between this and the innermost mouth-spine, and nearer to the latter.

Actino-lateral spines rather robust, well-spaced, tapering slightly at the tips, excepting those spines included within the inter-brachial angle, which are slightly thickened and do not meet their corresponding spines from the neighbouring ray in the median interradian line. There are 25 to 27 actino-lateral spines on each side of a furrow, the 7th or 8th from the mouth being longest; after this they gradually diminish in size as they proceed outward, maintaining, however, a fair length even at the extremity, where they are little shorter than the first (or adoral) spine of the series, thus forming a conspicuous little fringe round the extremity of the ray. The ambulacral furrow is extended vertically up the extreme tip of the ray, but is not exposed on the dorsal surface, being arched over by the terminal spinelets just described. Immediately inside this ocular fringe on the dorsal surface is a little ridge of 8 to 10 minute conical spinelets or papillæ, forming a semicircular collaret at the extreme tip.

The actinal membrane is as transparent as the dorsal membrane, the actino-lateral spinelets forming the floor of the test and projecting only their pointed tips beyond the sharp margin, to which they impart a delicate serrate character.

Colour, in alcohol, a light straw-colour, verging towards golden brown.

Station 122. Lat. $9^{\circ} 5' S.$ to $9^{\circ} 10' S.$; long. $34^{\circ} 49' W.$ to $34^{\circ} 53' W.$ Depth 350, 120, 32, and 400 fms.; mud. (Unfortunately only the station number is indicated on the label accompanying these specimens; and no record is given as to the particular dredging in which they were obtained.)

HYMENASTER, *Wyville Thomson*.*Synopsis of Species herein described.*

A. One ambulacral spinelet.

- † Paxillæ-crowns forming raised areas of membrane... } *nobilis*.
 Spiracula small, numerous, equidistantly spaced ... }
- †† Paxillæ-crowns not forming raised areas.
1. Spiracula single, large, uniformly spaced *formosus*.
 2. Spiracula in groups of 6-10, small, irregularly distributed *pergamen-*
[taceus].

B. Two ambulacral spinelets.

- † Muscular fibrous bands of dorsal membrane coherently reticulated.
- * Paxillæ-crowns forming definite areas. } *sacculatus*.
 Spinelets not prominent. }
- ** Paxillæ-crowns not forming definite areas.
 Spinelets very prominent.
1. Spinelets forming a raised keel over each radius. } *echinulatus*.
 Spiracula large, single, distributed. }
 2. Spinelets not forming a raised keel. } *carnosus*.
 Spiracula microscopic, in groups of 10 or more. }
- †† Muscular fibrous bands of dorsal membrane simply intercrossing.
- * Radial areas elevated in relief above the inter-brachial tissue. } *glaucus*.
 Paxillæ with three spinelets. }
- ** Radial areas not elevated above the interbrachial tissue.
 Paxillæ with more than three spinelets.
1. Radii broad. Aperture-papillæ simple *vicarius*.
 2. Radii attenuate. Aperture-papillæ comb-like.. *infernalis*.

C. Three ambulacral spinelets.

- † Muscular fibrous bands close, subdiffused, coherently reticulated.
- * Paxillæ-crowns forming definite areas in relief.
1. Paxillar elevations closely crowded. } *cælatus*.
 Spiracula uniformly distributed, not in lines. }
 2. Paxillar elevations widely spaced. [lines. } *crucifer*.
 Spiracula confined to interspaces, arranged in }
- ** Paxillæ-crowns not forming definite elevated areas.
- a. Ambulacral spines partially webbed. } .. *anomalus*.
 Three pairs of secondary mouth-spines. }
 - β. Ambulacral spines not webbed.
 Two pairs of secondary mouth-spines.
1. Meshes of dorsal membrane irregular and not uniform. } *latebrosus*.
 Ambulacral spines unequal. }
 2. Meshes of dorsal membrane small and uniform. } *porosissimus*.
 Ambulacral spines equal. }
- †† Muscular fibrous bands fine, definite, widely spaced, simply intercrossing.
- * Dorsal membrane with granular bodies *graniferus*.
- ** Dorsal membrane devoid of granular bodies.
- α. Ambulacral spines long and needle-shaped.. *geometricus*.

β. Ambulacral spines short and compressed.

- | | |
|--|------------------------|
| 1. Muscular fibres very numerous in dorsal membrane. | } <i>pullatus.</i> |
| Web of actinal floor with cross muscular fibres. | |
| Longest actino-lateral spine 12th. | |
| 2. Muscular fibres not very numerous in dorsal membrane. | } <i>membranaceus.</i> |
| No muscular fibres in web of actinal floor. | |
| Longest actino-lateral spine 17th. | |

D. More than three ambulacral spinelets.

- | | |
|---|--------------------------|
| 1. Ambulacral spinelets 3-4. | } .. <i>coccinatus.</i> |
| Aperture-papilla 5-7-rayed, comb-like, large. | |
| 1 pair of secondary mouth-spines. | |
| 2. Ambulacral spinelets 3-5. | } <i>præcoquis.</i> |
| Aperture-papilla simple, small and dumpy. | |
| 2 or 3 pairs of secondary mouth-spines. | |

HYMENASTER NOBILIS, *Wyville Thomson*.

Hymenaster nobilis, *Wyv. Thoms.* (1876), *Journ. Linn. Soc. Zool.* vol. xiii. p. 73, fig. 11; *Voy. of 'Challenger,' Atlantic*, vol. ii. p. 238, fig. 48.

Marginal contour pentagonal, interradial angles very slightly indented, the margin forming a continuous curve of small degree from tip to tip. Radii not produced, and tapering very slightly beyond the natural angle of a pentagon. The lesser radius is in the proportion of 71 per cent.; $R=138$ millim., $r=98$ millim. General form much depressed, slightly elevated in the centre of the dorsal area. Radial areas very conspicuously defined, the paxillar spinelets being exclusively confined to those areas, which consequently appear to stand at a higher level than the wide interbrachial areas, which are destitute of spinelets and covered with a thick fleshy membrane. Actinal surface flat, the margins of the furrows being rather tumid or convex.

Supradorsal membrane comparatively thin over the radial areas, and rather parchment-like in appearance. The paxillæ usually bear three spines, which are long, prominent, and arranged in triangle. Each spinelet raises the membrane into a sharp conical elevation, each maintaining its individuality, the subtriangular area in the centre of the paxillar crown remaining, however, more or less elevated above the general level. The paxillæ are arranged in regular longitudinal lines along the rays, three on each side of the median line, which is left free. The spinelets that compose the crowns are likewise remarkably uniform in disposition, two standing aboral to the third, which is opposite to their interspace; the base of the triangular crown-area thus formed is consequently at right angles to the median line of the ray, and the apex is

directed adorally. In the outermost row, however, on each side of a ray, this arrangement is more or less modified in consequence of lateral compression of the paxillæ-crowns—these being more compact and with the spinelets less regular in their disposition. The oscular orifice is large and very conspicuous, the valves composed of about a dozen moderately long, rather fine spinelets, all of which are webbed together; the valves expanding fan-like when opened, and forming a prominent vertical wall to the orifice. The spiracula are small, very numerous, closely and equidistantly placed, occupying the whole interspace between adjacent paxillar crowns. Very remarkable elongated tracts or lines of spiracula and an accompanying wrinkled membrane extend from the paxilliferous radial areas out upon the fleshy interbrachial membrane, which has the appearance of being inlaid with them. These lines are slightly curved, nearly equal in length to the half of the radial area, placed regularly parallel with one another and directed at an angle inward in relation to the direction of the ray.

Ambulacral furrows broad, almost straight, very slightly petaloid. Ambulacral suckers large and robust, arranged in simple pairs. Ambulacral spinelets, one to each plate, rather short, invested with a wide membrane which extends beyond the tip as a saccular prolongation twice as long as the spinelet itself. Aperture-papillæ large, fleshy, subspatulate or oval, occupying nearly the whole space between the bases of the actino-lateral spines.

Mouth-plates forming a broad rounded ridge at their line of junction, prominent aborally. Each plate bears one short secondary surface-spine with wide investing sacculus, placed about midway on the plate, quite behind the mouth-spines, the pair being very widely separated. Mouth-spines 3, short, conical, placed on the margin of the lateral flange of the plate, with saccular investments.

Actino-lateral spines about 45+ in number on each side of a furrow, hidden in the thick fleshy tissue, which forms little channels or wrinkles between each, giving a fluted appearance to the interbrachial area on the underside of the Starfish. The longest spines are little more than the extreme breadth of the ambulacral furrow—a wide space, greater at the margin than the length of the spines themselves, intervening in the interbrachial area between their extremities and those of the spines of the neighbouring ray. The spines are directed slightly backward (*i. e.* adorally in relation to the direction of the ray); and the series of those spines whose

extremities terminate in the ray-margin diminish very rapidly in length.

Colour in alcohol: Dorsal surface greyish-white, tinged with purple on the radial areas, the interradial areas and fringe being purplish grey. Actinal surface livid purple. Ambulacral suckers yellowish grey.

Station 158. Lat. $50^{\circ} 1' S.$, long. $123^{\circ} 4' E.$ Depth 1800 fms.; bottom temperature $0^{\circ} 3 C.$; *Globigerina*-ooze.

HYMENASTER FORMOSUS, n. sp.

Marginal contour subpentagonal, interbrachial angles very slightly indented, the lesser radius being in the proportion of 73.6 per cent.; $R=19$ millim., $r=14$ millim. General form depressed, dorsal area rising slightly conoid in the centre. Radial areas not specially defined, although to a certain extent indicated, the papillæ-spinelets being confined to the rays and not encroaching on the median interbrachial portion of the membrane. Marginal fringe very narrow, faintly crenulated, tips of spines rounded and thickened.

