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NOTES ON TWO SPECIES OF *ECHINASTER* MÜLLER AND TROSCHEL (ECHINODERMATA: ASTEROIDEA) FROM THE INDIAN OCEAN

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(With 1 Plate and 3 Tables)

INTRODUCTION

While studying the unnamed asteroids of the Zoological Survey of India, the authors came across some specimens of the genus *Echinaster* Müller and Troschel, collected from several localities in the Indian Ocean. On examination these were found to belong to two species, *E. purpureus* (Gray) and *E. luzonicus* (Gray). Both the species together with a third, *E. varicolor* H. L. Clark, have been distinguished from one another by the shape of the arms, appearance of the subambulacral area and capability for autotomy. However, the present material also includes some specimens showing intermediate characters, thereby suggesting their probable conspecificity. The present paper discusses variations observed along with the taxonomic status of these species and also includes some new distributional records.

SYSTEMATIC ACCOUNT

CLASS : ASTEROIDEA

ORDER : SPINULOSIDA

FAMILY : ECHINASTERIDAE

1. **Echinaster purpureus** (Gray)

(Plate I, Figs. 1-3)

1840. *Othilia purpurea* Gray, *Ann. Mag. nat. Hist.*, (i) 6 : 282.

1910. *Echinaster eridanella* : Koehler, *Echinoderma of the Indian Museum*, Part VI : 174.

1915. *Echinaster eridanella* : H. L. Clark, *Spolia zeylan.*, 10 : 89.

1926. *Echinaster purpureus* : Mortensen, *Trans. zool. Soc. Lond.*, 28 : 121.

Table 1. *Echinaster purpureus*

(All specimens have five arms and one madreporite)

Sl. No.	Locality	Reg. No.	R(mm.)	r (mm.)	br(mm.)	R/r	R/br	Remarks
1.	Suez Canal	E 696/1	70	8.5	10.0	8.2	7.0	Arms equal. Subambulacral area bare.
2.	Mauritius	E 404/1	45	7.5	7.5	6.0	6.0	Arms equal. Subambulacral spines continuous at the base of three arms, discontinuous in the remaining two arms.
3.	"	"	45	7.5	8.0	6.0	5.6	Four arms equal, fifth 33 mm. long. Subambulacral spines discontinuous in two arms, coninuous on one side and discontinuous on the other side of third arm and absent in the remaining two arms.
4.	Okha	E 699/1	95	10.0	10.5	9.5	9.0	Arms subequa R=75—95 mm. Subambulacral spines continuous.
5.	"	E 697/1	95	8.5	11.0	11.2	8.6	Arms equal. Subambulacral spines continuous.
6.	Beyt Island	E 698/1	140	13.5	13.5	10.4	10.4	" " " " "

1969. *Echinaster purpureus* : James, *Bull. Cent. mar. Fish Res. Inst.*, 7: 54.
1971. *Echinaster purpureus* : Clark and Rowe, *Monograph of Shallow-water Indo-West Pacific Echinoderms*, : 73.

Material : (i) 1 ex. Suez Canal (Received from *R. B. Seymour Sewell* on 8.i.1917) Z.S.I. Reg. No. E 696/1. (ii) 2 exs. Mauritius (*Berlin Mus.* Exch.) Z.S.I. Reg. No. E 404/1. (iii) 1 ex. Three miles SE of Okha Port, Gulf of Kutch, 22.i.19 2. Z.S.I. Reg. No. E 697/1. (iv) 1 ex. Beyt Island, near Okha, Gulf of Kutch, 31.xii. 1954. *T D. Soota*, Coll. Z.S.I. Reg. No. E 698/1. (v) 1 ex. Okha, Gulf of Kutch, 12.iii.1966. V. C. *Agrawal*, Coll. Z.S.I. Reg. No. E 699/1.

Description (*Table* 1) :

R=45—140 mm.; R/r = 6.0—11.2; R/br=5.6-10.4.

Arms five, long, cylindrical and subequal in length. Madreporite single. Abactinal surface reticular with short blunt spines. Furrow spines stout, round or slightly spatulate, often united by thick skin giving a serrate appearance. Subambulacral area generally bare, sometimes with a continuous or discontinuous series of short spines.

Remarks : The specimens show different degrees of variation in the compactness of the abactinal reticulum as well as in the occurrence of subambulacral spines. Thus the abactinal reticulum is wide in the single specimen from the Suez Canal and relatively compact in those from other localities. The variations in the subambulacral spines are presented in table 1.

Distribution: Red Sea, East coast of Africa, Islands of the western Indian Ocean, Gulf of Kutch and Bay of Bengal.

Generally a shallow-water species, though Bell (1909) reported it from 504 m. at Desroches in the western Indian Ocean which however needs confirmation.

The species is recorded here for the first time from the Gulf of Kutch.

