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Rediscovery of the Echinoid *Clypeaster tumidus* (Tenison-Woods) and an Emended Description

By R. Endean, Department of Zoology, University of Queensland, and Elizabeth Pope, The Australian Museum, Sydney

Plates 29 and 30. Figs. 1-7. Manuscript received 31.7.63

In 1878 Tenison-Woods described under the name *Echinanthus tumidus* an echinoid which was housed in the Australian Museum and which was believed to have come from the coast of New South Wales. The specimen was damaged in the region of the actinostome and the test was almost devoid of spines. Holes had been bored through the actinal surface, possibly with a view to mounting the specimen on a board. Bell (1884, plates II and III) amplified Tenison-Woods's brief description and erected a new genus, *Anomalanthus*, to accommodate the species. Subsequently, Mortensen (1948) placed the species in the genus *Clypeaster* but added little to knowledge of the species.

For decades the holotype remained the only representative of the species. Bell (1884) considered the species to be rare and possibly dying out whilst Lambert and Thiéry (1914) considered that the holotype was a fossil, and they attributed it to the Pliocene of Australia. However, in 1960 a specimen was dredged off Ball's Pyramid, Lord Howe Island, in 50-100 fathoms, and in 1961 another specimen was dredged off the coast of southern Queensland. Study of the new material and a re-examination of the holotype have revealed that many of Bell's (1884) statements concerning this species are both erroneous and misleading. In view of this, and also because of the inadequacy of Tenison-Woods's original description, it was decided to redescribe the species and to provide illustrations of the spines and pedicellariae.

The Lord Howe Island and Queensland specimens are illustrated in plates 29 and 30. Measurements for these specimens and for the holotype are as follows:—

Length (mm.)	Width (mm.)	Height (mm.)	Petaloid area (mm.)	Locality	Australian Museum No.
142	120	59	119	N.S.W.?	J. 1348
119	104	59	95	Lord Howe Is.	J. 7300
71	63	28	49	Queensland	J. 7343

Shape

The test in all three specimens is high and the margin elongate ovoid in outline. Both Tenison-Woods (1878) and Mortensen (1948) stated that the holotype is regularly arched. However, in all specimens there is a slight flattening (most pronounced in the Queensland specimen) around the test at the level of the distal ends of the poriferous zones. Thus the tests have short margins. Bell (1884) states that the test slopes " rather more sharply anteriorly than posteriorly ". Actually, the reverse is the case. Angles of slope for the three specimens are as follows:—

Specimen	Anterior	Posterior
Holotype	$46\frac{1}{2}°$	$50°$
Lord Howe Is. ..	$50\frac{1}{2}°$	$51\frac{1}{2}°$
Queensland ..	$43°$	$44°$

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The actinal surface is flattened, apart from the region around the actinostome which is deeply sunken.

In the holotype and in the Queensland specimen the sutures between the coronal plates are distinct, but in the Lord Howe Island specimen the sutures are rather indistinct near the margin of the corona.

Ambulacra

The petaloid area is extensive, its length being 0.70-0.84 that of the test length. In each specimen, the postero-lateral petals are the largest and the anterior petal is the shortest. Proximally, the pore pairs of each petal diverge from the apical system and each poriferous zone is V-shaped for slightly over half its extent. Then the two rows of pore pairs of each petal follow parallel courses almost to the distal extremity of each petal. The last one or two pore pairs are usually slightly closer together but each petal remains widely open distally.

Both pores of each pore pair are enclosed and linked by a furrow which is deep and sharply limited. For approximately half the distance along the length of each petal the furrows are oriented at right angles to the long axis of the petal. Distally, the outer pore of each pore pair is set closer to the margin of the test than is the inner pore. This arrangement is accentuated in the case of the last pore pair, and the furrow between these pores is usually curved. An apparent resemblance of the shape of each petal to that of a lyre (Bell, 1884) is the result of an optical illusion stemming from the arrangement of the furrows between the pores and is not borne out by measurements of the intervals between corresponding pore pairs.