Supradorsal membrane semitransparent, with closely and regularly reticulated muscular fibrous bands, the bands (which are robust and massively coherent) forming definite meshes over the entire area. The disposition of the tendons is not in any definable relation to the spinelets. Each mesh is filled up with a fine transparent tissue, in the centre of which is a single large spiraculum, surrounded by a conspicuous white ring. Consequent on the number and regularity of the meshes, the whole area is closely and uniformly covered with spiracula.

The paxillæ are few in number and bear 3 to 5 (or more) robust spinelets, which are well expanded and distributed pretty uniformly over the area, excepting the median interbrachial space. The rounded tips of the spinelets do not protrude, but simply elevate the dorsal membrane into little rounded tubercles, which rise directly from the surface like warts, and, owing to their somewhat sparse distribution, impart a very characteristic appearance to the dorsal area of the Starfish. Over the median portion of the radii and towards their extremities the tubercles are very much smaller in size and are more closely placed. A conspicuous subpentagonal ring of tubercles surrounds the centre of the disk at the base of the valves of the oscular orifice, the spinelets of fifteen paxillæ contributing to its formation. The

paxillæ stand at the base of each valve, one forming the actual support of the valve, and the other two being placed external to this, one on either side. Usually two of the spinelets of each of the outer pairs of paxillæ radiate outwards and produce a very striking appearance on the dorsal area, as their whole outline and method of arrangement are perfectly discernible in consequence of the semitransparency of the membrane. The oscular orifice is of moderate size, the valves being subregular and closely reticulated.

The ambulacral furrows are narrow and more or less uniform in breadth, except at the extremity, where they taper rapidly, and near the actinostome, where they are also constricted. There is only one ambulacral spinelet to each plate, which is comparatively long and cylindrical, and invested with membrane which develops a more or less extended sacculus at the extremity. Aperture-papillæ elongate, not tapering, nearly uniform in breadth, rounded at the extremity, almost as long as the ambulacral spinelets, and presenting a robust appearance in consequence of the investing membrane.

The mouth-plates are comparatively small, short, and inconspicuous; and the small secondary surface-spine which stands on the median portion of each plate is moderately long and robust. The rest of the armature is indeterminable without damaging the specimen, in consequence of the extrusion of the stomach and other organs.

Actino-lateral spines regular and delicate, the twelfth from the mouth being longest. The spines preceding this one do not meet in the median interbrachial line, but are separated from those of the neighbouring ray by a uniform narrow space, across which muscular fibres pass from side to side, uniting the tips of the corresponding spines on either side. The tissue of the lateral web is thickened along the margin, especially over the extremity of each spine, to which it gives a rounded capitate appearance, the web having the very faintest trace of incurving between the spinelets. The thickening of the membrane just mentioned is much more pronounced in the arm-angle, where all indentation of the web is obliterated and indications are present of a tendency to excrescent growth. A further faint line of thickening can be made out at the union of the dorsal and ventral tissues, which occurs just within the margin, especially round the shaft of the spines.

Colour, in alcohol, greyish white.

Station 158. Lat. $50^{\circ} 1' S.$, long. $123^{\circ} 4' E.$ Depth 1800 fms.; bottom temperature $0^{\circ} 3 C.$; *Globigerina*-ooze.

HYMENASTER PERGAMENTACEUS, n. sp.

Marginal contour stellato-pentagonal; interradial angles moderately indented, although the actual angle is masked by an abnormal development of the actino-lateral spines, which meet there and form a peak, and an irregular excrescence of the web. The minor radial proportion is about 60.5 per cent.; $R=66$ millim., $r=40$ millim. approx. The radial areas are well defined from the lateral fringe, and taper rapidly at the extreme tip to a fine, slightly produced extremity, which is recurved. The "fringe" is more or less irregular, owing to the thickening at the margin and abnormal growth, and is only slightly indented or festooned between the spinelets, the tips of which are rounded and thickened.

Supradorsal membrane thin, smooth and vellum-like. Paxillæ comparatively few in number, bearing 5 to 8 spinelets, which are robust and widely expanded. Although these are in a certain sense regular in their distribution over the area, no definite pattern of arrangement is produced. The extremities of the spinelets do not protrude through the membrane, but simply elevate it into small eminences; and, owing to the thinness of the supradorsal membrane, the outlines of the spinelets which form each paxilla may be more or less clearly discerned. The radii are well defined; and no paxillæ-spinelets occur in the immediate interbrachial portion of the lateral fringe, nor do any spinelets encroach upon a narrow clear space which runs down the median line of each radius. The fibrous bands are very numerous and closely massed together; indeed so great is their development that nearly all individuality of fascicular character is obliterated and they appear to form a compact muscular tissue. In certain lines, however, along the sides of the rays there seems to be a tendency towards a greater and more definite development of fibres in a lineal direction, parallel with the median line of the ray. The spiracula are very few in number, quite microscopic, and occur in little groups of 6 to 10 which are widely and irregularly distributed. The oscular orifice is large, the valves when closed forming a cone of small elevation; and the spines which compose them are somewhat irregular both in number and gradation in size.

At the base of each valve is a rather close aggregation of paxillæ-spinelets, whereby a more or less complete annulus is formed around the orifice; and from each of the five groups in question proceed a number of spinelets, which radiate outward from the centre and constitute a conspicuous feature.

Ambulacral furrows very wide, subpetaloid, tapering to a fine extremity, and constricted slightly near the actinostome. Ambulacral spines, only one to each plate, long, cylindrical, tapering to a fine point, and placed on a small process projecting into the furrow. Aperture-papilla elongate, covered with very widely expanded membrane, imparting an acumino-spatulate form.

The mouth-plates are long and thin, the pair having the appearance of being pressed together laterally, projecting aborally in a prominent rounded keel, and sloping off somewhat plough-share-like towards the mouth. Two spinelets, similar to the general ambulacral series, only perhaps rather shorter, stand on the superficies of each plate, one on the sloping curve leading to the adoral margin, and one aboral to this and more outward in relation to the median suture-line of the plates. These spinelets appear greatly modified both in character and position from the usual robust secondary spinelets of the genus. The mouth-spines are represented by two spinelets, similar in all respects to the ambulacral spines, only rather shorter, placed on the horizontal margin of each plate, and close up to the junction with the first adambulacral plate.

Actino-lateral spines very long, the longest being about the 15th from the mouth. In the inner part of the ray they are comparatively delicate, when regard is had to the size of the specimen—increasing, however, in robustness as they proceed along the ray, those near the angle and the succeeding ones being strong and thick. The spines reach quite up to the median line of the interbrachial area; indeed in the outer half they pass beyond and overlap; whilst the longest spines, which fall in the actual arm-angle, are much longer than the distance between the median interbrachial line and the margin of the furrow. In consequence a prominent outward peak is produced in the place of the angle, the web being much contorted, and an abnormal growth not unfrequently taking place, which produces an unsightly excrescence as well as an irregular thickening of the tissue. The outer extremities of the actino-lateral spines are not pointed, but rounded; and the web-tissue is scarcely indented. Owing to the abnormal

growth both of spines and tissue in the interbrachial angle, and the tension produced thereby, the majority of the spines at the extremity of the ray are made to radiate inwards towards the angle, and the web appears considerably stretched.

Colour, in alcohol, yellowish grey.

Station 325. Lat. $36^{\circ} 44'$ S., long. $46^{\circ} 16'$ W. Depth 2650 fms.; bottom temperature $-0^{\circ} \cdot 4$ C.; grey mud.

HYMENASTER SACCULATUS, n. sp.

Marginal contour stellato-pentagonoid; interradial indentation small; rays usually recurved dorsally, making the dorsal area deeply concave, the ventral being convex. Minor radial proportion 66.6 per cent.; $R=42$ millim., $r=28$ millim. Radii tapering somewhat sharply at the extremities; marginal fringe distinct and well-developed.

Supradorsal membrane thick and coriaceous in appearance. Papillæ numerous, crowns with rarely more than 4 or 5 spinelets, which are prominently protrusive of the membrane,—that portion lying between the tips of each individual crown being thick, devoid of spiracula, and forming a slightly distended saccular area. Thick bands of tissue, with fibres, radiate between the crowns; and the narrow interspaces are occupied by numerous small spiracula, generally three or four, or even more, in line together, separated only by very fine, thin dissepiments. Oscular orifice large; valves 5 in number, regular, and forming, when closed, a compact exactly fitted pyramid, rising as a small cone in the centre of the concave dorsal area. The spinelets of the valves are of moderate length, thickly webbed, and with numerous spiracula in the interspaces.

Ambulacral furrows moderately wide, very uniform in breadth, except towards the extremity, where they taper rapidly, and near the mouth, where they are also somewhat constricted. Ambulacral spines 2, of moderate length, but with a very long sacculate investing membrane; the pairs standing slightly oblique to the median line of the ray. Aperture-papillæ large, thickly invested, subspatulate, slightly constricted near the outer third.

Mouth-plates elongate, largely keeled, prominent aborally, each plate bearing two short, thick, dumpy secondary surface-spines—one near the adoral extremity, and the other, of similar size and character, standing behind this, about midway on the surface of the plate. Mouth-spines 4, small, short, conical, on the lateral

margin of the plate, ranged serially above and behind the anterior pair of spines just mentioned, and interlocking with the corresponding spines of the neighbouring mouth-angle.

Actino-lateral spines numerous and very closely placed, the longest spine far out upon the ray,—a much greater number being included within the disk-angle than usual. About 40 spines stand on each side of a ray, the 20th or 21st from the mouth being longest. The spines within the disk are comparatively short and uniform in length, and do not quite meet in the median interbrachial line; muscular fibres, however, may frequently be seen underlying the outer tissue, passing from the tips of the lateral spines to the corresponding ones of the neighbouring ray. In the immediate arm-angle, however, the spines are longer than the space between the angle and the furrow; so that a considerable overlap takes place, and a consequent puckering and deformity of the tissue ensues, which appears to develop frequently into an unsightly excrescence. The spinelets succeeding to the long ones taper very rapidly in size towards the extremity of the ray.

Colour, in alcohol, brownish white or grey.