2. Echinaster luzonicus (Gray)

(Plate I, Figs. 4—9)

1840. *Othilia luzonica* Gray, *Ann. Mag. nat. Hist.*, (i) 6 : 282.
1919. *?Othilia purpurea* : Fisher, *U. S. Nat. Mus. Bull.*, 100 (III) : 432. Non: *Othilia purpurea* Gray, 1840.
1921. *Echinaster luzonicus* : H. L. Clark, *Pap. Dep. mar. biol. Carnegie Instn.*, 10 : 98.
1969. *Echinaster luzonicus* : James, *Bull. Cent. mar. Fish. Res. Inst.*, 7 : 54.
1971. *Echinaster luzonicus* : Clark and Rowe, *Monograph of Shallow-water Indo-West Pacific Echinoderms*, : 72.
1974. *Echinaster luzonicus* : Marsh, *Micronesica*, 10 : 93.

Table 2. *Echinaster luzonicus*

(The specimen (Sl. No. 12) has four madreporites; the remainder have only two.)

Sl.No.	Locality	Reg. No.	No. of Arms.	R(mm.)	r (mm.)	br(mm.)	R/r	R/br	Remarks
1.	Horsburgh Atoll	E 700/1	6	50	5.5	7.0	9.1	7.1	One arm 50 mm., others 10-30 mm. Subambulacral series continuous.
2.	Beyt Island	E 701/1	6	120	14.0	14.0	8.6	8.6	Arms subequal. Subambulacral area bare or with discontinuous series of spines at the base and continuous only towards the tip.
3.	Andaman Sea	E 702/1	7	85	11.0	10.5	7.7	8.1	Arms unequal, R=40—85 mm. for six arms, the seventh broken at the base. Subambulacral area bare, interrupted here and there by a few spines.
4.	Camorta Island	E 703/1	5	60	8.0	8.5	7.6	7.1	One arm 60 mm., others 14-45 mm. Subambulacral series continuous.
5.	"	"	5	65	8.0	9.0	8.1	7.2	Two arms 65 mm., others 11-23 mm. Subambulacral series continuous.
	"	"	5	75	11.0	12.0	6.8	6.3	One arm 75 mm., two arms 65 mm. remaining 35 and 45 mm. respectively Subambulacral series continuous.

7.	"		6	32	7.0	7.0	4.6	4.6	Arms unequal, R=19-32 mm. Subambulacral series continuous.
8.	"	"	6	35	8.5	7.5	4.1	4.7	Four arms 30-35 mm., remaining 15 mm. Subambulacral series continuous.
9.	"	"	6	45	10.0	9.0	4.5	5.0	One arm 45 mm., remaining 30-35 mm. Subambulacral series continuous.
10.	"	"	6	55	9.0	8.0	6.1	6.9	One arm 40 mm., remaining 55 mm. Subambulacral series continuous.
11.	"	"	6	65	10.0	10.0	6.5	6.5	Two arms 60 and 65 mm., respectively, remaining 20-34 mm. Subambulacral series continuous.
12.	"	"	7	55	10.0	9.0	5.5	6.1	Two arms 55 mm., three arms 45 mm., remaining two arms 30 and 35 mm. respectively. Subambulacral series continuous.

Material : (i) 1 ex. Stn. 649. Boulder zone of marginal reef, Horsburgh Atoll, Maldive Is., 22.X.1923, *R.I.M.S. 'Investigator'*, Coll. Z.S.I. Reg. No. E 700/1. (ii) 1 ex. Beyt Island, near Okha, Gulf of Kutch, 31.xii. 1954, *T D. Soota*, Coll. Z.S.I. Reg. No. E 701/1. (iii) 1 ex. Stn. 222. Andaman Sea, 13° 27′ N 93° 14′ 30″ E, 729 m., 21.xii. 1896, *R.I.M.S. 'Investigator'*, Coll. Z.S.I. Reg. No. E 702/1. (iv) 9 exs. Camorta, Nicobar Is., 9.x. 1972, *K. Reddiah*, Coll. Z.S.I. Reg. No. E 703/1.

Description (*Table* 2) :

R=32–120 mm.; R/r=4.1—9.1; R/br = 4.68—.6.

Arms five to seven, often unequal in length. Madreporites two to four. Abactinal reticulum generally compact with often slender spines. Furrow spines long, sometimes united by thick skin. Subambulacral spines generally distinct from the actinal spines and in a continuous row.

Remarks : These specimens also show different degrees of variation in the compactness of the abactinal reticulum as well as in the occurrence of subambulacral spines. Thus the abactinal reticulum is campact in the specimens from Camorta Island and more open in those from the other localities. The variations in the subambulacral spines are presented in table 2.