The pores down the outer side of each petal are oval in outline and slightly larger than the rounded inner pores. Also, the pores at the distal end of each petal are slightly larger than those near the proximal end. Irregularities in pore size noted by Bell (1884) appear to be mainly due to occlusion of the pores of the somewhat damaged holotype and were not observed in the Lord Howe Island and Queensland specimens.

Distal to the petals small locomotive tube feet are common and they are very numerous in the ambulacral areas of the abactinal surface, particularly near the margin of the test.

On the actinal surface, the ambulacral furrows are well defined for most of their length from the peristome but they become shallower near the margin of the test.

The ambulacral plates widen markedly in the region between the distal ends of the petals and the margin, and at the margin and on the actinal surface the ambulacra are much wider than the interambulacra.

Interambulacra

The interambulacral areas are widest in the region near the distal ends of the petals. As occurs commonly in the Clypeastridae, the adoral interambulacral plate is separated from the following paired interambulacral plates by the interposition of the first two pairs of ambulacral plates.

Tubercles

The primary tubercles are irregularly scattered over the coronal plates but tend to be closer together on the plates near the margin. Those of the actinal surface are larger and more deeply sunken than those of the abactinal surface. The mamelon of each tubercle is highly polished and perforate. Closely packed miliary tubercles fill the spaces between the primary tubercles.

Apical system

The apical system is pentagonal and placed slightly anterior to the centre of the test. It is well covered with miliary spines which are scattered amongst the hydropores. Although Bell (1884) notes differences in the sizes of the five genital pores of the holotype, these differences are again due to occlusion of some of the pores as this area of the test is somewhat worn. After the pores had been cleaned by gentle brushing they were found to be equal in size, as is the case with the genital pores of both the Lord Howe Island and Queensland specimens. Bell also noted that one of the ocular pores of the holotype was enlarged and almost as large as the genital pores. It seems likely, however, that the ocular pore in question has been enlarged by probing. All the slit-like ocular pores are equal in size in the Lord Howe Island and Queensland specimens.

Periproct

The circular periproct is marginal and positioned at an angle of 45° to the actinal surface of the test. It is covered by small plates which bear spines.

Peristome

The peristome is small and deeply sunken.

Primary spines

The primary spines (fig. 1) are fusiform for most of their length but are usually attenuated distally. They are longitudinally grooved and terminate in simple points. In the Lord Howe Island specimen those on the abactinal surface average about 4 mm. in length whilst those on the actinal surface average about 5 mm. in length. The corresponding measurements for spines from the smaller Queensland specimen are 2 mm. and 3 mm. respectively. No spines are now associated with the holotype.

Miliary spines

Each miliary spine (fig. 2) is finely thorny throughout its length. The lengths of those from the abactinal surface average 1.1 mm. in the case of the Lord Howe Island specimen and 0.85 mm. in the case of the Queensland specimen, whilst those from the actinal surfaces average 1.2 and 0.75 mm. respectively.

Pedicellariae

Tridentate pedicellariae (fig. 3) are common on both actinal and abactinal surfaces of the Lord Howe Island and Queensland specimens. However, they are larger on the actinal surfaces of each specimen and their valves average 0.8 mm. in length. Each blade is slender and straight and the edges of the distal part are finely serrate.

The ophicephalous pedicellariae (figs. 4, 5, 6) are common on the abactinal surfaces but somewhat rare on the actinal surfaces of the two specimens. Their valves average 0.4 mm. in length. The spines on the lower part of each blade are strongly developed but the ophicephalous pedicellariae are of the usual shape and not especially characteristic.

The triphyllous pedicellariae (fig. 7) appear to be confined to the actinal surfaces. The valves of these pedicellariae average 110μ in length and are minutely serrated around their edges.

Occurrence

There is doubt as to the locality from which the holotype was secured but it is believed to have come from the N.S.W. coast. The Lord Howe Island specimen was dredged from 50-100 fathoms off Ball's Pyramid (22/11/1960) by Dr. J. MacIntyre, of the C.S.I.R.O. Fisheries Section (Station G 3/255/60). The Queensland specimen was dredged (7/6/1961) from 20 fathoms seaward of Stradbroke Island (Lat. 27° 31′ S.) by Professor W. Stephenson.

