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On some Genera and Species
of the Temnopteuridae



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The Smithsonian Institution
from the writer

Bill. L. Jeffrey

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OBSERVATIONS
ON THE
CHARACTERS OF THE ECHINOIDEA.

PART III.
ON SOME
GENERA AND SPECIES
OF THE
TEMNOPLLEURIDÆ.

BY
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[From the PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF
LONDON, June 1, 1880.]

(Plate XLI.)

For the purposes of present convenience I adopt the name *Temnopleuridæ* for those forms which are grouped under it by Prof. Alex. Agassiz in his 'Revision of the Echini.' I need not now de-

fine it in detail, but will say merely of it that it includes those forms which, with a varying arrangement of their ambulacral pores, are provided with more or less distinct sutural pores or pits at the angles of the coronal plates.

There is, perhaps, no group in which variations during growth are more remarkable than they are in this; there is certainly none in which they are more instructive. Following the method I have already adopted¹, I have, in the tables of measurement which form the great body of this paper, expressed the absolute diameter of the tests in millimetres, while for the height, the abactinal system, the anal area, and the actinostome, the percentage values have been calculated; the poriferous zone is also occasionally added. Two recommendations present themselves for undertaking this exceedingly laborious task: the changes which occur during growth are at once seen; and, secondly, an aid is afforded to that not small group of naturalists who have not under their hands so large a series of forms as is fortunately to be found in our own national collection. Differences in proportion will not now form the chief ground on which new species are established; and the value of the British-Museum series will be hereby extended to those naturalists who, for want of such, are, naturally enough, led to regard their single immature specimen as the representative of a new species².

I. TEMNOPLEURUS, Agassiz.

The type of this genus is *T. toreumaticus* (see Agassiz, *Introd. to Valentin's Anat. du genre Echinus*, p. vii, & *Observations sur les progrès récents etc.*, 1841, p. 7).

Prof. Alex. Agassiz recognizes in the genus three species, the forms *T. reevesii* and *T. granulosus* of Gray being regarded as synonymous with *T. reynaudi*, Agass. I have carefully examined Dr. Gray's types, and have been led to the conclusion that the two are not representatives of the same species.

The name *Toreumatica*³ is ordinarily regarded as a synonym of *Temnopleurus*; but it seems that Dr. Gray nowhere defined it, and it might well be allowed to fall out.

¹ P. Z. S. 1879, p. 662.

² It appears to me to be unnecessary to justify the selection, as a standard of the diameter of the test, of the *regular* Echinida. Save where abnormalities, easily enough detected, come to development, it seems plain that it stands in very much the same relation as the diameter of the human thorax does in measurements of this character, and is the nearest approach to that relation between the dimensions of the head and of the thorax which has been found so useful in the case of proportional measurements of the human subject (*cf.* Liharzik, 'Das Gesetz des Wachstums u. der Bau des Menschen,' Wien, 1862, p. 33).

³ See P. Z. S. 1855, p. 39.

1. TEMNOLEURUS TOREUMATICUS.

	Absolute diameter in milins.	Percentage value of			
		Height.	Abactinal area	Anal area.	Actino-stome.
i.....	9	61.1	33.3	15.5	44.4
ii.....	14.5	55.1	?	13.8	31
iii.....	27	50	22.2	11.1	29.6
iv.....	27.5	50.9	21.9	9.9	29.9
v.....	44	45.45	18.6	9	28.6
vi.....	47	40.4	19.1	8.5	28.7

This species is so well known that there is no need to delay over it.

2. TEMNOLEURUS HARDWICKII.

	Absolute diameter in millims.	Percentage value of			
		Height.	Abactinal area.	Anal area.	Actino-stome.
i.....	7	57.14	30	14.28	42.8
ii.....	11	63.63	29	13.6	45.5
iii.....	24	50	22.08	9.6	33.3
iv.....	27.25	47.7	21.8	9.17	29.1
v.....	32	56.2	21.8	9.37	29.06
vi.....	43	60.4	20.93	9.02	26.7

With regard to the height, it would seem that it is not so much that changes occur in it during growth, as that there are considerable variations in it, with a tendency to a high form (63 per cent.) and a low form (47.7 per cent.).

3. TEMNOLEURUS REYNAUDI.

As I have already pointed out, I believe that in the latest Revision two distinct species have been united under this head. Mr. Percy Sladen has given expression to a doubt on the subject¹; and he informs me that the type of Dr. Gray's *T. granulosus* struck him as being "a good species" when, some time ago, he had the opportunity of examining it. *T. reevesii* of Gray does, however, seem to be synonymous with the *T. reynaudi* of Agassiz.

When the types of the two species are compared, we find that in *T. granulosus* the abactinal area is of moderate size and there is no specially large plate in the anal area; the connecting ridge of the auricles² is lower than in *T. reevesii*; the miliary tubercles are very numerously developed and surround the primary tubercles; sutural furrows, quite distinct from the pits of *T. reevesii*, occupy the middle

¹ J. L. S. xiv. p. 437.

