

markings being much more like, but the colour wholly dissimilar. Primaries sandy buff, crossed by about seven lines or stripes of sap-green, but all ill-defined, excepting towards the inner margin, where they become blackish; all these lines excepting the fourth are irregularly zigzag or undulated, the fourth is regular and oblique, excepting at its extremities, which are angulated; the second and third and the fourth and fifth lines are most prominent, and, being near together, produce the effect of two narrow divergent bands: secondaries sandy buff; an arched dusky line near to the outer margin, and on each side of it upon the abdominal border a rather large dusky spot, the outer or inferior one being placed at the anal angle and surmounted by a small whitish border; external area beyond the dusky line somewhat greyish: body sandy buff, tegulæ bordered externally with sap-green. Under surface creamy ochreous: primaries with the discoidal cell greyish in the centre; discocellulars and a tapering submarginal streak also greyish; external border whitish; fringe dark brown: secondaries with faint indications of two slightly divergent and darker lines, dusky towards the abdominal margin, the outer one widely arched; anal angle greyish; abdominal area whitish; legs above slightly brownish. Expanse of wings 64 millim.

Aburi, Gold Coast (*E. T. Carter*).

It is possible that the upper surface of the primaries may be wholly greenish in freshly-caught examples, since green almost always sooner or later fades to buff-yellow.

XLIX.—*Remarks on the Genus Solaster.*

By D. C. DANIELSSEN and J. KOREN*.

THE genus *Solaster*, first established by Forbes, has at different times been subjected to various criticisms, certain authors, such as Lütken, Duncan and Sladen, and A. Agassiz, having expressed the opinion that its two species, *Solaster endeca* and *S. papposus*, ought to be placed in two genera. Agassiz has adopted for that containing *S. papposus*, Müller and Troschel's denomination *Crossaster*; while

* A section of a paper giving a preliminary account of the Echinodermata of the Norwegian North-Atlantic expedition, translated by W. S. Dallas, F.L.S., from an advance separate copy received from the authors. The paper is contained in the 'Nyt Magazin for Natur-Videnskaberne,' Bind xxvii. pp. 267-299; and the part here translated occupies pp. 286-293.

others, for example Viguiet and Perrier, will not accept any division, and have therefore retained Forbes's original generic name.

Prof. Verrill has established a new genus, *Lophaster*, for a third species, namely *Solaster furcifer*, which some few naturalists are inclined to accept. Thus for three species of the original genus *Solaster*, which is so poor in species, three genera, *Lophaster*, *Crossaster*, and *Solaster*, have been formed; and these we now propose to submit to a critical examination.

Prof. A. Agassiz, who first set up *Solaster papposus* as the type of a new genus and named it *Crossaster*, which is Müller and Troschel's first name for it*, expresses himself as follows in his memoir on North-American starfishes†:—"From an examination of the hard parts it is evident that *Solaster papposus* and *S. endeca* should not be included in the same genus, having really nothing in common beyond the great number of arms. The accompanying descriptions will fully show my reasons for placing these two species in different genera." In his descriptions of *Solaster papposus* and *endeca* we cannot find any such great differences as would justify their separation into two genera; and in this respect we must agree with Dr. Viguiet that it is rather difficult to understand why this distinction is made.

Prof. Agassiz himself says, in his important work just mentioned (p. 112):—"In *Solaster endeca* the arrangement and general structure of the ambulacral and interambulacral plates are identical with those of *Crossaster*. . . . The fundamental difference between the genera *Crossaster* and *Solaster* lies in the structure of the abactinal floor. The actinal floor between the arms is composed of small somewhat elongated plates, arranged in more or less irregularly diverging rows, quite similar to those of *Crossaster*."

According to what is here stated, it is principally the dermal skeleton of the back upon which Agassiz lays so great stress that he allows it to be decisive of the division of the genus. Dr. Viguiet, in his memoir on the skeleton of the Asterida‡, has pretty clearly shown that the dermal skeleton in *Solaster papposus* does not differ from that of *S. endeca* in any so essential degree as to render necessary any division of the

* In the 'System der Asteriden' of Müller and Troschel, however, Forbes's generic name *Solaster* is adopted for *papposus*, and *Crossaster* is cited as a synonym.

† Memoirs of the Museum of Comparative Zoology at Harvard College, vol. v. no. 1, p. 98 (Cambridge, 1877).

