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Some observations on the morphology of *Sclerasterias richardi* a rarely encountered Mediterranean Sea star (Echinodermata: Asteriidae)

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Abstract

The presence of specimens of the asteroid Sclerasterias richardi (Perrier, 1882) in Maltese waters, with some new details of its morphology (observed by SEM) and with special reference to its madreporites, is reported.

Keywords: *Sclerasterias richardi;* Asteriidae; Mediterranean Sea; SEM observations.

Introduction

Sclerasterias richardi (Perrier, 1882) is a small (max 30 mm in diameter) asteroid belonging to the order Forcipulatida, of the family Asteriidae. In the Mediterranean there are four species in this order *Coscinasterias tenuispina* (Lamarck, 1816), *Marthasterias glacialis* (Linnaeus, 1758), *Sclerasterias neglecta* (Perrier, 1891) and *Sclerasterias richardi* (Perrier, 1882). Although several authors have reported *S. richardi* in the Mediterranean Sea, it has always been considered as a rarely encountered species (KOEHLER, 1924; PÉRÈS & PICARD, 1956; TORTONESE, 1965; FALCONETTI *et al.,* 1976). This is mainly due to the depth and the type of habitat in which the species is always encountered. In the past, specimens of *S. richardi* were considered a fissiparous phase of an unknown adult such as *S. neglecta* (TORTONESE, 1965; CLARK & DOWNEY, 1992). The main differences between these two species, both present in the Mediterranean (HANSSON, 2001), are that *S. neglecta* can reach 160 mm in diameter (TORTONESE, 1965), possesses five arms and is reddish-brown in colour while *S. richardi* has always been reported as 'small' (up to 30 mm) and in different shapes. *S. richardi* may have six equal or unequal arms, e.g. three long and three shorter or three long and two shorter , or only two or three arms (TORTONESE, 1965; FALCONETTI *et al.,* 1976). Specimens with a single long arm and four or five smaller ones (the comet star form) are

also known to occur. Moreover, while *S. neglecta* has been reported as having a single madreporite, the much smaller *S. richardi* has either one or two madreporites (TORTONESE, 1965; the present note) and also ripe gametes (FALCONETTI *et al.,* 1976). Furthermore, no recent records are reported on the presence of the much larger *S. neglecta* for the Mediterranean. CLARK & DOWNEY (1992) in their treatment of the Atlantic Asteriidae cite *S. richardi* as a probable synonym of *S. neglecta* but do not mention anything on the madreporite of that species. In addition, they state that there is some doubt about the systematic position of this species.

Material and Methods

During the research cruise MARCOS, on board the CNR Research Vessel URANIA in April 2007, 25 specimens of *S. richardi* were found on the west side of Gozo Island (Maltese Archipelago). The specimens were recovered in one van Veen grab sample and in two trawls carried out using an Agassiz trawl net (Table 1). The substratum in which the specimens of *S. richardi* were found consisted of live and dead rubble of mixed coralline algae species (Maerl), at depths ranging from 135 to 208 m. The collected specimens were preserved in alcohol (70%). After a primary inspection under a stereomicroscope to determine the asteroids to species level, a few specimens were dried and electroplated with gold for SEM observations.

Results

The collected specimens were all small in size. The maximum diameter of a complete specimen with six arms was 22 mm. Although many of the specimens had the six arm morphology, with very variable R-r ratios, others had five, four or less arms, also with a very variable R-r ratio. (Table 2 & Fig. 1).