² I feel inclined to attach a little more importance to this character than does Prof. Agassiz, who says of it that it is high, when he is defining the genus, and very low, when defining *T. hardwickii* (p. 461).

line of the interambulacral area; and though not so deep nor so wide as in *T. toreumaticus*, they extend almost to the base of the primary tubercles; on the other side of these tubercles there are narrower and shallower furrows; and in the middle line of the ambulacral area there are deep sutural pits: all these depressions are much more distinct above the ambitus than they are on the actinal surface, in which point they offer a striking point of difference from *T. reevesii*. The test is by no means thin; all the ocular plates are excluded from the anal area; the outermost, not the innermost, of the three tubercles on the interambulacral plates is the smallest.

The following are the more important measurements:—

	Diameter.	Height.	Abactinal area.	Anal area.	Actinostome.	Spine.
Gray's type..	37	18	8		10·5	
		[48·6] ¹	[21·6]		[28·3]	
	32	16·3	7·0	3·5	10·2	10·5 ²
		[50]	[21·8]	[10·9]	[30·9]	

In other words *T. granulosus* differs from *T. reevesii* (i. e. *T. reynaudi*) in the facts that:—

- i. The abactinal area is not large; and the anal area is much smaller.
- ii. All the ocular plates are excluded from the anal area³.
- iii. There are sutural furrows and deeper angular pits.
- iv. The miliaries are much more numerous developed.
- v. There is no specially large anal plate.
- vi. The actinostome is a good deal smaller.

These differences appear to me to be sufficient to justify us in regarding *Toreumatica granulosa* as a distinct species; it is, however, obviously enough a member of the genus *Temnopleurus*.

The following is a table of the dimensions of *T. reynaudi* proper, the *T. reevesii* of Gray.

	Absolute diameter in millims.	Percentage value of			
		Height.	Abactinal area.	Anal area.	Actinostome.
i.....	7·1	46·5	38	17	40·8
ii.....	7·5	42·6	40	20	40
iii.....	10	42	31	15	33
iv.....	10·5		36·19	19	33·3
v.....	21	47·6	30·9	16·16	33·3
vi.....	35	42·8	25·7	15·1	31·4

As in the case of the preceding species, we may here note some

¹ The numbers in brackets are the percentage results.

² Greatest length measured.

³ Gray's type specimen has lost the abactinal plates; but two specimens collected by Capt. St. John in the Korean seas are perfect.

considerable variation in the height of the specimens; the actinostome does not diminish so much in size during growth as it does in *T. toreumaticus* or *T. hardwickii*.

II. MICROCYPHUS.

The specimens of this genus alter in appearance very greatly during growth, as may be gathered from the fact that Prof. A. Agassiz formed a new genus *Anthechinus* (*roseus* sp.) for some rather young examples of *M. maculatus*; and matters are, unfortunately, a little complicated by the fact that the young of *M. zigzag* (as determined by Prof. Alex. Agassiz) have externally a most remarkable resemblance to the young of *M. maculatus* (*Anthechinus roseus*).

The information which can be given regarding these two species is somewhat meagre; the most interesting point is, perhaps, the slight extent to which the actinostome of *M. zigzag* diminishes in proportional size during growth.

1. MICROCYPHUS MACULATUS.

	Absolute diameter in millims.	Percentage value of			
		Height.	Abactinal area.	Anal area.	Actinostome.
i.....	23	73.8	26	...	44.7
ii.....	27	70.3	26.3	11.1	40.7
iii.....	37	62.1	21.6	...	36.5
iv.....	45	62.6	20	...	33.3

2. M. ZIGZAG.

	Absolute diameter in millims.	Percentage value of			
		Height.	Abactinal area.	Anal area.	Actinostome.
i.....	8	...	...	...	31.2
ii.....	8.2	...	...	...	32.9
iii.....	15.5	77.4	32.2	12.9	25.8
iv.....	23	84.7	23.9	8.7	30.4
v.....	25	84	24	...	28.8

III. SALMACIS.

Of all the genera of the Temnopleuridæ, this is perhaps the most difficult; the determination of its species has more than once engaged my attention, and has been more than once put aside in despair. Now, however, I have the advantage of having at hand the preliminary set of specimens collected by the officers of H.M.S. 'Challenger' and named by no less an authority than Prof. Alex. Agassiz. Some of these are exceedingly interesting as being very young specimens. Now, too, I have at hand the three interesting

forms which were collected by Captain H. C. St. John (H.M.S. 'Sylvia'), and which have been so well described by Mr. W. Percy Sladen¹ as the young of *S. sulcata*.

The number of specimens of this genus, however, is by no means large; and though thus increased it is not yet sufficient to enable us to answer all the problems which the genus presents to us. On the other hand, the question of whether or not one should put out such results as have been attained to, seems to me to be more readily answered in the affirmative in the case of groups, specimens of which are notoriously infrequent. In other words, where specimens or series are scarce, bibliographical aid may be advantageously increased, and that the more when, as here, very little of that kind of work is already available. This section of the present communication will also differ in character from that of the greater part of the rest, by entering into a fuller account of the constituent species.

The reader shall first be put in possession of the number and characters of the more important specimens now in the British Museum:—

1. *SALMACIS BICOLOR*.

a. Two tests, without spines or abactinal plates, buccal membrane, or dentary apparatus. Coll. Inwood. *Hab.* — ?

b. A fine specimen in spirit, perfect. Coll. H.M.S. 'Challenger.' Zamboanga.

2. *S. DUSSUMIERI*.

a. Four dried denuded specimens. Coll. Inwood. *Hab.* — ?
(The *Toreumatica concava* of Gray.)

b. One injured denuded test. No history.