Station 158. Lat. $50^{\circ} 1' S.$, long. $123^{\circ} 4' E.$ Depth 1800 fms.; bottom temperature $0^{\circ} 3 C.$; *Globigerina*-ooze.

HYMENASTER ECHINULATUS, n. sp.

Marginal contour pentagonoid; interradial angles moderately indented, the lesser radius being in the proportion of 72·7 per cent.; $R=22$ millim., $r=16$ millim. The radii are sharply tapered at the extremity, although when seen from above the angles of the pentagon have the appearance of being well-rounded, in consequence of the outspreading and graceful curve of the marginal fringe; this is nipped together laterally at the extreme tip, and a slight upward continuation of the furrow is produced thereby. Form depressed, dorsal area slightly conoid, interradial spaces considerably sunken.

Supradorsal membrane thick and opaque, with very robust broad muscular fibrous bands, closely but irregularly reticulated, the interspaces being small, usually oval, and each occupied by a single spiraculum. Paxillæ rather widely spaced, the tips of the spinelets forming prominent little conical peaks or elevations of the membrane, which on certain parts of the area conform themselves to a regular definite order of arrangement. A curved

row or ridge of these spinelets stands on either side of the median line of a ray, forming a petaloid elevated area, which corresponds with the position of the underlying ray, and imparts a very characteristic facies to the species. A prominent circle surrounds the oscular orifice, marking out in a subpentagonal outline the place of the attachment of the valve-spines. The oscular valves are five in number, composed of rather short radiating spines, forming regular triangular fans, the web which unites them being reticulated in a similar manner to the rest of the dorsal membrane. The valves, when closed, form a prominent pyramidal peak in the centre of the disk. The reticulated dorsal membrane reaches close up to the margin of the lateral fringe.

Ambulacral furrows distinctly petaloid. Ambulacral spines 2, rather short, placed side by side well up in the furrow, and forming a straight line parallel therewith. The spines of a pair radiate slightly apart from one another in the plane of their position; and each is covered with a thick semitransparent membrane, which is somewhat expanded opposite the outer third of the spine, imparting thereby an elongate subspatulate form, the adoral spine of a pair being more robustly so than its companion. Aperture-papillæ small and short, suboval in form on the inner portion of the ray, but becoming more elongate as they recede from the mouth.

Mouth-plates small, with strongly developed ridge at the line of junction, and prominent peak aborally. Each plate bears two short, robust, conical secondary surface-spines, one placed near the adoral extremity, and the other about midway along the ridge; both spines are nearly equal in length, not longer than the ambulacral spines, very wide at the base, and taper to a blunt extremity, faintly bowed outward, and the tip approximated to the tip of the corresponding spine on the companion plate. Mouth-spines 3, small; two situated at the extreme outer portion of the lateral margin, one more inward.

Actino-lateral spines about 24 on each side, 8th or 9th from the mouth longest. The spines anterior to this are included within the disk, their extremities reaching almost, but not quite, up to the median interbrachial line. The succeeding spines diminish in length gradually as they proceed outward, and even towards the extremity remain comparatively long in comparison with those of the other members of the genus. The actino-lateral spines are very robust, and taper slightly to the tips, which project

well beyond the membrane, and give the appearance of a sharply indented margin. The web of the actino-lateral spines, which also forms the ventral floor, is made up of very thickly packed, fine, delicate crossing fibres.

Colour, in alcohol, light brown above, pure white beneath.

Station 286. Lat. $33^{\circ} 29' S.$, long. $133^{\circ} 22' W.$ Depth 2335 fms.; bottom temperature $0^{\circ} 8 C.$; red clay.

HYMENASTER CARNOSUS, n. sp.

Marginal contour substellate; interradial angles well defined, the lesser radius in the proportion of 58.2 per cent.; $R=103$ millim., $r=60$ millim. Radii tapering regularly to the extremity. Dorsal area slightly convex, rising somewhat conoid in the centre, radii rather roundly arched. Actinal area flat or convex. A narrow, thick, fleshy conspicuous fringe surrounds the entire margin.

Supradorsal membrane thick, fleshy, opaque. Paxillæ-spinelets uniformly and closely distributed over the whole area, greatly protruding and covered with membrane, which gives them the appearance of broad-based, robust, conical thornlets, about 3 to 4 millim. in height, springing from the general surface. They are very uniform in size; and no definite order of arrangement is perceptible, nor is it possible to distinguish the individual crowns to which the spinelets belong. A more or less homogeneous muscular layer overspreads the whole area; and no specialized bands or fibres are superficially apparent. The spiracula are quite microscopic, and confined to small round groups, containing ten or more very closely crowded together, placed in the hollow interspaces between the spinelets, and the whole quite invisible to the naked eye. Ocular orifice large, with valves broad and squarely truncate at the extremity, all webbed together; the prominent thorn-like spinelets above mentioned marking out a circle at their bases of attachment 24 millim. in diameter.

Ambulacral furrows wide (8.5 millim.), nearly uniform in breadth until near the extremity, where they gradually converge. Sucker-feet numerous and closely crowded, but maintaining the regular biserial arrangement. Ambulacral spinelets 2, long and needle-shaped, placed side by side in line with the margin of the furrow, or the very slightest trace oblique. The adoral spinelet is somewhat the longest; and both are invested with an extensive saccular membrane, extending beyond the extremity,

often to a length equal to that of the spinelet itself. Aperture-papillæ moderately large, elongate and suboval. A fleshy thickening or pad is developed on the surface that fits over the aperture, upon which it closes like a valve.

The mouth-plates are of moderate size, widely expanded laterally, the keel along the junction being well developed, prominent aborally, and with a rather produced peak adorally. Two secondary surface-spines on each plate—one near the adoral extremity, the other, shorter and more robust, midway on the plate and with wide-flaring investment. It is a question whether the anterior pair ought not, from their position, to be ranked with the true mouth-spines. Mouth-spines proper 3 to 4 in number, acicular, and placed on the margin of the lateral flange.

Actino-lateral spines closely placed, and entirely hidden in the thick fleshy membrane with which the ventral interbrachial areas are uniformly covered. 50 to 60 spinelets on each side of a ray.

Colour, in alcohol—dorsal surface purplish grey, actinal surface pinkish purple.

Station 295. Lat. $38^{\circ} 7' S.$, long. $94^{\circ} 4' W.$ Depth 1500 fms.; bottom temperature $1^{\circ} 4' C.$; red clay.

HYMENASTER GLAUCUS, n. sp.

Marginal contour stellato-pentagonal; interradial angles well indented, forming a distinct angle, except in very large specimens, where the web has become somewhat overgrown and abnormally thickened. Minor radial proportion from 68 to 76 per cent.; $R=46$ millim., $r=35$ millim. The rays taper to a fine extremity; and the web is rather full on the margins, and somewhat irregular in consequence. General form very depressed. On the dorsal surface the radial areas are well marked out, distinct from the fringe and interbrachial membrane, by a regular linear arrangement of paxillæ-spinelets, the radial areas being elevated above the general surface. The pseudo-sides of the rays are short and perpendicular; the rays themselves having the appearance of standing in relief above the superficies of the marginal and interbrachial web, tapering to a fine point, and maintaining their distinctness up to the very extremity. The lateral web or fringe is largely developed, and, being rather full, is in consequence somewhat irregular.

Supradorsal membrane with very numerous muscular fibres,

which radiate from the tips of the spinelets and pass to those standing in close proximity around, the bands crossing at various angles, overlying and underlying one other, and forming an interlacing tissue rather than a truly reticulated structure. Spiracula moderately large, irregularly placed, and not numerous. Paxillæ with seldom more than three spinelets, which are usually aggregated close together, and especially so along the median line of the ray and at the extremity, forming a crown of small expansion. Towards the disk the spinelets are more widely spaced; and the paxillæ, which form the pseudo-sides of the ray, are disposed in a perfectly straight line, no stragglers encroaching on the web or interbrachial area.

Oscular aperture large and conspicuous; valves regular and formed of comparatively few spinelets, seldom more than a dozen in each. The outer margin of the oscular ring is very strikingly marked out by short, prominently protruding, pointed spinelets, excentrically directed, very regularly disposed, and from the tips of which the membrane hangs in graceful folds.

Ambulacral furrows moderately broad, sublanceolate in outline, fairly uniform in width, except near the mouth, where they are constricted, and along the outer fifth, where they taper rapidly up to the extremity. Ambulacral spinelets 2, short, acicular, pointed, covered with membrane forming a moderately developed terminal sacculus. In some specimens this appears to be much more developed in the adoral spine of the pair than in the aboral, which seems frequently to be smaller than the other. The aboral spine is also placed higher in the furrow than the adoral. Aperture-papillæ large, and, with their investment, broadly lanceolate or acumino-spatulate in form.

Mouth-plates short and rather broad; aboral prominence blunt and well-rounded. Each plate with two very short, robust, stumpy secondary surface-spines; the adoral one (which is placed forward on the plate) shorter even than the mouth-spines proper, but much more robust. Mouth-spines proper 4 or 5 on each plate, rather long, fine, and nearly equal in length.

Actino-lateral spines robust, well-spaced, the 14th or 15th from the mouth being longest. None meet in the interbrachial median line, not even the longest, the space being filled in with fleshy membrane.

Colour in alcohol—dirty white in large specimens, greenish grey in those of smaller size.

Station 235. Lat. $34^{\circ} 7' N.$, long. $138^{\circ} 0' E.$ Depth 565 fms.; bottom temperature $3^{\circ} 3 C.$; mud.

HYMENASTER VICARIUS, n. sp.

Marginal contour subpentagonal; interradial angles well indented, the lesser radius being in the proportion of 69.2 per cent.; $R=39$ millim., $r=27$ millim. The lateral fringe is more or less distinct; and its margin forms a line that curves outwards after passing the middle of the ray, adding greatly to the appearance of its breadth; the margin then suddenly contracts and emphasizes the rapid tapering of the ray at the extremity.