The discovery of these additional specimens dismisses Lambert and Thiéry's (1914) theory that the holotype was fossil in origin, and places *C. tumidus* as an inhabitant of the continental shelf off the eastern coast of Australia. Its range extends eastward at least as far as Lord Howe Island. Further dredging will undoubtedly result in the collection of more specimens and there is no evidence to support the statement of Bell (1884) that the species is rare and possibly dying out.

Colour

The Queensland specimen possesses a light-brown test and the primary spines are white. The dried test of the Lord Howe Island specimen is a darker chocolate brown and its primary spines are white, tipped with brown. The test of the holotype is faded brown or khaki.

Growth changes

Although the Queensland specimen is less than half the size of the holotype it possesses well developed genital pores and is undoubtedly adult. Judging from measurements of the tests of the three specimens available, it seems that the value of the ratio $\frac{\text{height}}{\text{length}}$ increases with age. (It is assumed that the largest specimen is the oldest). Also, the degree of swelling of the test seems to be related to age. The tests of the holotype and Lord Howe Island specimen are markedly swollen whereas the smaller Queensland specimen gives only slight indication of this swelling.

The number of primary tubercles on the ridges between the paired pores of the poriferous zones increases with age. Thus there is one (occasionally two) primary tubercle on these ridges in the case of the Queensland specimen, whilst in the Lord Howe Island specimen the number varies between one and three and in the holotype from one to five.

The size and number of primary tubercles elsewhere on the test seem to increase with age, and probably the dimensions of the primary spines attached to these tubercles increase also. Those from the Lord Howe Island specimen average twice the length of those from the Queensland specimen.

Relationships

Bell (1884) considered that the specimen which Tenison-Woods named *Echinanthus tumidus* differed sufficiently from other clypeastrids to warrant the erection of a new genus, *Anomalanthus*. In his definition of the genus Bell stated that " the ambulacral pores are arranged in rows which are not closed or quite parallel, but which tend to spread out after a lyre-shaped fashion at their distal end ". However, the two rows of pore pairs at the distal end of each petal do not spread out after the manner of a lyre but are essentially parallel. Amongst the fossil clypeastrids are found many species in which the pore series of each petal are parallel or diverge distally. In some recent species similar arrangements of the pore series are found. Accordingly, *Clypeaster tumidus* cannot be separated from all other clypeastrids solely because of the shape of its petals.

When defining the genus *Anomalanthus*, Bell (1884) also stated that the actinal surface is free of pores, that the ambulacral grooves on the actinal surface are inconspicuous, that the genital pores are of unequal size and that the tubercles are regularly distributed over the whole test. These statements are all erroneous. Bell stated further that one ocular pore is enlarged. Although one of the ocular pores in the holotype is enlarged, this enlargement is probably due to probing. Bell's statement that the primary tubercles are perforate could apply to any clypeastrid. Indeed the only valid feature mentioned by Bell in his definition of the genus *Anomalanthus* which could conceivably be used as a basis for generic distinction concerns the marginal position of the periproct. The only other clypeastrid with a marginal periproct is *Clypeaster europacificus* (Clark) but in this species the periproct is set in a distinct notch. However, none of the other structural features of *C. tumidus* is especially characteristic and it appears unwise to give *C. tumidus* a new generic rank principally because of the marginal position of its periproct. Indeed, Mortensen (1948) after taking cognizance of the great polymorphism exhibited by both fossil and recent clypeastrids placed all of them in the genus *Clypeaster*.

Bell (1884) considered that *C. tumidus* was a primitive form unable to compete with organisms which were " more plastic and more easily adaptable and adapted to the conditions of their present environment ". Clark (1914) thought that discovery of further specimens would throw light on the phylogeny of clypeastrids. According to Mortensen (1948), the most primitive clypeastrids are those with straight pore series and, in this respect, *C. tumidus* may be primitive. However, the structural features of *C. tumidus*, with the possible exception of the marginal position of the periproct, are not especially characteristic nor do they throw light on the phylogeny of clypeastrids, and there appears to be no valid reason why *C. tumidus* should be removed from the genus *Clypeaster*. On the other hand, it does not appear to be closely allied to any of the fossil species and it possesses a combination of structural features which enable it to be separated readily from any of the recent species.