The aboral sides of the disc and arms are covered with regular rows of short,

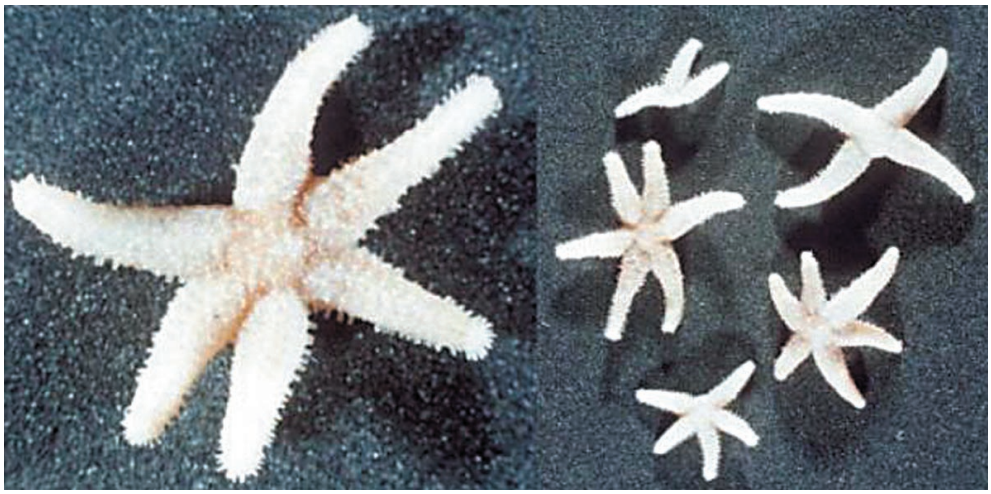

Fig. 1: Specimens of *Sclerasterias richardi* collected from western Gozo Island (Malta) (April 2007) with 3 to 6 arms.

Table 1
List of the sampling sites in which specimens of *S. richardi* were found (MARCOS cruise, April 2007), with indication of cruise code station, number of specimens (N), date, gear, geographic coordinates, type of substratum and depth.

Station	N	Date	Gear	Geographic coordinates	Substratum type	Depth (m)
MS 48	1	13/04/07	Grab	N36°03.626' E14°10.895'	mixed Maerl and gravel	135
MS 57	2	14/04/07	Agassiz Trawl	Start-N36°03.150' E14°09.650' End-N36°01.721' E14°09.779'	Maerl	177 185
MS 58	22	14/04/07	Agassiz Trawl	Start-N36°02.910' E14°09.410' End-N36°01.022' E14°10.343'	Maerl	160 208

Table 2
Maximum diameter and different number of arms of *S. richardi* collected from the west side of Gozo Island (Malta, April 2007).

n. of arms	n. of specimens	Max. size
Six arms	eleven	22 mm
Five arms	six	18 mm
Four arms	three	16 mm
Three arms	four	16 mm
Two arms	nil	----
Single arm	one	7 mm

stubby spines, armed with small spinelets at their distal ends (Fig. 2a). There may be one (Fig. 2b) or two madreporites (Fig.2c). The shapes of the madreporites observed by SEM are very different. In particular Figure 2b shows a specimen of *S. richardi* with a U-shaped madreporite encircled by stubby spines, while Figure 2c shows a specimen in which there are 2 madreporites with different shapes, the first with two S- and C-shaped openings (Fig. 2d) and the second with only a single S-shaped opening (Figs. 2 e,f). The crossed (Figs. 3a,b,c) and straight pedicellariae (Figs. 3b,d) are evident around the spines on the aboral side of the disc. These crossed or pincer-shaped pedicellariae are also present among the tube-feet. The oral armature plates have short spines arranged in pairs along the lateral sides (Figs. 3e,f). The marginal ossicles of the arms each have two erect, long, flat, serrated spines. The adambulacral ossicles and oral area are surrounded with long, cylindrical, thin, vertically-ribbed and distally tuberculated spines. The long arms are tapering, with a large, distal, tuberculated, blunt ossicle. The colour when alive is light brown or dirty white.