Supradorsal membrane thin and papyraceous in appearance. Muscular fibres numerous and irregular, rather thick, closely placed, radiating from the tips of each spinelet to those around, and thus forming an interlacing web with moderately large meshes of rhomboid or quadrate form. The interspaces are filled in with transparent membrane, punctured in the centre by a spiraculum; these are moderately large, well-spaced, and uniformly though irregularly distributed over the dorsal area. Paxillæ numerous,—carry 4, 5, or 6 spinelets, which are rather short, pointed—their tips elevating the membrane into small pointed papillæ, which are very evenly spaced over the dorsal area and appear to rise sharply from the surface, whilst their small size and comparative closeness of position give an easily recognizable character to the Starfish.

Ambulacral areas moderately broad, lanceolate in outline, tapering rather rapidly before they reach the extremity, which is in consequence somewhat produced. Ambulacral spines two, rather short, cylindrical and pointed, covered with an extensive investing membrane, which forms an elongate sacculus at the tip, and also adds greatly to the apparent robustness of the spinelets. Aperture-papillæ large, acumino-spatulate, wide and rotund at the base, often contracting rapidly to a point at the free extremity, or simply rounded.

Mouth-plates small, elongate, narrow, keeled, prominent aborally, each bearing two short robust secondary surface-spines, one near the adoral extremity, and the other placed more aborally, near the middle of the plate. The horizontal margins of the plate which fall into the actinostome are expanded into a rather wide flange, upon the edge of which are situated 4 or 5 short

cylindrical mouth-spines, slightly curved, rounded at the tips but not tapering.

Actino-lateral spines delicate, those included within the disk being short and not reaching up to the median interr radial line, but leaving a rather wide space. The longest spine is about the fifteenth from the mouth; but even these do not meet in the arm-angle, where a considerable amount of thickening and deformity of the membrane occurs. The tips of the spinelets are rather tapering, and not thickened or nobbed. Margin of the web slightly thickened, not indented or festooned.

Colour in alcohol, white, tinged with yellow where the membrane is thickened in the arm-angles. Sucker-feet yellow.

Station 300. Lat. $33^{\circ} 42' S.$, long. $78^{\circ} 18' W.$ Depth 1375 fms.; bottom temperature $1^{\circ} 5 C.$; *Globigerina*-ooze.

HYMENASTER INFERNALIS, n. sp.

Marginal contour substellate; interr radial angles well indented and somewhat angular, the lesser radius being in the proportion of 43 per cent.; $R=28$ millim., $r=12$ millim. approximately. Radii broad at the base, but greatly attenuated outwardly. General form depressed.

Supradorsal membrane very thin. Paxillæ having long pedicels, with 8 to 10 elongate delicate spinelets. Muscular fibres extremely fine and thread-like, rather numerous, radiating from the tips, which are more or less prominent, suggesting the character of the same structure in *H. pullatus*, the fibres, however, being much more delicate and less numerous. Spinelets forming the valves of the oscular orifice rather robust.

Ambulacral furrows narrow. Ambulacral spines 2, long and needle-shaped, placed slightly oblique to the line of the furrow. Innermost aperture-papillæ very large and comb-formed, composed of a number of radiating shafts. Adambulacral plates elongate.

Mouth-plates with prominent and rather angular keel along line of juncture, and bearing two short and moderately robust superficial secondary mouth-spines, the anterior pair close to the adoral margin. Several (three or more) mouth-spines on the margin of the lateral expansions.

Actino-lateral spines short, robust, and placed wide apart, the 6th or 7th from the mouth being longest. Character

along the free portion of the ray indeterminable. Actinal membrane with numerous fine muscular fibres.

Unfortunately this delicate specimen has been so shattered and distorted that its present state of preservation will not admit of a satisfactory description. This difficulty of study is the more to be regretted as the form is one of the deepest-dwelling Asterids obtained during the Expedition. The characters above enumerated are sufficient, however, to indicate that the species under notice is clearly distinct from any other in the group. The attenuation of the rays, the number and delicacy of the paxillæ-spinelets, and the characters of the actinal surface readily distinguish the form. On these grounds I have deemed it advisable to establish the species, although loth to do so on such imperfect material.

Station 244. Lat. $35^{\circ} 22'$ N., long. $169^{\circ} 53'$ E. Depth 2900 fms.; bottom temperature $1^{\circ} 2$ C.; red clay.

HYMENASTER CÆLATUS, n. sp.

Marginal contour stellato-pentagonoid; interradial angles sharply indented, the lesser radius being in the proportion of 63·3 per cent.; $R=30$ millim., $r=19$ millim. The dorsal area is concave, the radii being curved upward and their extremities recurved and quite turned over; actinal area very convex. The radial areas are well marked out, the lateral margins converging gradually to the tip, which is not attenuated or produced. A secondary membrane extending beyond the actino-lateral spines forms a conspicuous fleshy fringe.

Supradorsal membrane rather thick. Paxillæ with 4 to 5 spinelets, forming regular crowns, which elevate the membrane into rhomboid or pentagonal areas, raised in relief as it were, and closely placed, the margins of the tabulæ being more or less incurved, and the interspaces between deep and furrow-like. Muscular fibres closely interwoven, bands ill-defined, and meshes irregular; spiracula small, and frequently two or more together—this structure being uniform over elevated areas and interspaces alike. Tips of the paxillæ-spinelets only slightly protuberant; the relief-areas which fall in the margin of the ray are smaller, more compressed, and somewhat modified in form from the others. About 7 longitudinal rows of elevated areas or tabulæ may be counted at the base of a ray.

Oscular orifice small, circumference at the base of the valves pentagonal, 9·25 millim. in diameter, and marked out by spinelets.

Valves 5, very regularly triangular, apices sharply pointed, all webbed together, the whole forming a regular pyramid when closed. The two innermost spines of each valve stand somewhat apart, and the membrane is rather deeply drawn in between, producing a well-defined furrow along the median line. The projecting tips of spinelets are prominent at the sides of the valves. At the base of each valve are two large elevated areas, formed by paxillæ-crowns of 6-8 spinelets, and thus nearly twice the size of the other elevated tabulæ upon the dorsal surface: they are subpentagonal in shape; and the ten form a conspicuous and well-defined circlet round the oscular pyramid.

Ambulacral furrows rather wide, straight, uniform in breadth, except at the extremity, where they rapidly converge. Ambulacral spines 3, very short, cylindrical, slightly tapering, covered with membrane, placed in line oblique to the furrow. Aperture-papillæ large and subcircular, with its investing membrane somewhat Japanese fan-shaped. The calcareous portion of the papilla is very flaring in habit, sometimes appearing as if made up of a comb of radiating spinelets.

Mouth-plates small, short but broad, with widely-expanded lateral flanges, broadly rounded in front, keel along line of junction feebly developed, aboral extremity only slightly prominent. Two secondary surface-spines borne on slight tubercles, one near the adoral extremity, and the other near the middle of the plate. These spines are short, comparatively small, broad at base, and taper slightly at the tip—the adoral pair being rather the smaller, and not much larger than the ambulacral spines. Mouth-spines 3, similar in size and form to the ambulacral spines, arranged on the lateral margin of the plate and away from the adoral peak of the keel.

Actino-lateral spines widely spaced, the difference in the length being comparatively small along the inner two thirds of the ray. About 27 spines on each side of a ray, the 6th or 7th from the mouth slightly longest. None of the spines meet in the inter-brachial median line, but are widely separate; they are covered with a thick fleshy tissue, which is slightly turned over the tips of those spinelets that fall beyond the arm-angle, and is then extended in the form of a fleshy supplementary web or fringe, which is very conspicuous in the arm-angle, and extends up to within a short distance of the extremity of the ray, gradually diminishing in breadth as it proceeds outwards. The margin of

this supplementary fringe is thickened, and furnished with a powerful muscular band.

Colour, in alcohol, a rather livid pink; ambulacral furrows and sucker-feet a yellowish white.

Station 158. Lat. $50^{\circ} 1' S.$, long. $123^{\circ} 4' E.$ Depth 1800 fms.; bottom temperature $0^{\circ} 3 C.$; *Globigerina*-ooze.

HYMENASTER CRUCIFER, n. sp.

Marginal contour subpentagonal; interradial angles very slightly indented, the lesser radius being in the proportion of 66.6 per cent.; $R=51$ millim., $r=34$ millim. Radii tapering to a fine extremity, which is somewhat attenuated and produced. Marginal fringe comparatively insignificant as seen from above, and narrowing rapidly towards the extremity of the rays. Form depressed, more convex on the actinal than on the abactinal surface.

Supradorsal membrane rather thin, muscular fibres numerous, thick, and radiating regularly from the tips of the spinelets. Paxillæ numerous, though somewhat widely spaced, bearing a crown of four or sometimes five spinelets, which usually elevate the membrane into slightly raised, Maltese-cross-shaped areas. The spinelets are sharply prominent; and the fibres for a short distance around the tip are merged together and form a homogeneous "cap;" the caps of each of the spinelets of a crown coalesce, and thus produce the subcruciform or rhomboid elevations above mentioned. The paxillæ are well spaced, and are arranged in longitudinal lines along the rays. No spiracula occur on the raised areas; but in the intermediate spaces they are very numerous and closely placed, the intervals between the thick radiating bands being very narrow, and occupied by a great number of small spiracula placed close together in line, 4 to 8, or even more in each, and separated from one another by only the finest dissepiment. The numerous spiracula and the isolated unpunctured cruciform areas give a striking character to the dorsal surface. The oscular orifice is large, the valves all webbed together, and the spinelets quite hidden in membrane, the whole of which is uniformly punctured with a great number of small spiracula, not quite so closely placed as those on the disk, and not arranged in lines.