Definition of species

The species may be defined as follows:—

Large form of elongate ovoid outline, high test with short margin, apical system anterior to centre of test, petals widely open and only slightly sunken, distal ends of pore series of each petal parallel and reaching almost to margin of test, peristome deeply sunken, periproct marginal.

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EXPLANATION OF FIGURES 1-7

Fig. 1. Primary spine from oral surface of Lord Howe Island specimen.
Fig. 2. Miliary spine from oral surface of Queensland specimen.
Fig. 3. Valve of tridentate pedicellaria of Queensland specimen.
Fig. 4. Valve of ophicephalous pedicellaria of Queensland specimen.
Fig. 5. Valve of ophicephalous pedicellaria of Queensland specimen.
Fig. 6. Valve of ophicephalous pedicellaria of Queensland specimen, side view.
Fig. 7. Valve of triphyllous pedicellaria of Queensland specimen, side view.

EXPLANATION OF PLATE 29

Clypeaster tumidus (Tenison-Woods)

Fig. 1. Oral surface of the Lord Howe Island specimen (length 119 mm.).
Fig. 2. Aboral surface of the Lord Howe Island specimen.

EXPLANATION OF PLATE 30

Clypeaster tumidus (Tenison-Woods)

Fig. 1. Side view of the Lord Howe Island specimen.
Fig. 2. Side view of the Queensland specimen (length 71 mm.).
Fig. 3. Aboral surface of the Queensland specimen.