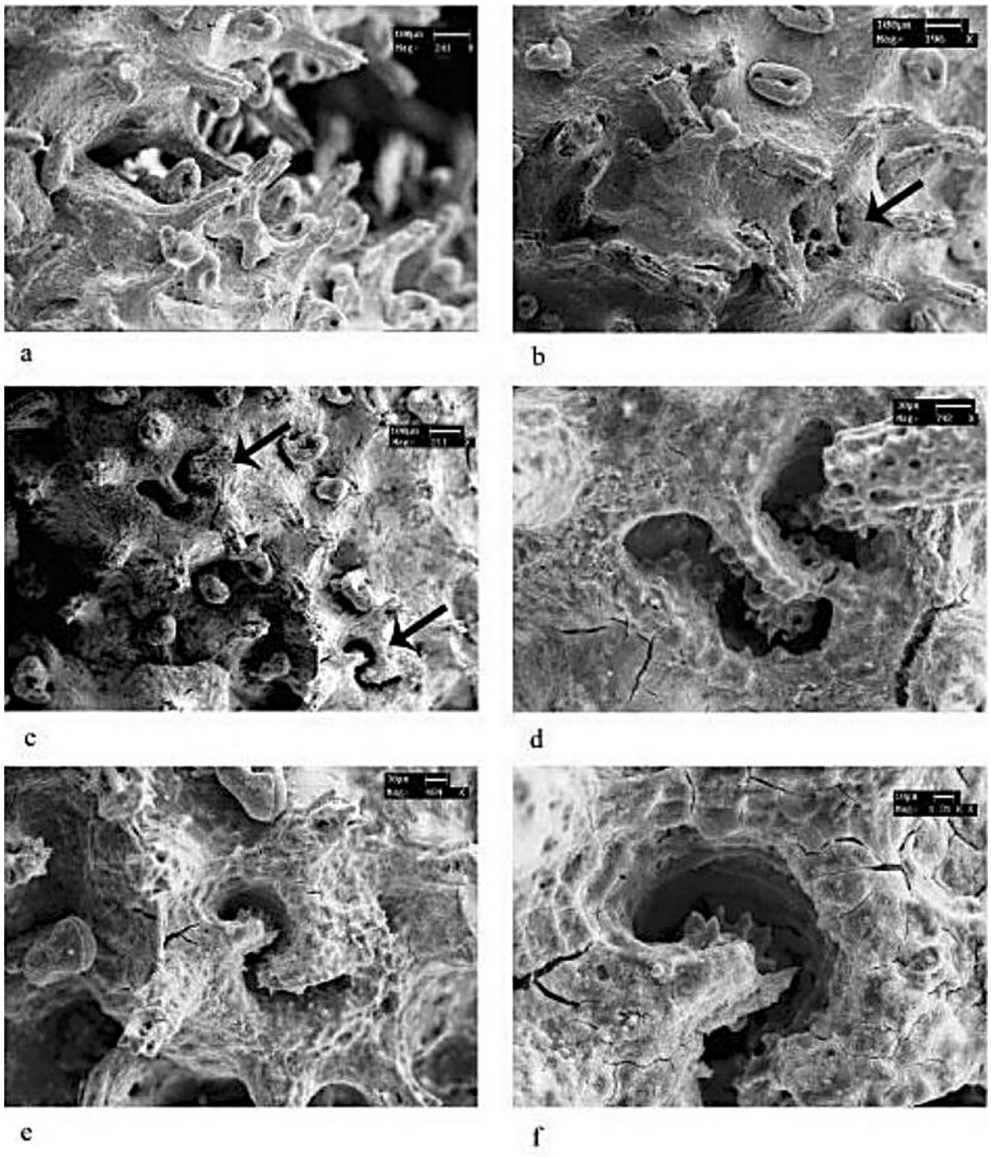

Fig. 2: Scanning electron micrograph (SEM) specimens of *Sclerasterias richardi* collected from western Gozo Island (Malta) – April 2007.
a: Aboral side of disc and arms covered with regular rows of short, stubby spines, armed with small spinelets at their distal ends.
b: Specimen with a single U-shaped madreporite encircled by stubby spines.
c: Specimen with 2 madreporites.
d: Particular of the first madreporite with two S- and C-shape openings.
e-f: Particular of the second madreporite with only one S-shaped opening.