‡ "Anatomie comparée du squelette des Stellérides," par le Dr. Viguiet, Archives de Zoologie expérimentale et générale, tome vii. p. 138 (1878).

genus as a consequence of it. Our investigations lead us herein to agree with Dr. Viguiet. It is true that in *Solaster papposus* the meshes of the calcareous reticulation are much larger than in *S. endeca*; but this can only come into consideration in specific determination.

In *Solaster affinis* the meshes are smaller than in *S. papposus*; in *S. furcifer* they are still smaller; and in the new species, *S. glacialis*, established by us, the meshes in size approach very closely to those of *S. endeca*. In all the reticulation is formed by larger or smaller, oblong or angular calcareous pieces, which are imbricated and form longer or shorter beams, by the union of which the reticulation is produced.

The ventral interbrachial space in all the species named is occupied by calcareous plates, which are sometimes oval or nearly round, and contiguous without being truly imbricated, as, for example, in *S. papposus* and *affinis*; sometimes flatter, angular, and imbricated, as in *S. endeca*, *glacialis*, and *furcifer*; but these differences cannot serve as generic characters, nor has Viguiet adopted them as such.

The paxillæ, which are borne upon the calcareous reticulation, are placed closer together or further apart in the different species, generally according as the meshes are larger or smaller; they are furthest apart in *Solaster papposus*, closest in *S. endeca*. Transitions occur distinctly in the three intermediate species, *S. affinis*, *furcifer*, and *glacialis*. As regards their form and development also we find transitions which may well assist in the discrimination of species, but certainly not of genera. They are longest and have the longest pencil of calcareous needles in *Solaster papposus*; in *S. affinis* they are shorter, still shorter in *S. furcifer* and *glacialis*, and shortest of all in *S. endeca*.

Prof. F. J. Bell, who has paid attention to the genus *Solaster*, is inclined to support Dr. Viguiet in his opinion against Agassiz's division; but he nevertheless expresses himself with reserve, and says*, "but that excellent investigator seems to me to have not fully weighed all the facts which can be made out with regard to these two forms, which he retains in one genus." He remarks further that the circumstance that *Solaster endeca* has only ventral and *S. papposus* only dorsal marginal plates may furnish very "considerable support" to Agassiz's opinion. If this were really the case we should admit that there was some justification for making the division, although we cannot see that this peculiarity of the marginal plates alone was a sufficient ground for the division of the genus. Of the five species that were at our disposal

* Ann. & Mag. Nat. Hist. ser. 5, vol. viii. p. 140 (1881).

we have subjected the parts of the skeleton to a very careful examination, and we shall now state what we have found with regard to the marginal plates.

In *Solaster endeca* there are two rows of marginal plates, one belonging to the dorsal, the other to the ventral surface. They are concealed by the thick skin, and are observed only when this, together with the paxillæ, is removed.

The dorsal marginal plates are flattened, and have a triangular form, with the narrower part turned outward; on the lower surface of this narrower part there is a small button-like elevation, which forms the articular surface for the paxilla. The broader part is directed inwards, and rests with its slightly concave superior surface upon the corresponding ventral marginal plate, while the slightly convex inferior surface contributes, in conjunction with the ventral plate, to form a common point of support for the broad transverse row of paxillæ which is nearest the papillæ of the groove.

The ventral marginal plates are likewise flattened; they are somewhat broader than the dorsal, but, like these, have a triangular form, of which the broader part is turned outwards, and forms with its lower surface a point of support for the dorsal marginal plate. The smaller part of the ventral plate is turned inward; its upper surface is concave, and rests for the most part against the lower rounded margin of the ambulacral plate (in the interbrachial space it is in contact with one of the ventral plates); its lower surface is slightly convex, and, in conjunction with the broader part of the dorsal marginal plate, forms a sort of articular surface for the before-mentioned transverse row of paxillæ.

In the broader parts of the arms and in the angles of the arms both the dorsal and ventral marginal plates stand a little apart from each other; but they become closer and closer together as they approach the ends of the arms.

Solaster papposus has also two rows of marginal plates, which are likewise well covered, but differ essentially from those of *S. endeca* in bearing only one row of paxillæ, while in *S. endeca* each bears its own, and there are therefore two.