Ambulacral furrows rather widely petaloid, rapidly constricted at the extremity. Ambulacral spines three, short, nearly uniform in length, pointed, and covered with a membrane expanded into

a lanceolate shape, but with no terminal saccular prolongation. Each series of spines is placed diagonally upon its plate, or oblique to the line of the furrow. Aperture-papillæ large and broadly subspatulate or even subrhomboid, expanded somewhat obliquely, the pedicel seeming to be attached rather on one side.

Mouth-plates rather broad, prominent aborally, having 5 or 6 short mouth-spines attached to the lateral aliform extensions, and directed horizontally. Two short, robust, subconical secondary mouth-spines are borne on the superficies of each plate—one near the adoral extremity, and the other, which is thickest, placed midway between this spine and the aboral extremity of the mouth-plate.

Actino-lateral spines long and well spaced, about 40 on each side of a furrow, the 11th or 12th from the mouth being longest. The spines within the disk do not quite meet in the median inter-radial line; and those along the outer third of the ray diminish in length very rapidly; they are, however, rather irregular in their length throughout, which gives a ragged appearance to the fringe. The spines are pointed at their extremity; and the web is very slightly indented between.

Colour, in alcohol, yellowish grey.

Station 158. Lat. $50^{\circ} 1' S.$, long. $123^{\circ} 4' E.$ Depth 1800 fms.; bottom temperature $0^{\circ} 3 C.$; *Globigerina*-ooze.

HYMENASTER ANOMALUS, n. sp.

Marginal contour stellato-pentagonal; interradial angles wide and rather sharply and angularly indented, the lesser radius being in the proportion of 63–65 per cent.; $R=15$ millim., $r=9.5$ millim. approximately. Radii subtriangular in outline, and tapering to a fine extremity. Form very depressed, only slightly elevated in the centre of the disk. Marginal fringe quite inconspicuous when seen from above.

Supradorsal membrane with uniformly thick fibrous bands closely reticulated, the network exhibiting a certain incipient regularity of construction. The meshes or interspaces are large and equidistant; and a more or less distinct grouping round centres is distinguishable, where the fibres become massed together—these thickened portions corresponding usually with the tips of the spinelets, upon which they form a cap. Six to eight bands usually radiate from these centres; and if the plan just indicated were regularly carried out, an arrangement of more or less dis-

tinctly hexagonal compound meshes, divided by fibres radiating from their centre, would be produced—one primary mesh around each spinelet, and secondary meshes within this, formed by each of the radiating fibres. This disposition of reticulation, however, is by no means regular, as numerous supplementary meshes and centres occur. The meshes are usually circular, oval, or sub-triangular in outline, and are filled in with a fine semitransparent membrane, punctured in the centre with a minute spiraculum, which is surrounded by an opaque whitish ring. The dorsal membrane and its system of reticulated fibres extends almost up to the extreme edge of the lateral fringe. The tips of the paxillæ-spinelets produce slight, uniform, rounded elevations of the membrane, distributed over the whole dorsal area, to which they give a papillose or coarsely granulate appearance when seen by the naked eye. Ocular orifice small, the circumference at the base of the valves being circular and well marked out. The spines of the valves are webbed together by an investing membrane, with reticulated fibres, into five regular, triangular fans, the margins slightly overlapping, and, when shut down, completely closing the ocular orifice.

Ambulacral furrows lanceolate, scarcely, if at all, expanded in the middle, and gradually tapering to the extremity. Ambulacral spinelets 3, short, and placed obliquely—the two outermost standing almost at right angles to the furrow, the innermost, which is slightly smaller, being placed rather in advance of, or aboral to, these latter. The spines are invested with an extensive transparent membrane; and frequently two, or even all the three, are webbed together. When single, the covering gives them a broadly lanceolate shape. The aperture-papillæ are very small and elongately oval in form.

Mouth-plates small, the pair forming a prominent though narrow ridge. Each plate carries three very robust, blunt, secondary superficial spinelets placed in line along either side of the keel, the anterior pair near to the adoral extremity, and the posterior pair near the aboral extremity of the mouth-plate. They differ slightly in size, the adoral being smallest and the aboral largest. On the horizontal margin of each plate are two mouth-spines, the innermost pair immediately above the anterior secondary spinelets, of which series they seem to form the continuation, being directed downwards and centripetally. The aboral pair of secondary spinelets are directed centrifugally. The

second, or outer, mouth-spine is very much smaller, and placed away from the inner mouth-spine, somewhat isolately on the margin of the plate, and is directed horizontally.

Actino-lateral spines about 21 on each side (of fairly large ones only 18), the 6th from the mouth being longest; this and all the spines preceding it join close up in the median interrarial line with the corresponding spine of the neighbouring ray, whilst the succeeding spines diminish by regular steps. Spines tapering and pointed. Membrane made up of very fine fibres; margin very slightly festooned between the tips of the spines.

Colour, in alcohol, white; ambulacral furrows and sucker-feet yellowish brown.

Station 335. Lat. $32^{\circ} 24'$ S., long. $13^{\circ} 5'$ W. Depth 1425 fms.; bottom temperature $2^{\circ} 3$ C.; *Globigerina*-ooze. Also off coast of Portugal; label marked 'Station I.-VII.'

HYMENASTER LATEBROSUS, n. sp.

Marginal contour substellate; interrarial angles sharply indented, the lesser radius being in the proportion of 63.6 per cent.; $R=22$ millim., $r=14$ millim. Arm-angle acute; rays broad and subtriangular, with their margins gracefully curved outward. General form depressed; dorsal surface over the radii more or less bombous; radial areas not specially defined. Dorsal membrane continuous up to the margin; lateral fringe narrow, regular, and sharply indented.

Supradorsal membrane fine and semitransparent. Paxillæ-spinelets uniformly distributed over the entire area, but presenting no definite order of arrangement. Paxillæ with few spinelets, 4 to 5 being the general number. Muscular fibres numerous and closely, though rather coarsely and irregularly, reticulated (intercrossed). Interspaces filled in with a delicate semitransparent membrane, punctured with spiracula, usually one to a mesh, and consequently rather widely spaced. Oscular orifice comparatively small, the valves lying almost level with the surface of the dorsal membrane.

Ambulacral furrows moderately broad, and subpetaloid in outline, tapering gradually to the extremity along the outer third of the ray, and slightly constricted towards the actinostome. Ambulacral spines 3 in number, short, cylindrical, rapidly tapering to a fine point, and covered with thin membrane. Each series is placed high in the furrow, and very oblique to the median line of

the ray; the aboral spinelet is much smaller than the other two, of which the adoral is slightly the longest. Aperture-papillæ small and oval or subcircular in form, sometimes expanded laterally to such an extent that the breadth is greater than the length.

Mouth-plates comparatively small and short; keel prominent, having a rhomboid outline when seen from above, and inclined upwards into the mouth-cavity, with rather widely expanded lateral flanges, straight and square in front. Each plate bears two robust secondary spines, one on the middle of its surface, standing in the lateral angle of the rhomb, and another, comparatively smaller and thinner, placed near the adoral extremity. Mouth-spines proper are represented by three small tapering spinelets placed on the lateral margin of each plate.

Actino-lateral spines robust and of moderate length, the 7th to 9th from the mouth being longest. The spines of two adjacent rays do not quite meet in the median interradial line, a little narrow channel or wrinkle of the membrane being maintained between their tips. The spines diminish regularly in length after the angle is passed, until they become microscopic at the end of the ray; they are pointed at their outward extremity; and the web being well indented between gives a serrate appearance to the margin.

Station 157. Lat. $53^{\circ} 55' S.$, long. $108^{\circ} 35' E.$ Depth 1950 fms.; diatom-ooze.

HYMENASTER POROSISSIMUS, n. sp.

Marginal contour subpentagonal; interradial angle scarcely indented, forming simply a slight curve inward. The lesser radius is in the proportion of 75.5 per cent.; $R=45$ millim., $r=34$ millim. The radii do not taper beyond the extent of a true pentagon, and are slightly rounded at the extremity, which is somewhat feebly upturned.

Supradorsal membrane very uniformly reticulated; the muscular fibres so closely and regularly placed that their radiation from the spinelet-tips as centres is scarcely apparent; meshes very small and regularly spaced, each with one small spiraculum. Paxillæ-spinelets 3, 4, or 5 in number, evenly spaced, rounded at the tips, very slightly prominent, and producing a uniformly papillate appearance on the dorsal area, no general pattern of arrangement being discernible. The crowns of a great number of the paxillæ

form a more or less distinctly visible Maltese cross, in consequence of two prominent fibres joining the tips of the opposite spinelets. Oscular orifice moderately large; circumference at the base of the valves very clearly marked out by prominent spinelets. Valves triangular, 5 in number, forming a regular pyramid; the whole series webbed together with a membrane closely punctured with spiracula like the rest of the dorsal area, and with 2 or 3 prominent spinelets projecting along the sides of each valve.

Ambulacral furrows rather wide, subpetaloid, or gracefully lanceolate. Ambulacral spines 3, short, delicate, slightly tapering, nearly equal in length, covered thinly with membrane, but with no saccular extension present. Each series placed slightly oblique to the median line of the ray. Aperture-papillæ large and squarely oval, with a thick plump sacculus, and attached close up to the outer extremity of the diagonal series of ambulacral spinelets.

Mouth-plates very elongate and remarkably narrow, the pair together forming a prominent, elevated, rounded ridge, tapering and roundly pointed at either extremity. Near the adoral extremity of each plate stands a single, rather large spine, subconical, becoming attenuated towards the extremity, but not pointed. These spines are directed horizontally over the peristome, the pair in each mouth-angle diverging slightly apart from one another and away from the median line of the mouth-plates; these are the anterior pair of secondary mouth-spines, placed unusually forward. From the superficies of each mouth-plate, and about one third from the inner or adoral extremity, rises a second, robust, subconical, and moderately long spinelet, directed downwards and slightly inwards. Both these pairs of secondary superficial spinelets are about equal in length to the ambulacral spinelets, but are more robust, the aboral being stouter but rather shorter than the companion pair. Mouth-spines 4 or 5, short, subcylindrical, thickened at their bases, placed on the margin of the plates, and directed horizontally. These spines are much smaller and shorter than the secondary superficial spines above noted, and are attached to a wide lateral extension or flange of the mouth-plate.