3. *S. GLOBATOR*, *vide infrà*.

4. *S. RARISPINA*.

a. A denuded specimen with abactinal and anal area complete. Bondy Head. Earl of Derby.

b. A similar specimen. "Portugal." Purchased of Cuming.

c. Small, denuded. H.M.S. 'Challenger,' Station 188.

d. Two small, with a few spines. H.M.S. 'Challenger.' Station 186.

e. A larger specimen with some spines. H.M.S. 'Challenger,' Station 186.

f. A small dry test. Coll. Belcher. East Indies.

g. A small dry test with a few spines. Mindanao. (I place this specimen here with considerable hesitation.)

5. *S. SULCATA*.

a. Three small specimens, with some spines. Coll. St. John. 34° 38' N, 126° 24' E.

b. Two, with spines, in spirit. H.M.S. 'Challenger,' Island of Mactan, Cebu, Philippines.

¹ J. L. S., Zool., xiv. p. 439.

1. SALMACIS BICOLOR, Ag.

Salmacis bicolor, Agassiz and Desor, Cat. Rais., Ann. Sc. Nat. (3) vi. p. 359.

This, when completely covered with spines, is a most beautiful form: above the ambitus it is covered with short sharp purplish red spines, banded with greenish-yellow; at and below the ambitus the spines are much stronger and longer and are more closely packed, while the colours are reversed in relation, and they may be said to be of a greenish-yellow, banded with a purplish red; the base, however, is always coloured red. Around the actinostome the spines are still stronger and are completely flattened. The test is well rounded and by no means conical. The actinal and abactinal arææ are of a moderate size; a bare median space can, above the ambitus, be distinctly made out in both the ambulacral and interambulacral arææ.

In the denuded test the primary tubercles on the interambulacral plates are, above the ambitus, best developed on the half of the plate nearest the ambulacral pores; about the middle of the side of the test there are two well developed primary tubercles, and internally to these there are two smaller ones; passing upwards these latter gradually diminish in size till they disappear; and within a few plates of the abactinal area the same happens with the outermost row of tubercles; so that the uppermost of the coronal plates have only one well-developed primary tubercle each. At the ambitus there are five well-developed primary tubercles on each interambulacral plate; and these tubercles, forming a close mail on the actinal face of the test, gradually disappear as they pass towards the actinostome. There is a fairly well-marked series of miliary tubercles running along the upper edge of each coronal plate; but these become much more irregular on the uppermost plates. A dark-coloured band runs along the sutures of the plates above the ambitus.

On the ambulacral plates the primary tubercles form a single row, which is placed quite at the outer edge and extends regularly from pole to pole, gradually decreasing in size as they pass in either direction from the region of the ambitus; it is only quite close to the ambitus that a second row of primary tubercles is at all well-developed. The actinostome is of a moderate size, not sunken; its decagonal form is well marked, the ridges connecting the auricles are low; the pore-areas are wide, four pores, or two pairs, being placed in an almost horizontal line. The sutural pores appear to become indistinct with age.

	Absolute diameter in millims.	Percentage value of				Poriferous zone.
		Height.	Abactinal area.	Anal area.	Actinostome.	
i.....	44	59	18	...	29.5	2
ii.....	52	59.6	17.39	...	27.8	2.6
iii.....	75	66.6	16	8	24	3

The last specimen had spines of three lengths—8, 13, and 9·5 millims. long being averages.

This species has been very well figured by Desor (Synopsis des Echin. fossiles, pl. xvii. figs. 11–12).

2. SALMACIS DUSSUMIERI, Ag.

S. dussumieri, Agassiz & Desor, Cat. Rais., Ann. Sci. Nat. (3) vi. p. 359.

Toreumatica concava, Gray, P. Z. S. 1855, p. 39.

This species is so well marked that it is unnecessary to give as full an account of it as of the preceding species. It is certainly not the most nearly allied of the genus to *Temnopleurus toreumaticus*; and Prof. Alex. Agassiz seems to be completely justified in associating the *Toreumatica concava* of Gray with the representatives of the genus *Salmacis*¹.

Very few spines remain on the five tests in the Museum collection; what there are are quite close to the actinostome, and are of a milky-white colour; some must have been of some strength, and others more delicate; the longest I could measure was 4 millims. long (from a test 32 millims. in diameter). The ocular plates may be shut out from the anal area; the anal orifice seems to be placed at the edge, and not in the centre, of the anal area; when there are vertical rows of tubercles on each half of the ambulacral plates, the tubercles do not form transverse rows, but are set alternately. The auricles are connected by ridges about half their height.

	Absolute diameter in millims.	Percentage value of			
		Height.	Abactinal area.	Anal area.	Actinostomè.
i.....	37	30	21·6	12·1	24·3
ii.....	32	29·7	18·7	12·5	26·5

3. SALMACIS RARISPINA, Ag.

Salmacis rarispina, Agassiz & Desor, Catal. Rais., Ann. Sc. Nat. (3) vi. p. 359.