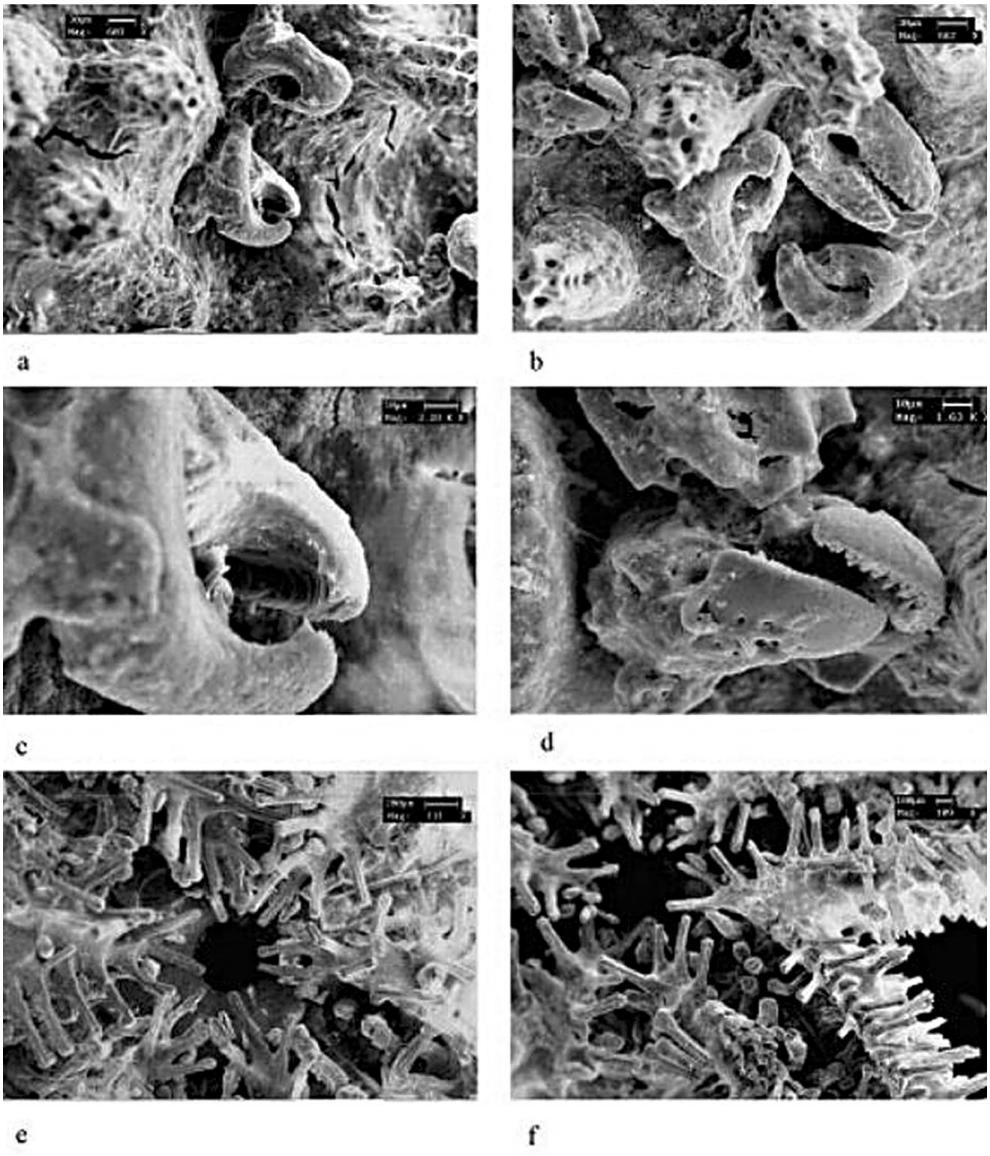

Fig. 3: Scanning electron micrograph (SEM) of specimens of *Sclerasterias richardi* collected from western Gozo Island (Malta) – April 2007.
a-b: Aboral side of disc with crossed and straight pedicellariae.
c: Particular of the crossed pedicellariae.
d: Particular of the straight pedicellariae.
e-f: Oral side with mouth and biserial tube feet.

Conclusions

The different forms of *S. richardi* encountered are the result of fissiparous propagation which is characteristic of the family Asteriidae (KOEHLER, 1924; FISHER, 1925; TORTONESE, 1965; FALCONETTI *et al.,* 1976). During this phase the animals shed one of their arms (or part of the disc) which in time will regenerate a new disc and the other arms. In fact, the finding of several specimens in various stages of development in single dredge hauls, confirms earlier observations (FALCONETTI *et al.,* 1977) that the common method of reproduction of this small species is by fissiparity. The new SEM images show the occurrence of specimens with one or two madreporites as reported in TORTONESE (1965). Curiously however, all the Corsica specimens (40 and 131) reported and studied by FALCONETTI *et al.* (1976; 1977) had only a single madreporite, and this was oval in shape. While it may not be significant, it may be worthwhile noting here that the specimens of FALCONETTI *et al.* (1976; 1977) were obtained during the month of October, while the present material was obtained during the month of April. This could imply that the species may have a seasonal change in the number of madreporites. During this short study only a small part of the collected material has been examined (by SEM); it was originally intended to obtain good SEM images of the external morphology of the species in the study. It was not possible at this stage to check (by SEM) all the specimens with the two similar madreporites, or even whether there are specimens with madreporites similar to those studied by FALCONETTI *et al.* (1976) in our study material. Neither have any anatomical studies been performed in order to determine the function of these two, differently shaped madreporites. It may be that these differently shaped madreporites are the beginning of the process of fissiparity. A similar species from the same family, *C. tenuispina*, a shallow water species usually inhabiting rocky substrates, also has two (or three) madreporites (TORTONESE, 1965) and it is also a fissiparous species. Further studies of the material would be required in order to solve this single or double madreporite phenomenon and their various shapes. However, the present discovery confirms the presence of *S. richardi* in Maltese waters as previously reported by TORTONESE (1965) and PÉRÈS & PICARD (1956). Finally, the present record updates the recent list of the echinoderm fauna of the Maltese islands published by TANTI & SCHEMBRI (2006).

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