Actino-lateral spines long and rather widely spaced, the longest about midway out on the ray (the eleventh from the mouth); about 40 in all. The spines within the disk come nearly up to the median interradiial line, but do not meet. The spines whose free extremities fall in the marginal fringe diminish gradually

and with regularity up to the extremity, the few last maintaining, however, a nearly uniform length, which gives a rounded appearance to the fringe at the ray-tips. The actino-lateral spines are finely pointed at their extremities; and the web-membrane is moderately indented between them. The marginal fringe is perfectly even and regular, forming a conspicuous marginal border when seen from the upper surface, although the reticulated dorsal membrane is continued close up to the margin.

Colour, in alcohol, greyish white.

Station 300. Lat. $33^{\circ} 42' S.$, long. $78^{\circ} 18' W.$ Depth 1375 fms.; bottom temperature $1^{\circ} 5 C.$; *Globigerina*-ooze.

HYMENASTER GRANIFERUS, n. sp.

Marginal contour almost pentagonal, the interradial angles being very slightly incurved. The radii are more or less attenuated or produced at the extremity, which is upturned; and their effect on the contour is consequently inconspicuous. Minor radial proportion about 69–73 per cent.; $R=30$ millim., $r=22$ millim. Radial areas not specially defined externally from the rest of the dorsal surface. Lateral fringe or web thickened at the margin and little conspicuous.

Supradorsal membrane delicate. Paxillæ-spinelets delicate, with fine sharp extremities protruding well through the dorsal membrane, evenly distributed over the area, but presenting no definite pattern of arrangement. The fibrous bands are rather thin but clearly defined, comparatively few in number, well isolated, and radiate not only to those spinelets which form the immediate circle, but some also pass through the interspaces and reach to the spinelets beyond. In this manner a more or less irregular and very open network is produced, in which, however, a tendency to an interpenetrant hexagonal pattern is discernible as the general plan, here and there—the whole being overlain by a very delicate semitransparent membrane, in which a number of small, round, closely-placed granule-like bodies occur. The spiracula are small and sporadically placed, very frequently two or even three together in a mesh; but the groups are well isolated, and the apertures by no means numerous. Ocular orifice large, with 5 regular valves fitting evenly together, each with about a dozen spines, the two innermost being longest, and the others diminishing regularly and gradually, the articulatory base being prominent.

Ambulacral furrows narrow, much constricted towards the actinostome and at the extremity of the ray. Ambulacral spines 3, acicular, unequal in length, rather short, placed in line parallel to the median line of the furrow, excepting towards the extremity, where the series become rather oblique. The aboral spine is almost aborted, and the middle one less than the adoral spine of the trio; this latter is invested with a widely expanded sacculus, which makes the spine appear many times thicker than its companion and nearly twice as long, the large sacculus usually taking a pointed or sublanceolate form, whilst the small investment of the aborted aboral spine is generally rounded and somewhat knobbed. The aperture-papilla is remarkably large, elongately oval, and with its membrane acumino-spatulate in shape, much broader than the sacculated ambulacral spinelets, and often nearly as long.

Mouth-plates short and comparatively broad, with widely expanded lateral flanges. No prominent keel at the line of junction, which is flatly rounded. Two robustly clothed, rather short, obtuse secondary surface-spines on each plate, one near the adoral edge, the other near the middle of the plate, both maintaining a wide space between their corresponding spines on the adjoining plate. About four mouth-spines proper on the horizontal margin of each plate, moderately long, very wide at the base, and sharply tapering; the external one sometimes reduplicated.

Actino-lateral spines delicate, well spaced, the longest about 15th from the mouth; none meet in the interradial line, but are widely separate even at the angle; the spines vary but little in length up to this point, but diminish very rapidly beyond.

Colour, in alcohol, white.

Station 146. Lat. $46^{\circ} 46'$ S., long. $45^{\circ} 31'$ E. Depth 1375 fms.; bottom temperature $1^{\circ} 5$ C.; *Globigerina*-ooze.

HYMENASTER GEOMETRICUS, n. sp.

Marginal contour substellate; interradial angles well rounded, the lesser radius being in the proportion of 52.3 per cent.; $R=42$ millim., $r=22$ millim., approximately. Radii greatly attenuated and tapering, with the fringe almost, if not quite, aborted towards the extremities. Dorsal surface uniformly flat; under surface prominently convex.

Supradorsal membrane thin and semitransparent, supported

by extremely delicate thread-like fibres, which form a regular pattern upon the disk. Usually six fibres proceed from the tip of each paxilla-spinelet, and pass to the tips of the neighbouring spinelets; and as these are all equidistant, it follows that a series of regular interpenetrant hexagons is produced. The fibres are all of uniform length, and do not cross over or under one another as in *H. pullatus*. The spaces marked out or bounded by the fibres form regular triangular meshes, and enclose several small spiracula, generally 3 to 5. Sometimes the fibres are doubled, and the tips of the spinelets protrude prominently.

The valves of the oscular orifice are not conspicuous, the general tissue of the dorsal area just described seeming to be continued up to the extremities of the valves, whilst their bases of attachment, which are usually well marked out by spinelets on prominent bosses, are undistinguishable in the present example.

Ambulacral furrows rather narrow, not petaloid. Ambulacral spines 3, long and needle-shaped, placed in line parallel with the median line of the ray; the adoral spine longer than the breadth of the furrow.

Aperture-papillæ of moderate size, subquadrate or rather elongate in shape, when invested with membrane.

Mouth-plates short, with wide lateral flanges; the keel along the line of junction very prominent aborally. Mouth-spines 5 to 6 on each plate, moderately long and subaciculate, the middle one longest; the innermost one ought perhaps to be ranked as a secondary or superficial mouth-spine, although similar in form and serial in position with the true mouth-spines. Midway on the superficies of the plate and well away from the median keel is a longer and slightly more robust secondary spinelet, similar in character to the rest of the armature.

Actino-lateral spines very wide apart, probably not more than 20 on a side, although the rays are so long, the 4th or 5th from the mouth being longest; these and the preceding spines, which are included within the disk, all converge towards the interradial angle, instead of running parallel to one another as in nearly all the species of this genus.

Station 286. Lat. $33^{\circ} 29'$ S., long. $133^{\circ} 22'$ W. Depth 2335 fms.; bottom temperature $0^{\circ} \cdot 8$ C.; red clay.

HYMENASTER PULLATUS, n. sp.

Marginal contour more decidedly stellate than pentagonoid.

The interradiar angles appear to have been well rounded, with the lesser radius probably in the proportion of about 57 per cent. ; $R=35$ millim., r =about 20 ; but the specimen is unfortunately so much damaged in each of the arm-angles that it is impossible to give the smaller dimension exactly. Radii well produced, fine and tapering at the extremities. Dorsally the centre of the disk is elevated into a sharp conoid, and the radii are prominently arched.

Supradorsal membrane very delicate. Spinelets of the paxillæ prominently projecting, very delicate, and tapering towards their extremity, distributed regularly at uniform intervals apart over the whole dorsal area. Numerous very fine thread-like fibrous bands pass between the tips of the spinelets, crossing over and under one another, but not merging or forming a coherent reticulated structure. The fibres are not tightly stretched between the tips of the spinelets, but slope downward at a high angle, like slackened ropes round a tent-pole ; in consequence of this and of their great prominence, the spinelets appear to superficial examination to stand like well-spaced conical prickles upon the dorsal area. The oscular orifice is of moderate size, the outer margin (from which the valves take their rise) being marked off by prominent sharp spinelets into a pentagon, 9.5 millim. in diameter, the angles opposite to the radii. The valves are very regularly subtriangular, composed of 10 to 12 radiating spines, and when closed form a pyramidal peak in the centre of the disk.

Ambulacral furrows narrow and deeply sunken, constricted near the mouth, widest about the outer third, and then sharply tapering to the extremity. Ambulacral spinelets 3, short, stout, tapering, compressed, placed in line oblique to the direction of the furrow and also to the horizontal plane of the ray. The ambulacral spines are quite hidden in the furrow, not webbed together, but probably invested with a rather long membrane. Aperture-papillæ large and squarely oval.

Mouth-plates somewhat broad, short, almost perpendicular in position ; keel flattened. Each plate bears two short thick secondary superficial spinelets, the aboral one most robust. One mouth-spine stands above the innermost secondary ; and another, much smaller, is placed isolately on the horizontal lateral margin of the plate.

Actino-lateral spines 27 +, perhaps about 30, robust at the extremity of attachment, but very delicate and taperin outward, not meeting in the interradium.

Colour, in alcohol, dark purple; the fibrous bands on the dorsal surface being white, giving a very elegant effect. The suckers very dark purple, almost black, with white tips.

Station 218. Lat. $2^{\circ} 33' S.$, long. $144^{\circ} 4' E.$ Depth 1070 fms.; bottom temperature $2^{\circ} 1 C.$; *Globigerina*-ooze.

HYMENASTER MEMBRANACEUS, *Wyville Thomson*.

Hymenaster membranaceus, *Wyv. Thoms.* (1877), *Voy. of 'Challenger,' Atlantic*, vol. i. p. 108.

Marginal contour subpentagonal; interr radial angles wide and flat, the lesser radius in the proportion of 62 per cent. or less; $R=35$ millim. approximately, $r=22$ millim. Radii very narrow, and tapering on their outer portions. Dorsal area almost flat, actinal slightly convex, but deeply incurved along the median interbranchial lines.

Supradorsal membrane thin and transparent, with a great number of fine muscular fibrous bands extended between the tips of the paxillæ-spinelets, passing from one to each of these in the vicinity and crossing one another in all directions, but without merging or forming a reticulated tissue in the true sense of the word. Tissue semitransparent, with a few isolated spiracula here and there. The tips of the spinelets produce slight prominences but there is no massing of the tissue or the fibres upon their extremities, which are consequently quite sharp and little conspicuous. Oscular orifice very large, the outer or basal circumference measuring 12.5 millim. in diameter. Each valve is composed of at least ten radiating spines, their bases of articulation forming a prominent semicircular boss in each radius.