This is, on the whole, one of the most easily recognizable of the species of this difficult genus; but its distribution appears to be somewhat unusual if the locality of "Portugal," attached to one of the specimens in the collection, be correct; it will be safer, however, to wait for further examples of the occurrence of this form off the Portuguese coast:

It is at once distinguished not only by the flesh-coloured lozenge-shaped patterns on its yellowish-green upper surface, but by its

¹ *T. concava* was not the type of Gray's genus *Toreumatica*; nor is there any example of the species in coll. B. M. which is known to have come from Hong-kong. None of the Museum specimens has any locality attached; but Gray (*loc. cit.*) gives "*Hab. China.*"

enormous abactinal system, its comparatively large anal area, and its small rounded actinostome with a thin complete edge.

The following measurements of the specimens from Bondy Head and "Portugal" may be compared with those given by much younger and by intermediate specimens.

	Absolute diameter in millims.	Percentage value of			
		Height.	Abactinal area.	Anal area.	Actinostome.
Portugal	74	66	19	9.86	22.19
Bondy Head...	64	60	21.09	10.1	21.9
Station 188 ...	22.5	53.3	22.2	11.1	31.6
Station 186 α..	14	57.14	21.4	...	32.1
Station 186 β..	9	...	...	...	33.3

It is obvious from the above figures that the most marked changes occur in the actinostome, which, almost large in the young, becomes so small in the well grown forms; and it is interesting to compare the change with what obtains in *Temnopleurus*. *T. torumaticus* has the actinostome even proportionally larger when young; but its adult specimens (50 millims. in diameter) present a percentage value for their actinostome of as much as 26, the relation between the young *Salmacis* and the adult *Temnopleurus* being, even in the character of the actinostome, not obscurely indicated.

The following points may also be noted in the young specimens:—The lozenge-shaped patches are not yet apparent; the sutural pores are much more distinctly marked; there is only one distinct series of primary tubercles in each set of coronal plates above the ambitus; below the ambitus there are indications of a second and, still more faintly, of a third series in the interambulacral area; the anal covering-plates are for the most part large, and consequently few in number; the most striking in the specimen, 22.5 millims. in diameter, are five peripherally placed plates, which are separated from one another by small triangular plates, one for each.

The test is much thinner in the fully grown than in the young specimens; the bare median spaces are more considerable in this than in any other species of the genus; and the tubercles are proportionally smaller; the actinal surface becomes a little swollen, so that the actinostome becomes somewhat depressed; the ridges connecting the not strongly developed auricles are low; the madreporic is hardly larger than the other genital plates; the anal opening is at or close to the centre of the anal area.

4. SALMACIS SULCATA, Ag.

Salmacis sulcata, Agassiz & Desor, Catal. Rais., Ann. Sc. Nat. (3) vi. p. 359.

Test rounded, or somewhat conical, closely covered with spines of a general green coloration, but becoming almost white towards

their tips; the upper ones are banded with brown, those near the ambitus with purplish brown; those around the actinostome are flattened, and the bands become distinctly purple, while the green is evanescent.

The denuded test, though not unlike that of *S. bicolor*, is distinguished from it by its depressed actinostome, the greater height of the ridges connecting the auricles, the somewhat narrower ambulacral pore-areas, and the more distinct sutural pores. The changes during growth in the proportional size of the actinostome are somewhat striking; and I regret that it is only in the lately acquired specimens that the abactinal and anal areas are complete, so that it is impossible to trace the changes which occur in this region. Prof. Agassiz's specimens seem to be in a somewhat similar plight; for he is only able to give the measurements of the abactinal and anal systems of one of his specimens; the percentage value of the abactinal area in the specimen measured by him is 18·5. The great changes in the proportions of the actinostome point to the necessity of carefully examining a series of forms before using the size of this orifice as a specific character.

	Absolute diameter in millims.	Percentage value of			
		Height.	Abactinal area.	Anal area.	Actinostome.
i.....	14	59·2	22·1	12·5	42·8
ii.....	17	64·9	23·5	11·7	41·1
iii.....	45	51·1	...	...	25·4
iv.....	59	45·7	...	...	26·6

It may be of interest to point out that there is in the Museum collection a specimen which, resembling very closely the *S. conica* of von Martens, appears to bear out the view of Prof. Alex. Agassiz that *S. conica* is synonymous with *S. sulcata*. Von Martens's specimen measured 72 millims. in diameter and 55 millims. in height, thus giving the latter a percentage value of 76·3; the specimen now under description had a diameter of 77 millims., and the percentage value of the height, abactinal and actinal areas, were respectively 65, 15·5, and 22.

Some link is yet wanting to connect with these conical specimens of *S. sulcata* a specimen from an unknown locality, the height of which is 91 per cent. of the diameter, and which hardly conforms, in some other points, to the ordinary specimens of this species.

5. SALMACIS GLOBATOR.

Two distinct species appear to have been described under this head—one by Agassiz & Desor, in the Catal. Raisonné (Ann. Sc. Nat. (3) vi. p. 359), the other by Prof. Alex. Agassiz, in the 'Revision of the Echini' (iii. p. 473). One point will suffice to

show that the same specimens can hardly have been described by both these writers—the only authors who have given us original accounts. The first description of the species contains the words “Deux rangées de tubercles sur les aires ambulacraires et sur les aires interambulacraires;” in the second we find:—“In specimens measuring 60 millims. there are as many as six vertical rows [of primary tubercles] on each side of the median line at the ambitus in the interambulacral, and three in the ambulacral space.” This would give twelve interambulacral tubercles, and might therefore lead us to think that “deux” was a misprint for “douze,” were it not that there are still only six ambulacral tubercles.