The dorsal marginal plates in *Solaster papposus* are rather small, oval in the upper part of the arm, while in the middle and in the narrow part they are nearly cubical. When they bear a paxilla, two stand together and form with their outer ends a concave articular surface, which receives the large paxilla forming the boundary between the dorsal and ventral surfaces; very often, however, the inner end of a calcareous trabecula is contiguous to the above-mentioned articular surface, as if to complete it for the large articular head of the

paxilla. Between these dorsal marginal plates which form articular surfaces for the series of paxillæ there are other dorsal marginal plates which bear no paxillæ; but it is only with their outer end that they unite with the general calcareous network. The dorsal marginal plates rest with their inner extremity upon the ventral marginal plates; sometimes two of the former are in contact with one ventral plate. In old animals the dorsal marginal plates which form the articular surface above described are completely amalgamated with the basal part of the paxillæ, and then these articulate with the corresponding ventral marginal plates; if we remove one of these paxillæ it appears as though there were no dorsal marginal plate. The amalgamation is so complete that we have been unable to dissolve it even with solution of caustic potash.

The ventral marginal plates are nearly lancet-shaped; their broader part turns outward; and their lower surface gives off a strong point of support for the dorsal marginal plates. The inner, somewhat narrower part has a concave upper surface, which rests against the lower rounded margin of the adambulacral plate. The lower surface is rough and convex. The ventral marginal plates bear no paxillæ, but serve exclusively for the support of the dorsal marginal plates. As a matter of course, in the interbrachial spaces the ventral marginal plates are in immediate contact with the ventral plates.

The odontophores (interbrachial plates, Agassiz) present no difference worthy of notice; both in *Solaster papposus* and *endeca* they are of the type given for the genus *Solaster*.

The true skeleton is as good as the same in both forms. Both ambulacral and adambulacral plates stand perhaps a little further apart in *Solaster papposus* than in *S. endeca*; but even this slight difference is not constant. The teeth are somewhat stronger in *Solaster endeca* than in *S. papposus*; but in other respects they are the same.

After what we have now brought forward as to the anatomy of these two species, it seems to follow clearly that their differences are not greater than they should necessarily be in order that the species should be sustainable as such, and that, according to our conception, nothing need be said about a division of the genus for any thing relating to the two species under consideration. Should any such division be made, it will become necessary also to form a new genus for our new species, *Solaster glacialis*; for, on this principle, it can belong neither to *Solaster* nor to *Crossaster*, as it stands almost exactly in the middle between them. It forms a transition from *Solaster endeca* to *S. papposus*.

Thus the paxillæ in *Solaster glacialis* stand further apart and are a little longer than in *S. endeca*, but neither so long nor so wide apart as in *S. papposus*; along the margin of the arms there is a series of pretty large penicilliform paxillæ, which are seen most distinctly from the dorsal side, as in *S. papposus*, but without projecting so strongly as in that species, while the transverse rows of paxillæ which are so characteristic of the ventral surface in *S. endeca* are far from being so prominent in *S. glacialis*. And with regard to the dermal skeleton, we find that the small calcareous pieces which form the net have much agreement in form and distribution with those of *S. endeca*, although they most resemble those of *S. furcifer*, which the species exactly resembles in the form and arrangement of the marginal plates. We think therefore that *Solaster glacialis* shows the utter untenability of the above-mentioned division of the genus *Solaster*.

Finally, we shall now take into consideration the genus *Lophaster*, recently proposed by Prof. Verrill for *Solaster furcifer*, Düb. & Kor.

To justify the establishment of this genus Prof. Verrill expresses himself as follows:—"This species differs so widely from *Solaster* in the structure of the skeleton and the small development of the disk as to require the establishment of a new genus for this type. It is specially distinguished by the highly developed skeleton of the underside, differentiated marginal plates, and prominently reticulated dorsal plates"*. Professor Jeffrey Bell is rather inclined to admit that the genus *Lophaster* is well founded, laying great stress especially upon the "differentiated marginal plates, one dorso-marginal and one ventro-marginal." We have already admitted that the marginal plates play an important part in characterizing genera, although we are unable to recognize them as decisive. Verrill says that *Solaster furcifer* differs so remarkably from the genus *Solaster* in the structure of the skeleton and in the small development of the disk that a new genus must be formed for it; it is principally the strongly developed skeleton of the ventral surface, the differentiated marginal plates, and the strikingly reticulated dorsal plates that determine the formation of the new genus.

Now with regard to the size of the disk in proportion to the arms, this varies very considerably, and is only of slight importance in generic determinations; but it is otherwise with the structure of the skeleton. We shall first refer to the dermal skeleton.