Ambulacral furrows narrow and deep, scarcely petaloid although much narrower near the mouth and rapidly tapering at the extremity; adambulacral plates high. Ambulacral spines 3, very short, stout, slightly tapering and slightly compressed, placed high in the furrow, and each series standing in line slightly oblique to the median line of the ray, and oblique also to the horizontal plane of the furrow, the innermost spine being highest up in the furrow and most aboral. Not webbed. Aperture-papillæ very large, covered with widely expanded membrane, giving them a squarely oval or subquadrate shape, often with a slight peak.

Mouth-plates rather small, sloping upward into the mouth, aboral extremity tilted downward, prominent keel along the line

of junction, internal peak rounded and very little produced. Each mouth-plate carries two secondary superficial spines—one short, dumpy, obtuse, compressed, standing on the surface of the plate at about one third the distance from the adoral extremity, and directed somewhat outwards and away from the mouth; the other, rather longer but much less robust, placed quite at the adoral extremity and rather geniculated sideways; in fact this spinelet might almost be ranked as a mouth-spine proper, except that it stands at a slightly lower level, more on the plate itself. On the horizontal margin of the plate, and situated on the widely expanded lateral flange, are 4 to 5 small compressed mouth-spines, very much smaller than those just described, and similar to the ambulacral spines, only smaller in size.

The actino-lateral spines, although long, do not meet in the interradium; indeed the dorsal and ventral membranes coalesce, apparently normally, in the outer portion of the median inter-radial line, thereby forming a partition in the interbrachial chamber. The spines which come near the interbrachial margin are much thickened and knobbed at their extremity; indeed all of them are more or less so except the most outward of all. There are about 32 to 36 actino-lateral spines, the 15th to 17th from the mouth being longest; beyond this they diminish very rapidly in size.

Colour, in alcohol, white.

Station I. Lat. $41^{\circ} 57' N.$, long. $9^{\circ} 42' W.$ Depth 1125 fms.; *Globigerina*-ooze.

HYMENASTER COCCINATUS, n. sp.

Marginal contour stellato-pentagonoid, interradian angle well rounded; radii tapering to a fine point, with lateral margins almost straight. Minor radial proportion 55.5 per cent.; $R=18$ millim., $r=10$ millim. Form very depressed, slightly convex and rising in the centre. No definite marginal fringe.

Supradorsal membrane very fine; muscular fibres thin, filiform and well defined, forming a rather wide and irregular reticulation, resembling to a large degree the venation of certain leaves more than the characteristic intercrossing of fibres radiating from neighbouring spinelets which is generally noticeable throughout the genus. This peculiarity arises from the frequent bifurcations, bendings, and sudden terminations to which the fibres are subject, and which, together with the presence of small secondary

fibres, modify the normal arrangement of radiation from tip to tip, which is, after all, the principle of the disposition of this structure even in the species under notice. The meshes are filled in with an almost hyaline tissue, punctured with two, three, or even more small spiracula, each surrounded with a definite white ring. The spinelets of the paxillæ are not numerous, and are but slightly protuberant, the tips being covered with a little cap of membrane which gives them rather a knobby appearance. The oscular orifice is moderately large, its outer circumference at the base of the valves being well defined by a pentagonal outline formed of thickened or fibrous tissue. The five valves are regular and triangular, with about 8 spines in each; and the whole series are webbed together and form a very slightly elevated pyramid when closed.

Ambulacral furrows wide and open, very slightly petaloid opposite the commencement of the outer third, and rather rapidly constricted towards the tip. Ambulacral spines 4 (but often towards the extremity only 3), short, delicate, acicular, and well spaced. Three stand on the margin of the plate parallel to the furrow, the aboral smallest, the adoral nearly twice as long. The fourth spine—equal in length to the last named, or even longer—is placed close to it, but on the outer side and away from the furrow. These two spines are present throughout the ray, and maintain this position. The three marginal spines usually stretch horizontally over the furrow; but the fourth spine is almost perpendicular, frequently radiating at an angle away (outward) from the furrow. The spines are covered with an investing membrane, which in the three marginal spines is expanded towards the tip and gives them a claviform appearance, the most adoral one of the three being more robust than the others; in the fourth or outward spine the investment is even more developed, and the covered spine presents a somewhat more lanceolate shape than those just referred to. The aperture-papillæ are very singular in form, and consist of a comb of about 5 to 7 radiating spinelets which spring from a common base, the central spinelet being straight and much longer than the others, which are curved, the two outer ones forming together a regular semi-circular span, and the rest radiating within this curve, at gradually lessening angles of divergence from the central spinelet. The investing membrane by which the papilla is covered owes its form in a great measure to this skeleton. It is ovate or oblate

basally, with an elongate acicular prominence in its outward prolongation. Near the extremity of the ray this central shaft of the papilla is greatly lengthened, being little shorter than the lateral spines.

Mouth-plates short but extraordinarily broad, the lateral flanges being developed to an abnormal extent. The keel at the junction is feebly represented, only flatly rounded, slightly prominent aborally, adoral peak well developed. One moderately robust, short, conical spinelet, very wide at the base, sharply pointed, and covered with membrane, is placed near to the adoral extremity of each plate and rather above the actual margin. No other secondary surface-spine present. Mouth-spines 3, about equal in size to the ambulacral spines, placed on the extreme outer portion of the margin of the lateral flange; and sometimes the outer one is doubled.

Actino-lateral spines delicate and well spaced, 16 on each side of a ray, the third or the fourth from the mouth usually the longest, the rest gradually diminishing in size as they approach the extremity of the ray.

Colour, in alcohol—dorsal surface white with the faintest shade of pink, actinal surface scarlet, the suckers white.

Station 146. Lat. $46^{\circ} 46' S.$, long. $45^{\circ} 31' E.$ Depth 1375 fms.; bottom temperature $1^{\circ} 5 C.$; *Globigerina*-ooze.

HYMENASTER PRÆCOQUIS, n. sp.

Marginal contour subpentagonal, interradial angles very feebly incurved, the radii slightly attenuated at their extremity. Minor radial proportion 65 per cent.; $R=10$ millim., $r=6.5$ millim. The dorsal surface forms a uniform convex curve of low elevation, the membrane arching over from margin to margin, and the radial areas being in no way specially defined externally. No lateral fringe. Actinal surface flat.

Supradorsal membrane very fine and semitransparent. Muscular tissue very feebly developed, no definite series of fibrous bands being present, although under considerable magnification the existence of aggregated fibres may be discerned. Spiracula comparatively large, numerous and equally distributed, with conspicuous white ring. Paxillæ large, robust, closely placed, usually with five (sometimes six or seven) spinelets, which are thick and widely expanded from the pedicel. The spinelets do not taper at their extremities, but expand somewhat and are flaring, elevating

the membrane very slightly. The paxillæ are clearly visible through the transparent membrane; and about nine longitudinal rows may be counted across the base of the ray. The oscular orifice is small, with the spines of the valves long and slightly tapering.

Ambulacral furrows narrow, lanceolate, maintaining a nearly uniform breadth till near the extremity. Ambulacral spines 3 to 5 in number, rather long, delicate and acicular, arranged on the adambulacral plate in a semicircular curve when the larger number are present—three usually being on the margin of the furrow, and the two adoral ones standing successively more outward (away from the furrow) on the plate. These two obliquely placed spinelets maintain their position throughout the ray; and any diminution which takes place in the number towards the extremity is manifest in the marginal or aborally placed members of the series. The most aboral spine is rather shorter than the others, which are nearly uniform in length; and each of them is invested with a very thin membrane, and no sacculus is produced. The first adambulacral plates (nearest the mouth) bear only two spines; and these sometimes are webbed together.

The aperture-papillæ are small and dumpy, the calcareous portion being little more than twice (or at most three times) as long as broad; and very frequently this is bulged out somewhat at the side. The papilla is not free as usual in this genus, but is clothed with the general tissue of the actinal area, the aboral lateral margin alone being free and forming the actual lip of the segmental aperture as in *Pteraster*; the papilla fits close up to the spine, aboral to it, and slants rather obliquely in consequence.

The mouth-plates are small, short, narrow, both plates elevated prominently rather than forming a true keel at the junction; aboral extremity gently rounded, not prominent. Each plate bears two large, robust, conical secondary superficial spinelets, longer than the plates themselves, tapering to a fine point, and their bases occupying nearly the whole of the length of the short plate. These spines stand perpendicular to the superficies, the aboral pair radiating rather wider apart and more outward than the adoral pair. Mouth-spines 2 (or 3?), delicate, pointed, rather wide apart, and placed on the lateral margin of the plates opening into the peristomial circle.

Actino-lateral spines comparatively robust and well spaced, 16 to 17 on each side of a ray, the fifth from the mouth being

longest; they are slightly tapered at their extremity, and just protrude beyond the margin, which is feebly festooned between.

Colour, in alcohol, greyish white, nearly transparent.

Station 146. Lat. $46^{\circ} 46'$ S., long. $45^{\circ} 31'$ E. Depth 1375 fms.; bottom temperature $1^{\circ} 5$ C.; *Globigerina*-ooze.

Station 147. Lat. $46^{\circ} 16'$ S., long. $48^{\circ} 27'$ E. Depth 1600 fms.; bottom temperature $0^{\circ} 8$ C.; *Globigerina*-ooze.

In a specimen from Station 147 four seems to be the normal number of ambulacral spinelets, the adoral one being relatively smaller, and the transverse tendency of the series upon the plate being even more marked than in the specimen from which this description is taken. In this specimen (from Station 147) an additional pair of superficial secondary mouth-spines is present, making three pairs, and the innermost pair of mouth-spines proper are nearly as large as the adoral pair of secondaries.