Any zoologist who will take the trouble to refer to Mr. Alex. Agassiz's description, will see that it is impossible to found any definite opinion on the subject from the data there given; nor can I reconcile with one another the two following statements concerning the species:—(i.) “There are no sutural furrows on the actinal side;” and (ii.) “The sutural furrows of lighter colour and yellowish on the actinal surface.”

There are in the Museum collection specimens which can be made to agree with the greater part of Mr. Alex. Agassiz's description; and the national collection is credited by him with specimens from the east and west coasts of Australia. I have searched in vain for specimens of *Salmacis* from a locality so described; but there is a specimen from the east coast of Australia collected by Stutchbury (?), which is either a representative of L. Agassiz's *S. globator*, or is a member of an undescribed species; for this specimen has above the ambitus only one row of primary tubercles in each half of the interambulacral area.

To attempt to resolve the difficulties which beset the determination of this species, I addressed myself to the distinguished naturalist who has the care of the Echinodermata in the Muséum d'Histoire Naturelle at Paris, thinking that, as the type of Agassiz and Desor's species was in the “Collection Deshayes,” it was possible it might be now under his care. Prof. Edmond Perrier responded to my appeal with a courteous rapidity; but, unfortunately, he could only say that the species is not in the Museum of the Jardin des Plantes. With great kindness he promised to pay a visit to the Ecole des Mines, as he fancied the species was there; as, however, I have not again heard from M. Perrier, I fear that his search has not been rewarded.

Whatever course be now adopted, it is obvious that there is one which would add to the present existing confusion; that would be to propose a new specific name. That course I will not adopt; and while it is difficult to know what to do to escape from the difficulty, I think the safest course at present is to give a short description of the two forms, and to supply accurate figures of them both. Notwithstanding the large number of plates, which form a not inconsiderable portion of the Revision of the Echini, the only parts that are figured of the rare and little known *S. globator* is a plate from the ambulacral tube.

(α) The specimens with a number of primary tubercles in a transverse row (Plate XLI. figs. 1, 7).

The test is pretty thick; the poriferous zones are narrow; the actinostome is of moderate size, and sunken; the actinal cuts are very shallow and wide. The test is grey or light brown; the poriferous zones and the median space of the interambulacral area may be of a yellowish hue. At the ambitus there are, in the interambulacral area, six or seven tubercles on either side of the middle line. In the ambulacral area there are three tubercles on each plate; all these tubercles are of very much the same size; they decrease in number as they pass to the actinal and abactinal poles: but they are more closely packed on the actinal surface; for there there is no bare median space; there, too, the plates are not quite so wide, and they are not separated from one another by any sutural furrows. The upper portion of the plate is occupied by a fairly regular row of miliaries. The auricles are exceedingly strong and high, as are, too, the connecting ridges; the foramen is not as high as the ridge, and is triangular. I can give no information regarding the abactinal or anal areas.

Two specimens measured in diameter 67 millims.; one was 30 and the other 33 millims. high; the actinostome of either measured 18 millims. across; the smallest of the three specimens was 58 millims. in diameter, 40 in height, and had the actinostome 17 millims. broad.

None of the specimens has any known history or locality.

(β) Specimens with one vertical row of primary tubercles above the ambitus (Plate XLI. figs. 2, 3, 8).

Test not quite so thick as in (α); the actinostome somewhat smaller, and the cuts deeper; it is not quite so sunken; the poriferous zone wider; the pores frequently have on their outer edge tubercles, and do not, therefore, occupy a completely marginal position on the ambulacral plates.

At the ambitus there is only one large primary tubercle on either interambulacral plate; this is rather nearer the outer than the inner edge of the plate; and on either side of it there are two or three distinct secondaries. On the actinal surface there are four, three, or two tubercles, large, and of much the same size, on every interambulacral plate; below the ambitus in the ambulacral area there are two rows of primary tubercles; and from the ambitus to the actinostome two rows, gradually decreasing in size, are intercalated between these; above the ambitus the outer rows, which are continued to the abactinal pole, decrease at first rapidly in size. The other rows are likewise continued some way up the side of the test; but the tubercles diminish so much in size that they are with difficulty to be distinguished from the miliaries.

The anus is large, the genital rings narrow, the madreporite not much larger than the other genital plates; the ocular plates are excluded from the anal area. The auricles are very well developed, but the connecting ridges are rather low; the foramen is a little larger than in the form just described, is triangular, and is just

higher than the connecting ridge. The sutural furrows are barely indicated; there are pores, not pits, in the middle line.

Australia (coll. J. B. Jukes). E. coast Australia (Stutchbury?).

	Absolute diameter in millims.	Percentage value of			
		Height.	Abactinal area.	Anal area.	Actinostome.
i.....	72	61.1	16.6	9	25
ii.....	75	61.3	...	...	25.3
iii.....	102	64.7	...	...	21.08

IV. MESPILIA.

1. MESPILIA GLOBULUS.

I have not the time to notice in detail the bibliography of another writer; but there are some omissa of references and misprints in the bibliography and synonymy of this genus, as given in the 'Revision of the Echini,' that, to save future students a labour similar to that which has been imposed on myself, I will for a moment turn aside to point out.