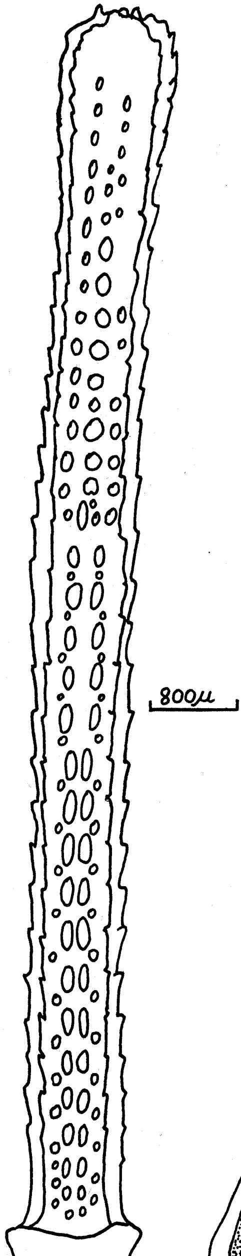


Fig. 2

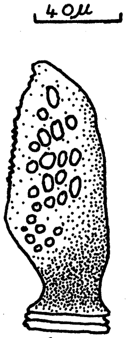


Fig. 7

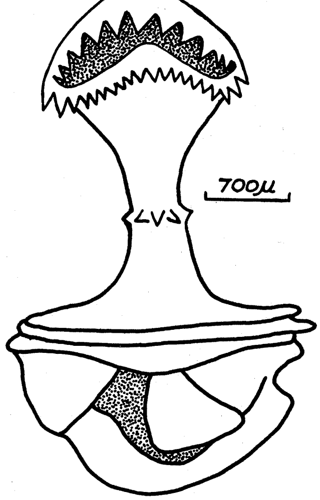


Fig. 4

Fig. 6

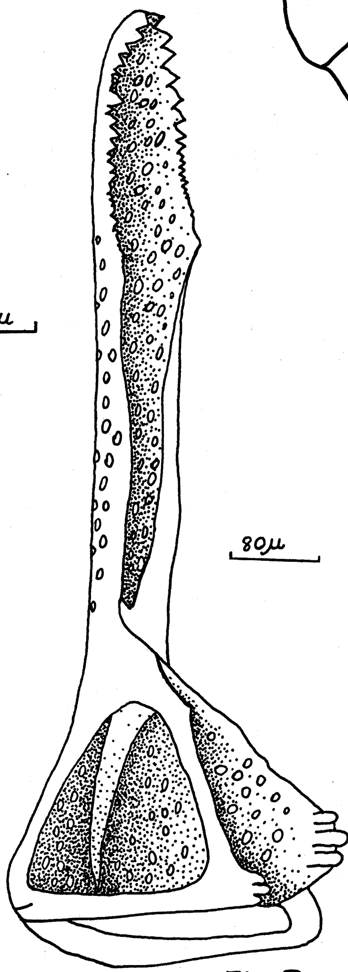


Fig. 3

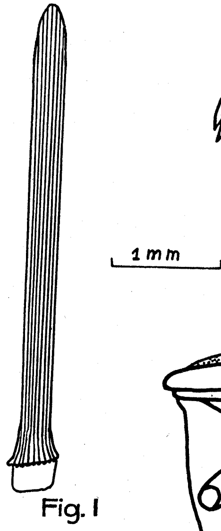


Fig. 1

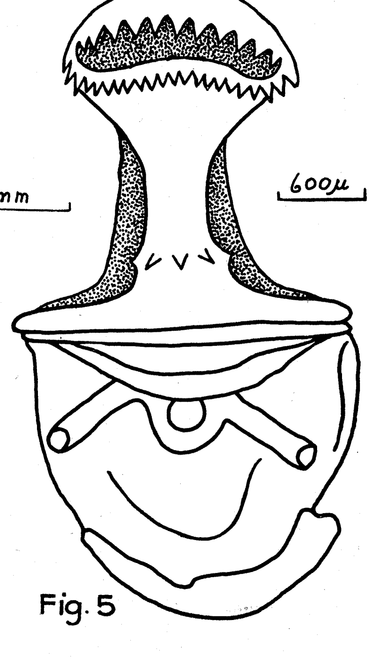
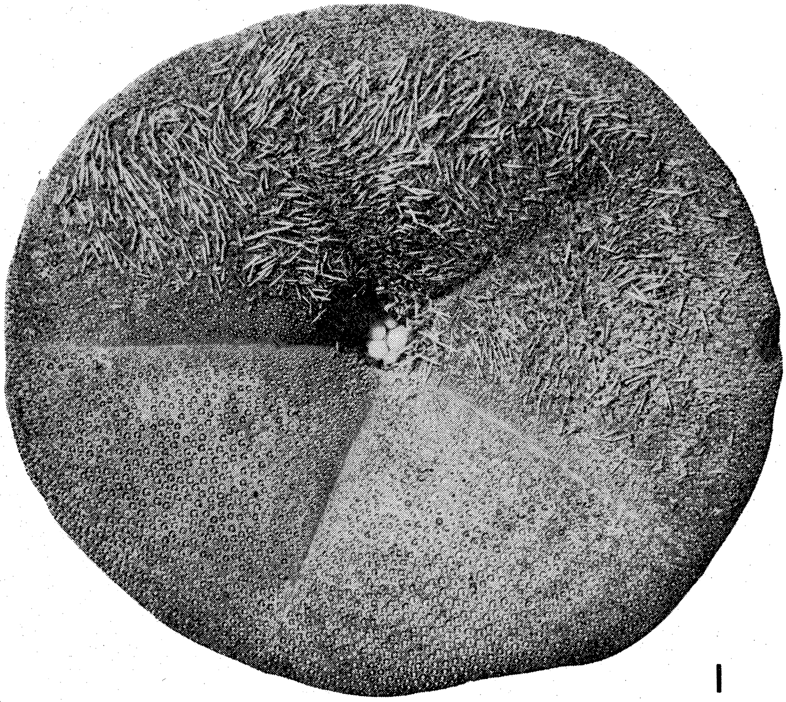