BENTHASTER, n. gen.

Form depressed, marginal contour stellato-pentagonoid, dorsal area convex, actinal area plane. Supradorsal canopy rudimentary. No muscular fibrous bands. No spiracula. Nidamental cavity more or less aborted. Paxillæ with subfascicular crowns; spinelets trilaminar, of extraordinary length, delicacy, and number, protruding the greater portion of their length naked beyond the supradorsal membrane. Paxillæ probably devoid of investing membrane. Papulæ simple globular sessile sacs, comparatively large. Special dorso-lateral plates at the extremity of the rays. Ossicles of the dorsal surface cruciform, greatly attenuated; the whole calcareous framework being reduced to a minimum. Ambulacral spinelets one or two, long, needle-shaped, independent, not united by membrane. Aperture-papillæ more or less modified. (?) Segmental apertures aborted. Mouth-plates of the *Hymenaster* type. Two pairs of secondary mouth-spines, robust, clavate, thorny, probably without saccular membrane. Mouth-spines proper 2 or 3, the innermost resembling the anterior pair of secondaries, only rather smaller, the others pointed. Actino-lateral spines merged in the actinal floor.

The superficial aspect of this genus recalls, to a certain extent, that of *Korethraster*, from which, however, it is structurally widely separate. The rudimentary supradorsal membrane and the long fasciculated naked paxillar spinelets, protruding far beyond the membrane, readily characterize the genus from *Hymenaster*; whilst the simple, independent ambulacral spines, not forming combs and not webbed, at once distinguish it from *Marsipaster*, the only other form to which it can be compared.

BENTHASTER WYVILLE-THOMSONI, n. sp.

Marginal contour substellate; rays broad at base, and tapering to a very fine extremity; interradian angle well indented, not rounded; the lesser radius in the proportion of 50 per cent.; $R=18$ millim., $r=9$ millim. General body-profile much depressed, slightly elevated in the centre of the disk.

The dorsal aspect is very remarkable, recalling at first sight the appearance of *Korethraster*. This resemblance, however, is merely illusory, and arises from the presence of prominent tufts of long spinelets that project free beyond the dorsal membrane. The pedicels of the paxillæ are comparatively short, reduced almost to tubercles on the outer part of the rays, bearing about 8 to 10 spinelets, which are of great length and expand very slightly apart from one another. Paxillæ standing on cruciform ossicula, the prolongations of which are very long and thin, and the central portion where they cross little, if at all, widened.

Supradorsal membrane represented by a loose irregular spongi-form tissue, which fills up the paxillæ-crowns near their bases, and extends over the whole dorsal area. This spongy mass is not uniform in thickness or density, and nowhere forms a definite membrane. The paxillæ-spinelets protrude a great portion of their length through this tissue, and have the appearance of being entangled amongst it—a conventional definition of their character expressing more than any rigid description of this part of the structure. No muscular fibrous bands, and no spiracula present. The spinelets are transparent and vitreous in appearance, regularly trilaminate (which may be distinctly seen in every broken section), and taper to a fine sharp point. No trace apparent of any true membranous envelope to the paxillæ. The spinelets on the disk are much longer and more robust than elsewhere, attaining their greatest size in the neighbourhood of the centre. Oscular orifice rather indistinct, margined by five somewhat irregular tufts of spinelets, longer and more robust than any of the others. No definite or regular valves appear to be formed. It is doubtful to what extent the dermal chamber is developed; but probably its character is greatly modified: the specimen under notice leads to the inference that it is almost aborted in the present instance.

At the extremity of the rays there is on either side an elongate dorso-marginal plate, equal in length to about 7 or 8 segments of the ray, becoming thicker at the aboral end and

developing more or less of a knob. These expansions join at the extremity of the ray, and form an arch over the termination of the ambulacral furrow, the knobs bearing several prominent spinelets stouter than any of those in the vicinity.

Ambulacral furrows broad and rather petaloid. Sucker-feet arranged in simple pairs. Adambulacral plates very narrow and spaced widely apart, the margin of the furrow being simply a narrow ridge. Ambulacral spines normally two, placed transversely and very slightly oblique; but frequently only one is present. They are long, thickened at the base, tapering to the point; and when two are present, the outer one is often much larger than its companion. No trace of any investing membrane. Squamous plates are present on the outer margin of the adambulacral plates, which doubtless are the representatives of the aperture-papillæ. They seem to be more or less aborted functionally in the specimen under notice, and are apparently ankylosed, at any rate on the inner half of the ray, to the general body-skeleton; they are large, and broadly oval or subspatulate in shape.

The mouth-plates resemble in character those of *Hymenaster*. Median keel along suture very prominent adorally and sharply rounded. Two short, robust, curved, slightly clavate, and rather thorny spinelets stand on either side of the keel near the middle of the plates. Owing to the bad state of preservation of this specimen, the rest of the armature is unfortunately undistinguishable.

Actino-lateral spines 15 to 20, or perhaps rather more; comparatively short, delicate, and widely spaced; the longest about fourth from the mouth, and rather shorter than the breadth of the ambulacral furrow, measured from the base of this spine to the base of its correspondent on the opposite side. The actino-lateral spines do not diminish very rapidly in length as they approach the extremity. A fibrillar tissue of very loose construction forms the web uniting the spines, and at the same time constitutes the actinal floor of the test, beyond the margin of which the spines project considerably. In places where the actinal web has been removed in the interradi al space, no papillæ are to be seen for supporting the pseudo-supradorsal membrane from the sides of the rays, the cavity appearing to be very feebly developed there.

Station 244. Lat. 35° 22' N., long. 169° 53' E. Depth 2900 fms.; bottom temperature 1°·2 C.; red clay.

BENTHASTER PENICILLATUS, n. sp.

Marginal contour stellato-pentagonoid; interradial angles moderately indented and well rounded. Minor radial proportion 65.2 per cent.; $R=11.5$ millim., $r=7.5$ millim. The radii taper gradually, and their extremities are somewhat upturned.

Supradorsal membrane exceedingly delicate and rudimentary, appearing little more than a thin mucous film over the interbrachial areas, becoming, however, rather spongiform over the rays. Pedicels of the paxillæ very thin and delicate, bearing a crown of extremely long, thin, needle-like spines seven or eight times the length of the pedicel; about 20 spinelets in a crown on the disk, and about half that number, or less, towards the extremity of the rays. The spinelets are of the most delicate description, vitreous in appearance, trilaminar, the transverse section representing three cylindrical rods placed together, instead of three flattened laminae as in the previous species. The spinelets are widened at their proximal extremity into a condyloid articular base, all fitting close together, each moulded to the form of its fellows, the whole forming a compact basement to the crown. The spinelets constituting a crown expand very slightly apart, and protrude the greater portion of their length free and naked through the supradorsal membrane.

The cruciform ossicles of the dorsal surface upon which the paxillæ are borne are very delicate, the prolongations being attenuated in a remarkable degree, here and there almost aborted, and the central portion of the ossicle manifesting a tendency to become rotund and squamiform. This modification is so far carried out, that in the centre of the disk the whole of the dorsal surface that can be seen under the oscular orifice is simply covered with subcircular imbedded scales.

The oscular orifice is very large. The valves (or their representatives) consist of a compressed paxilla-crown composed of rather more robust spinelets than the rest. The pedicels of these modified paxillæ are very much enlarged, compressed laterally, and expanded at the top, upon which the spinelets are articulated in a more or less regular double row, the pedicels standing in the median radial line. Powerful muscular bands run between the bases of the pedicels of the valves and form a regular pentagon, near the centre of which the periproctal aperture is situate. Close to the periproct and less than its own breadth away is the remarkably small, round, insignificant, madreporiform body.

The papulæ are simple round sacs, as broad as long, and immensely large in proportion to the pedicels by which they stand.

Dorso-marginal plates are present at the extremity of the ray, and form a terminal arch or ocular guard; but they are not half the length of the similar pieces in the preceding species.

Ambulacral furrows wide, not petaloid; margins of the furrow very narrow. Ambulacral spines 2 or 3, placed very obliquely, the inner or aboral spine the smallest; whilst the outermost spine is probably the representative of the aperture-papilla, of which it occupies the place, although it differs in no way from the other two spinelets; sometimes a small additional spinelet is present. The spines are long, delicate, and needle-shaped; and there are traces of a fine investing membrane.

The mouth-plates are of the *Hymenaster* type, and present a prominent peak aborally, sloping adorally, and little prominent in front. Each plate bears two, long, clavate, thorny, somewhat curved secondary surface-spines, nearly equidistant from one another and from the extremities, and rather wide away from the keel or median suture, the posterior spinelets being longest. Two mouth-spines proper are situated on the horizontal margin of each plate, the innermost one being slightly smaller than the anterior secondary (surface) spine, which it resembles exactly both in form and character; whilst the outer spinelet is very much smaller, and slightly tapering and smooth, instead of being clavate and thorny.

Actino-lateral spines delicate, rather widely spaced, about 15 on either side of a furrow, the 4th or 5th from the mouth being longest. The spines diminish slowly in size as they proceed outward, and maintain a fair length even at the extremity of the ray. The actinal membrane is perfectly transparent, and composed of very fine and widely spaced fibres, reticulated rather rectangularly. No marginal fringe is formed; and the actinal tissue appears to pass over the margin continuous with the dorsal tissue. The actino-lateral spines project considerably beyond the margin, and are naked.

Colour, in alcohol, greyish white.

Station 218. Lat. $2^{\circ} 33' S.$, long. $144^{\circ} 4' E.$ Depth 1070 fms.; bottom temperature $2^{\circ} 1 C.$; *Globigerina*-ooze.



Sladen, W. Percy. 1882. "The Asteroidea of H.M.S. ' Challenger' Expedition.-Part I." *The Journal of the Linnean Society of London. Zoology* 16(91), 189–246. <https://doi.org/10.1111/j.1096-3642.1882.tb02281.x>.

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