This species is known to reproduce by autotomy and regeneration and the arms are unequal in all the specimens except the one from Beyt Island, in which they are subequal. The specimen from the Maldive Is. is a 'comet' form with one arm 50 mm. long and five regenerating arms 10-30 mm. long. It is interesting to note that some of the madreporites in the specimens from Camorta Island are irregular in shape and extend to the sides of the disc along the interradii (Fig. 8) or to the base of the adjacent arms.

Fisher (1919) considered *E. luzonicus* as conspecific with *E. purpureus*. From the geographical occurrence and description, most of his specimens of *Othilia purpurea* appear to belong to *E. luzonicus*. There were also in his collections a few five-rayed specimens with equal arms and single madreporite which may as well belong to *E. purpureus*.

Distribution : Maldive Is., Gulf of Kutch, Bay of Bengal, East Indies, China Sea, Japan, Australia and Islands of South Pacific.

Generally a shallow-water species. However, the present material includes a specimen from 729 m. in the Andaman Sea.

The species is recorded here for the first time from the Maldive Is., Gulf of Kutch and the Andaman and Nicobar Is.

DISCUSSION

The three Indo-West Pacific representatives of the asteroid genus *Echinaster*, *E. purpureus* (Gray), *E. luzonicus* (Gray) and *E. varicolor* H. L. Clark, are distinguished from one another by the shape of the arms and occurrence of subambulacral spines. A perusal of the available literature reveals not only that these characters show a very wide range of variation, but there is also limited correlation between some of the morphological variations and geographical distribution, resulting in confusion regarding the identification and distribution of these species.

Gray (1840) described *E. purpureus* as 'purplish (i.e. when preserved) and with rays three times as long as the width of the body' (R=6 r) and *E. luzonicus* as 'reddish brown and with five or six rays, four times as long as the width of the body' (R=8r). It appears that Brown (1910), Clark (1915) and Fisher (1919) considered them to be conspecific.

Later, Clark (1921) separated these two species and subsequently (1938) described a third, *E. varicolor*, from Australia, distinguishing them from one another, chiefly by the shape of the arms as determined by R/r and R/br ratios and the occurrence of the subambulacral spines. However, the observations of A. M. Clark (in Clark and Rowe 1971) and of the present authors (Table 3) show that these ratios are variable and the ranges of variation overlap.

Though A. M. Clark used the occurrence of the subambulacral spines in distinguishing these species, she nevertheless noticed their variability. In our material also, they vary in the specimens of both species, collected from the same or nearby locality and even in different arms of the same specimen. Thus, in all the specimens of *E. purpureus* from the Gulf of Kutch (Fig. 3) the subambulacral spines are in a continuous series[1] in one of the two from Mauritius they are continuous in three arms and discontinuous in the remaining two, and in the other they are continuous in two arms, continuous on one side and discontinuous on the other side in one arm and totally absent in the remaining two arms and finally in the specimen from the Suez Canal they are totally absent.

Regarding *E. luzonicus*, in the specimen from the Gulf of Kutch (Fig. 6) the subambulacral spines are either totally absent or are in a discontinuous series proximally and in a continuous series only distally; in those from the Maldive Is. and Andaman Sea (Figs. 4, 7) they are

[1] Recently one of us (D.R.K.S.) examined two specimens of *E. purpureus* collected from the Gulf of Kutch and present in sir P. P. Institute of Science, Bhavanagar. These show five subequal arms, single madreporite and continuous series of conspicuous subambulacral spines.

Table 3. Comparison of published and observed variations in three nominal species of *Echinaster* Müller and Troschel

Sl. No.	Character	*E. Purpureus*	*E. luzonicus*	*E. varicolor*	*Present material*
1.	Arms	Five, equal or subequal with stout base and tapering tip	Five or more, unequal, cylindrical	Same as in *E. purpureus*	*E. purpureus* with cylindrical arms. *E. luzonicus* with subequal arms and arms with stout base and tapering tip.
2.	R/r	6-7 (H. L. Clark, 1921) 5.6-9.6 (Mean 7.3) (A.M.Clark, 1971)	7-10.5 (H. L. Clark, 1921) 5.6-9.5 (Mean 6.8) (A.M.Clark, 1971)	8-10 (H.L.Clark, 1938) 5.8, 6.4, 7.3 (A.M.Clark, 1971)	*E. purperus* 6-11.2 (Mean 8.6). *E. luzonicus* 4.1-9.1 (Mean 6.6).
3.	R/br	5.5-6.5 (H.L.Clark,1921) 4.8-8.6 (Mean 6.3) (A.M.Clark, 1971)	7-10.5 (H.L.Clark, 1921) 5.6-8.4 (Mean 6.8) (A.M.Clark, 1971)	6-8.5 (H.L.Clark, 1938)	*E. purpureus* 5.6-10.4 (Mean 7.8). *E. luzonicus* 4.6-8.6 (Mean 6.5).
4.	br-r	br greater than r	br equal to or less than r	br greater than r	*E. purpureus* with *br* equal to r. *E. luzonicus* with br greater than r.
5.	Subambulacral area	Bare or with discontinuous series of spines	Continuous series of spines	Spines continuous only at the base of arms	*E. purpureus* with continuous serie. of spines. *E. luzonicus* with bare subambulacral area or discontinuous series of spiness

either totally lacking or are scattered and very discontinuous and finally in all the specimens from Camorta Island they are distinctly arranged in a continuous row (Fig. 9)[2]