Fig. 5

Figs. 1-7



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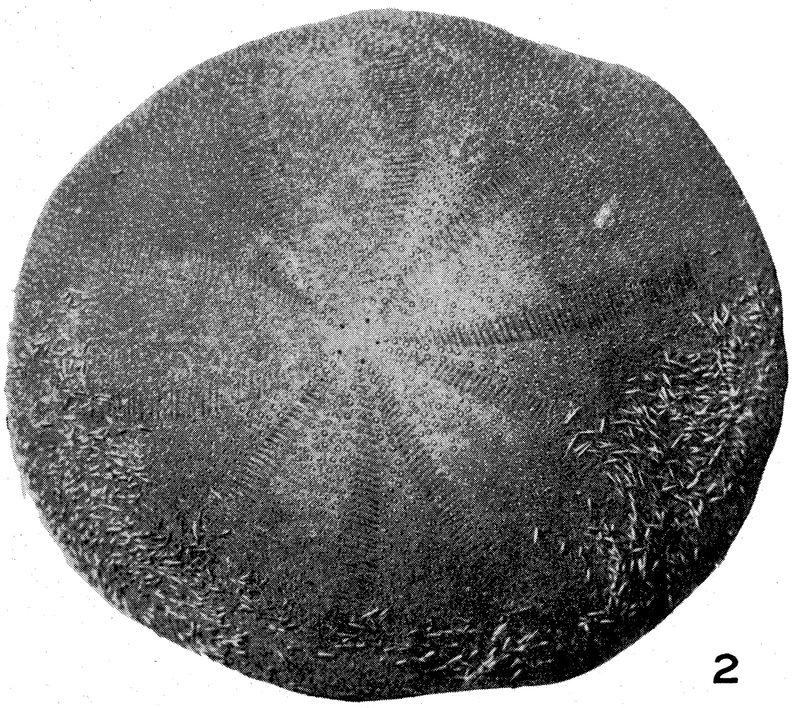

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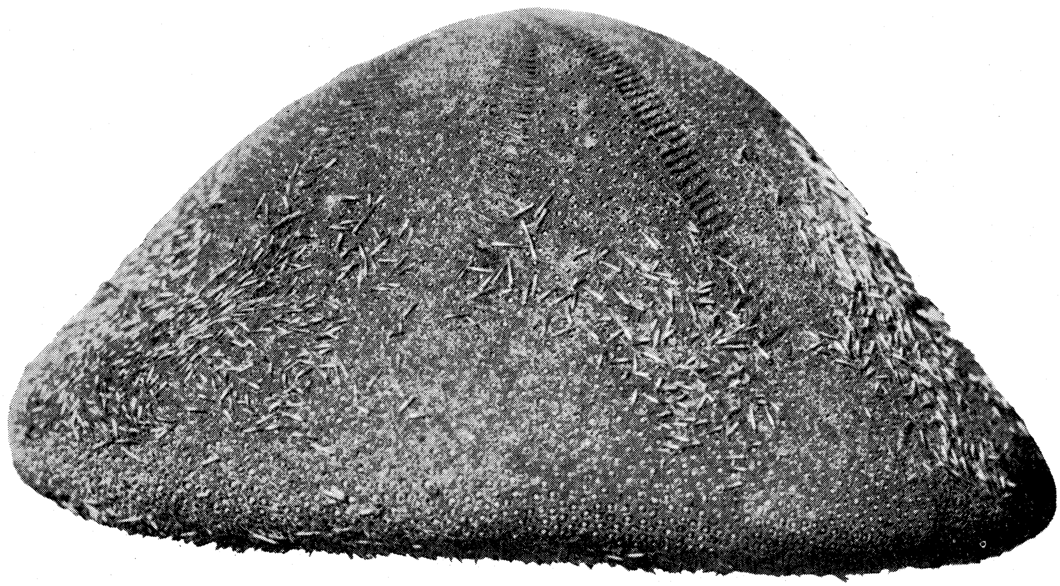

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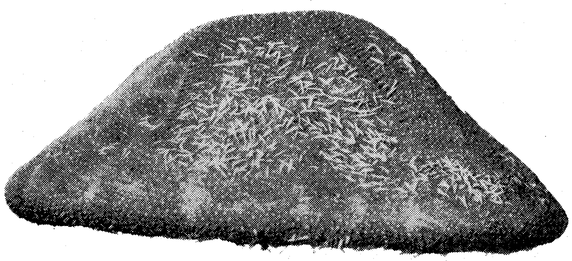

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