On p. 143 *Mespilia* is ascribed to Agass., on p. 193 to Des. (*i. e.* Desor); a reference to the Catal. Raisonné (p. 357¹) shows that the latter authority is the correct one². In the reference to Klein the page (p. 16) is omitted; in that to Leske the page is again omitted (it is p. 152): pl. x. is a misprint for pl. xi., in the case of both these authorities. It is impossible to discover whether the MS. name of *versicolor*, first used by Agassiz in his 'Observations,' &c. published in the 2^{de} Monograph. des Echinodermes (1841), p. 7³, is to be ascribed to Valenciennes, who did name a number of Echinids, or to Valentin, who was a valuable collaborateur of Prof. Louis Agassiz. With such confusion, due to the adoption, without definition, of a MS. name, it is surprising that Mr. Agassiz should complete his synonymy with giving publication to a manuscript name by Michelin.

It is not the purpose of the present communication to give fresh definitions of all the genera or species, or there would be much to say of this interesting and beautiful form. The accessions to the Museum since the time when the geographical range of the species was stated in the 'Revision of the Echini' have been from three sources—(1) the Rev. S. J. Whitmee, (2) the collection of H.M.S. 'Challenger,' and (3) the collection of the late Dr. Bleeker,—these being (1) Samoa and Savaii, (2) Zamboanga, and (3) Celebes and New Guinea respectively; but they do nothing to increase the extent of its area. A specimen from the island of Masbate has long been in the collection of the Museum. An examination of the

¹ Ann. de Sc. Nat. (3) 1846, vi.

² Cf. also Desor, 'Réponse à M. Agassiz' (Syn. d. Echin. foss. p. xv).

³ This is ordinarily quoted by Prof. A. Agassiz as Int. Mon. Scut.; on this occasion, however, he prefers to refer to it as "Monog. Scut."

appended Table will show very clearly that the abactinal, anal, and actinal areas rather vary in individuals than grow smaller with age; in this point the species resembles rather *Amblypneustes* than *Temnopleurus*. The specimens vary considerably in colour, being in some cases banded with bright red and altogether devoid of a greenish hue; in another the bands are not purplish, but of a darker green at the base; in others the base of the spine is not light green, but is of a dark straw-colour. The variations in height are shown by the measurements to extend within wide limits.

	Absolute diameter in millims.	Percentage values of			
		Height.	Abactinal area.	Anal area.	Actino-stome.
i.....	16.5	78.7	21.2	10.9	33.3
ii.....	23.5	72.3	19.1	8.5	34
iii.....	24	84.5	18.7	8.75	33.7
iv.....	31	67.7	19.3	8.3	32.2
v.....	36	88.8	16.6	8.6	27.7
vi.....	40	85	...	...	25
vii.....	42.5	66.1	18.8	9.8	34.1

V. AMBLYPNEUSTES.

It will still, I fear, be some time before we shall be able completely to "unravel this difficult genus;" and so far as the difference in size of the genital pores is concerned, a new difficulty is almost as much introduced as old difficulties explained.

I have seen no specimen of *A. pentagonus*, A. Ag. If *Codechinus*, Desor, is really synonymous with *Amblypneustes*, the genus will differ from all its allies by passing back as far as the Lower Cretaceous formations; for even *Pleurechinus* and *Temmechinus* are, so far as we yet know, Tertiary forms¹. But *Codechinus* is defined by Desor as having no angular pores, and it is possible that the two genera are distinct.

I. AMBLYPNEUSTES OVUM.

	Absolute diameter in millims.	Percentage value of				Puriferous zone.
		Height.	Abactinal area.	Anal area.	Actino-stome.	
i. (?) ...	15	83.3	22	43.3	1.5
ii. (?) ...	21	88	20.3	10	33.3	
iii.	35	80.5	21.4	11.4	28.5	
iv.	40	102.5	20	9.7	28.7 ²	
v.	42	100	27	8.3	26.1	
vi.	47	100	15	7.5	21.3	
vii.	58	97.4	16	8	21.5		2.0

¹ Handbuch der Paläontologie (Zittel), i. 3, pp. 507-509, and Synop. des Échinides foss. p. 111.

² This is almost a pentagonal variety.

It is with some hesitation that I include in this rather unsatisfactory series the first and second examples, the great difficulty in the way of associating them with the larger specimens being the much greater proportional size of the tubercles on the test; other forms, however, present just the same relation, and the difference in the proportional size of the tubercles in examples iii. and vii. is itself sufficiently striking.

Two of the specimens in the Museum collection are stated to have been collected at the Cape of Good Hope. The test is sometimes reddish or purplish in colour, and it is not always that all the ocular plates are shut off from the anal area.

2. AMBLYPNEUSTES GRISEUS. (Plate XLI. figs. 4, 5, 6.)

The Table just following shows that there is a considerable variation in the proportions of the species; it will, however, be pointed out that these differences are associated with others which led to the possibility of their being different sex-forms. In any case, it is, without a large series of specimens, impossible to see fully how these differences run, and I am convinced that no good would be gained by attempting to affix distinct names to the two forms. Younger specimens than have yet come to hand will resolve some of the difficulties, and an examination of living specimens will do even more.