Further, A. M. Clark observed that the abactinal reticulum was more compact in *E. luzonicus* than in the other two species. However, we find that it is compact only in the specimens from Camorta Island (Fig. 8) while it is somewhat wide in those from the remaining localities (Fig. 5) thus resembling the specimens of *E. purpureus* (Fig. 2).

While *E. luzonicus* is autotomous with five or more unequal arms, *E. purpureus* and *E. varicolor* consistently have only five equal or subequal arms. But it is not always possible to distinguish the autotomous specimens as in the case of Fisher's (1919) six-rayed specimens with a single madreporite, from the Sulu Archipelago and our six-rayed specimen with subequal arms and two madreporites, from Beyt Island (Table 2, No. 2) and the five-rayed specimen with one shorter arm, from Mauritius. (Table 1, No. 3) Moreover, Clark (1921) included specimens with five equal arms and a single madreporite under *E. luzonicus* and later (1938) erected *E. varicolor* for similar specimens with the sumbabulacral series continuous only at the base of the arms. But A. M. Clark who compared specimens, including a paratype of *E. varicolor* and two syntypes of *E. purpureus*, did not find significant differences among them.

In view of the extent of variation found, it appears that all three nominal species may be conspecific. From a comparative study (Table 3), it appears likely that *E. varicolor* is conspecific with *E. purpureus*. There is also a strong indication that *E. luzonicus* too may be conspecific with *E. purpureus*. However, nothing definite can be stated until their reproductive behaviour and the probable influence of ecological factors on the morphological variations are studied (see Achituv, 1969; Thayer, 1975).

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[2] We also examined, five more specimens of *E. lmonicus* from Camorta Island, collected by Dr. K. Reddiah and party on 8-10-1972. Four of these specimens show six unequal arms while the fifth shows four such and a fifth broken at the base. In all the five specimens the subambulacral area is bare.

SUMMARY

Two species of the asteroid genus *Echinaster* M. & T., *E. purpureus* (Gray) and *E. luzonicus* (Gray) are reported, both of which are recorded for the first time from the Gulf of Kutch, in addition, *E. luzonicus* from the Maldive, Andaman and Nicobar Islands. Variations observed in the present material throw some doubt on the validity of *E. luzonicus* and *E. varicolor* H. L. Clark, as distinct from *E. purpureus*. Their taxonomic status is discussed in the light of observed variations.

REFERENCES

ACHITUV, Y. 1969. Studies on the reproduction and distribution of *Asterina burtoni* Gray and *A. wega* Perrier (Asteroidea) in the Red Sea and the eastern Mediterranean. *Israel J. Zool.* **18** : 329—342.

BELL, F. J. 1909. Report on the Echinoderms (other than Holothurians) collected by Mr. J. Stanley Gardiner in the western parts of the Indian Ocean. *Trans. Linn. Soc. Lond. Zoology.* (2) **13** : 17—22.

BROWN, R. N. R. 1910. Echinoidea and Asteroidea from the Mergui Archipelago and Moskos Islands, Lower Burma. *Proc. R. Phys. Soc. Edin.* **18** : 21—35.

CLARK, A. M. and ROWE, F. W. E. 1971. *Monograph of shallow-water Indo-West Pacific echinoderms.* British Museum (Natural History) London. Publication **69 0** : 1—238.

CLARK, H. L. 1915. The echinoderms of Ceylon, other than holothurians. *Spolia Zeylan.* **10** : 83—102.

CLARK, H. L. 1921. The echinoderm fauna of Torres strait. *Pap. Dep. mar. biol. Carnegie Inst. Wash.* **10** : 1—223.

CLARK, H. L. 1938. Echinoderms from Australia. *Mem. Mus. Comp. Zool. Harv.* **55** : 1—596.

FISHER, W. K. 1919. Starfishes of the Philippine Seas and adjacent waters. *U. S. Nat. Mus. Bull.* **100** (III) : 1—711.

GRAY, J. E. 1840. A synopsis of the genera and species of the class Hypostoma (*Asterias* Linn.) *Ann. Mag. nat. Hist.* (1) **6** : 175—184, 275—290.

THAYER, C. W. 1975. Morphological adaptations of benthic invertebrates to soft substrata. *J. Mar. Res.* **33** (2) : 117—189.