* "Notice of recent Additions to the Marine Fauna of North America," by A. E. Verrill (Amer. Journ. Sci. ser. 3, vol. xvi. p. 214).

The dermal skeleton of the dorsal surface in *Solaster furcifer* consists of a tolerably closely reticulated calcareous net, produced by small cross- or X-shaped calcareous plates laying their branches upon one another; between the meshes we see one or more tentacular pores, according as the meshes are large or small. We find almost the same arrangement in *Solaster endeca*, but still more strikingly in *S. glacialis*, in which the only difference is that the individual calcareous pieces are somewhat larger and have rather shorter branches, by which means the meshes are rather smaller than in *S. furcifer*.

The dermal skeleton of the ventral surface, which is particularly prominent in the interbrachial spaces, should, according to Verrill, be more highly developed in *Solaster furcifer*; but in this we cannot agree with him. The calcareous plates of the ventral surface in *S. furcifer* are more or less cruciform, with short arms, which certainly lie in an imbricated fashion upon each other, but which nevertheless leave small vacant spaces; while the calcareous plates in *S. glacialis*, which are nearly cruciform, and in *S. endeca*, where they are more oval, are closely imbricated.

The odontophores in *Solaster furcifer* do not differ from those of the other species; they have the typical form of the genus *Solaster*.

The marginal plates are placed in two series, the one belonging to the dorsal, the other to the ventral surface.

The dorsal marginal plates are small, somewhat oval, thin plates which lie upon the innermost part of the arms a little apart, but approach each other more and more as they advance towards the end, until they come together completely. They have upon the upper surface a small depression which serves as an articulating surface for the dorsal series of paxillæ along the margin, while the lower surface is smooth and rests upon a small part of the corresponding ventral marginal plate, united to it by strong ligamentous tissue.

The ventral marginal plates are a little more oblong and rather larger than the dorsal; their lower surface, besides attaching itself by a small part to the dorsal marginal plate, furnishes articular surfaces for the ventral series of paxillæ; their upper surface is somewhat concave, and rests upon the rounded lower part of the corresponding adambulacral plate.

The skeleton almost exactly resembles that of *Solaster papposus*. The ambulacral plates have perhaps rather broader transverse processes, and the adambulacral plates are somewhat thinner; but beyond these we can find no difference.

From what has been stated it must be seen that *Solaster*

furcifer has no more highly developed dermal skeleton than several of the other species of the genus; that the marginal plates do not differ in any essential degree from those of *S. glacialis*, *endeca*, *affinis*, and *papposus*; that the skeleton presents no special differences; and that, as a consequence of all this, there are no grounds for the establishment of a new genus for it.

We believe therefore that we have now sufficiently established the opinion formerly expressed by us, that the genera *Crossaster* and *Lophaster* cannot be sustained.

Before closing these remarks we shall think ourselves justified in enlarging the characters of the genus *Solaster* in accordance with the investigations that we have made:—

Body with five or more arms, everywhere beset with penicilliform paxillæ; between these, tentacular pores. Two series of marginal plates, more or less developed, but concealed by the skin. Anus central.

L.—*Descriptions of some new Genera and Species of Curculionidæ, mostly Asiatic.* By FRANCIS P. PASCOE.

[Plate XVIII. figs. 1–9.]

OTIORHYNCHINÆ.

Epilaris, n. g.
— *concinna*.
Bryochæta palliata.

Alcides Kirschii.

— *dædalus*.
— *monilifer*.
— *crassus*.

ERIRHININÆ.

Lixodes, n. g.
— *tæniatus*.

MENEMACHINÆ.

Menemachus stigma.

BALANINÆ.

Ergania, n. g.
— *gibba*.

CRYPTORHYNCHINÆ.

Aryptæus, n. g.
— *suturalis*.
— *pustulosus*.
— *trinarius*.
— *galeotes*.

ALCIDINÆ.

Alcides mustela.
— *divergens*.
— *bisignatus*.
— *indigaceus*.
— *parilis*.
— *distigma*.
— *amœnus*.
— *bellus*.

ZYGOPINÆ.

Tyriotes, n. g.
— *cuneipennis*.

CEUTHORHYNCHINÆ.

Diacritus, n. g.
— *pinguis*.



Danielssen, D. C. and Koren, Johan. 1882. "XLIX.—Remarks on the genus Solaster." *The Annals and magazine of natural history; zoology, botany, and geology* 10, 436–443. <https://doi.org/10.1080/00222938209459746>.

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