	Absolute diameter of test in millims.	Percentage value of				Poriferous zone.
		Height.	Abactinal area.	Anal area.	Actinostome.	
i.....	14	...	21·4	...	35·7	1·2
ii.....	28	89·2	22·1	11	31·1	1·9
iii.....	28	91·4	16	7·8	23·6	2
iv.....	28·5	...	21·9	...	35	2
v.....	33	...	...	...	33·3	2
vi.....	35	92·9	17·1	8·5	22·8	2·2
vii.....	40	90	22·5	10·2	27·5	2·3
viii.....	41·5	91·5	14·4	7·2	22·1	3·1
ix.....	42	75	20·2	10·6	29	2·6
x.....	45	86·6	14·4	6·6	20	3·5
xi.....	56	85·7	16	7·5	21·4	4·1

It does not require much observation to see that these measurements point to two distinct series of proportions among forms which by the other characters of their test appear to be most intimately allied: one series, represented by xi., x., viii., and vi., have a small actinostome, a small abactinal area, and a rather wide poriferous zone; the other, as seen in ix., vii., iv., has the actinal and abactinal areas very much larger and the poriferous zone rather narrower. With these characters two others, that cannot be represented in the Table, are associated; those with the small actinostome have much larger genital pores, and the madreporic plate is much more prominent. I hesitate, however, to separate them, for

in other points they are almost exactly alike. Is it possible that they are different sex-forms of the same species?

3. AMBLYPNEUSTES FORMOSUS.

Capt. Hutton states (Trans. New-Zealand Inst. ix. p. 352) that his *E. elevatus* (Catal. N.-Z. Echinodermata, p. 11) is synonymous with this species.

There are, as is well known, a number of specimens of this species to which it is easy enough to allot their place, and the only difficulties which arise are those which are consequent on the close affinity of the species *A. pallidus*.

What is of especial interest to note is that here, just as in the forms united under the head of *A. griseus*, there are two very distinct sizes of the genital pores; the distinction is obvious enough when a few specimens are carefully observed; but there is no great difference in the moderately-sized madreporic plate, nor can I arrive at any definite correlation of differences in proportion, similar to those already noticed in *A. griseus*. It is to be hoped that naturalists, who are enabled to get their specimens fresh, will be able to discover with what difference, if any, in the characters of the genital organs this difference is connected. I have been anxious to find some means of expressing this difference:—first, for the purpose of affording a standard to those who are also working at this subject; and, secondly, for the purpose of presenting the difference in relations distinctly to the minds of those who take a less special interest in the matter. By the kindness of a colleague I was provided with four entomological pins of different sizes; the most delicate was almost exactly half the diameter of the strongest; their numbers, for which neither he nor I are responsible, are respectively 2, 17, 14, 16. No. 2 is the most delicate, and no. 14 is thicker than no. 17; and no. 16 is the thickest, and is rather more delicate than an ordinary toilet-pin.

i. A specimen measuring 34·5 millims. in diameter just allowed the insertion of pin 16 into one of the genital pores.

ii. A specimen measuring 35·1 millims. in diameter was injured by pin 17.

iii. A specimen measuring 28 millims. would only admit the tip of pin 2.

iv. A specimen measuring 20·5 millims. easily admitted pin 17, and just refused 14.

v. A specimen measuring 21 millims. only admitted just the tip of pin 2.

Two series are therefore quite evident.

Prof. A. Agassiz has directed attention by his figures to the depressed and oviform varieties of the test; the succeeding Table illustrates this well enough, as it shows that the height may be only 84·1 or as much as 102 per cent. of the diameter of the test; the three other specimens present, however, a very striking similarity in proportion.

	Absolute diameter in millims.	Percentage value of				Poriferous zone.
		Height.	Abactinal area.	Anal area.	Actinostome.	
i.....	14	92·8	21·4	10	35·7	·9
ii.....	21·5	84·1	18·6	9·3	30·2	1·1
iii.....	28	92·8	17·8	...	28	
iv.....	34	91·1	17·6	8·8	24	
v.....	36	102	16·9	10	27·7	·2

The diminution in the proportional size of the abactinal or actinal areas is very fairly shown by this Table. The auricular foramen is sometimes almost a complete square; the auricles vary a little in height, but the connecting ridges are always low. The spines may be all white, or they may be of a light brick-red.

4. AMBLYPNEUSTES PALLIDUS.

Just as it is possible to distinguish a number of forms which, by their exquisite pattern, are seen to be specimens of *A. formosus*, so, too, it is possible to separate off a series of forms in which the pattern on the test is only visible on very close examination; these can at any rate be ranged under the head of *A. pallidus*. When the succeeding Table of measurements is compared with that of *A. formosus*, it will not be hard to formulate certain differences between them: the fifth specimen is interesting as presenting the oviform arrangement in having the height greater than the diameter; and here, as in *A. formosus*, we find an example of how greatly the species of this genus may vary in form. We find, moreover, that in *A. pallidus* (saving always specimen v.) the abactinal area increases in size with an increase in diameter, whereas in *A. formosus* it diminishes very markedly; so, again (again excepting v.), we find the actinostome to be not much larger or much smaller proportionately in specimens of different sizes, while in *A. formosus* the actinostome diminishes very much in size at a comparatively early stage, and then varies within considerable limits. These, however, though real characters, are not easily grasped, and it is difficult to say what points of distinction can be at once appealed to as readily accessible to the zoologist.

Prof. Alex. Agassiz states that the only points of difference which he can find between them are:—

- (1) The slight development in *A. pallidus* of the coloration and pattern of sculpture so distinctive of *A. formosus*.
- (2) The presence of secondaries and small miliaries in the narrow poriferous zone of *A. pallidus*.
- (3) The less numerous median sutural pores of the same form.
- (4) The greater uniformity [in size] and more irregular arrangement of the tubercles of *A. pallidus*¹.

¹ I base this view on the supposition that the word "separate," in line 9 of p. 482, is a *lapsus plumeæ* for "unite."

For the purpose of this investigation it is unnecessary to enter into a detailed comparison of the two admirable sets of figures of *A. formosus* and *A. pallidus* given by Valenciennes in the plates to the 'Voyage de la 'Vénus,'¹ for there is no question as to the existence of two very different forms; the difficulty lies rather in the presence of intermediate forms. Thus both Valenciennes and Agassiz would seem to look upon the rarer sutural pores of *A. pallidus* as an important distinction; but specimens, and those always small, will be found in which these pores are just as numerous as in *A. formosus*; and, on the other hand, there may be found examples of *A. formosus* in which the sutural pores are just as rare as in the typical *A. pallidus*. Again, although they are rare, secondaries and miliaries are to be found in the poriferous zones of *A. formosus*, and may be rare enough in *A. pallidus*.

I am, on the whole, inclined to keep these two species distinct; the differences in proportion are differences which, if, on further investigation, the results here attained to shall be confirmed, should of themselves be regarded as at least of equal value with such eminently variable characters as the number of pores or the distribution of miliary tubercles. But, while I thus exhibit a somewhat stronger inclination than Prof. Agassiz to keep the species separate, I shall, no less than he, look out anxiously for those intermediate forms, of which he speaks with such confidence.

	Absolute diameter in millims.	Percentage value of				Poriferous zone.
		Height.	Abactinal area.	Anal area.	Actinostome.	
i.....	17	84·7	15·2	...	32·3	1·1
ii.....	19·2	87·5	15·6	...	31·8	1·2
iii.....	31	91·9	19·3	10·3	30·6	1·9
iv.....	33·5	92·8	19·4	9·8	32·8	2
v.....	41	103	14·6	...	22·6	2

VI. HOLOPNEUSTES.

HOLOPNEUSTES POROSISSIMUS.

The single specimen by which this genus or subgenus is represented in the Museum belongs, I fancy, to this species, and not to *H. purpurascens*, as stated by Prof. Agassiz. I give the more important measurements, which throw into relief the rather small size of the actinal and abactinal areas, and the extraordinary development of the poriferous zone.

Diameter. millims.	Percentage value of				Poriferous zone.
	Height.	Abactinal area.	Anal area.	Actinostome.	
52	78·8	15·3	6·9	22·1	6·2

¹ Zoophytes, pl. ii.

EXPLANATION OF PLATE XLI.

- Fig. 1. Test of *Salmacis globator* (form α), p. 431; nat. size.
2. " " (form β); nat. size.
3. Apical area of *S. globator*, β ; somewhat magnified.
4. Apical area of *Amblypneustes griseus*, p. 436, from a specimen with large generative pores; somewhat magnified.
5, 6. *A. griseus*; the two forms, showing the difference in the width of the poriferous zone; nat. size.
7. Outline sketch of auricle of *S. globator*, α .
8. " " " " β .



Fig. 4.

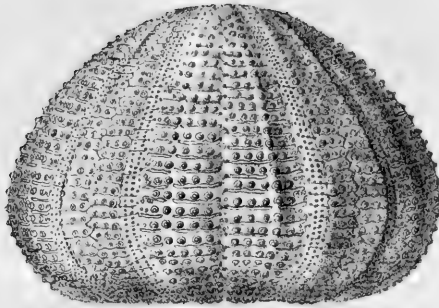


Fig. 1.

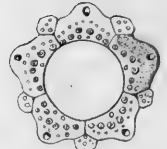


Fig. 3.

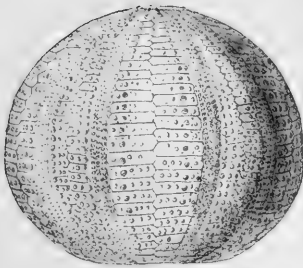


Fig. 5.

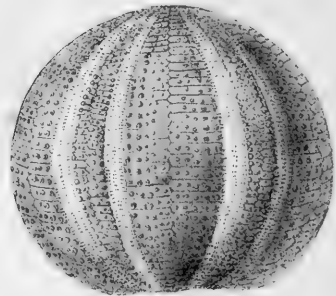


Fig. 6.



Fig. 7.

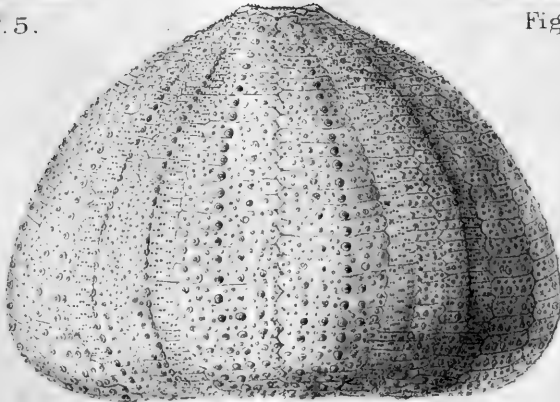


Fig. 2.

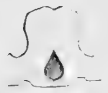


Fig. 8.





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