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A note on the obligate symbiotic association between crab *Zebrida adamsii* White, 1847 (Decapoda: Pilumnidae) and Flower Urchin *Toxopneustes pileolus* (Lamarck, 1816) (Camarodonta: Toxopneustidae) from the Gulf of Mannar, India

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The *Toxopneustes pileolus* (Image 1) is one of the most venomous sea urchins. Venom comes from the disc-shaped pedicellariae, which is pale-pink with a white rim, but not from the white tip spines. Contact of the pedicellarae with the human body can lead to numbness and even respiratory difficulties. This species of sea urchin comes under the family Taxopneustidae which includes 11 other genera and 38 species. The general distribution of the flower urchin is Indo-Pacific in a depth range of 0–90 m (Suzuki & Takeda 1974). The genus *Toxopneustes* has four species viz., *T. elegans* Döderlein, 1885, *T. maculatus* (Lamarck, 1816), *T. pileolus* (Lamarck, 1816), *T. roseus* (A. Agassiz, 1863). James (1982, 1983, 1986, 1988, 1989, 2010) and Venkataraman et al. (2013) reported the occurrence of *T. pileolus* from the Andamans and the Gulf of Mannar, but did not mention the association of *Zebrida adamsii* with this species. On examination of these sea urchins the parthenopid crab *Zebrida adamsii* association was noted. Generally echinoderms and many species of crustaceans live in symbiotic association with each other. Many sea urchin species, some of which harbor endo or ecto-symbiotic crustaceans, form aggregations consisting of tens of individual (Telford 1978; Bell 1984). In these dense aggregations, ectosymbiotic crustaceans may easily move from one sea urchin to the next under the cover of their spines.

Members of five genera of eumedonid crabs (*Echinoecus, Eumedonus, Gonatonotus, Zebridonus* and *Zebrida*) are known obligate symbionts on sea urchins (Ng & Chia 1999). Organisms with an obligate symbiotic lifestyle are restricted in their distribution and abundance by the availability of suitable hosts. The symbiotic genus *Zebrida* was thought to be monotypic for a long time, but recently, two additional species, namely *Zebrida brevicarinata* Ng & Chia, 1999 and *Zebrida longispina* Haswell, 1880; were recognized bringing the total number to three (Ng & Chia 1999).

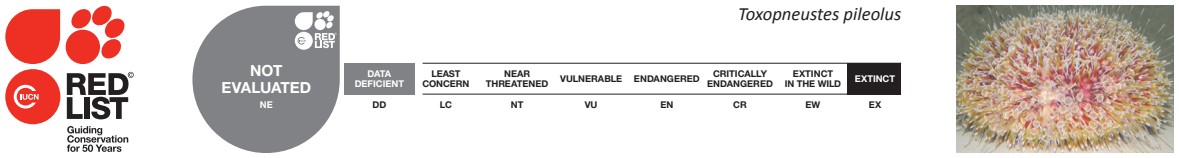

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Image 1. Live *Toxopneustes pileolus*

Materials and Methods

About 15 specimens of *Toxopneustes pileolus* with a test diameter ranging from 35–98 mm were brought alive from bottom set gillnet landing at Vedalai fishing village along the Gulf of Mannar during the regular survey trip in December 2013. A thorough visual examination was carried out to count the number of symbionts. All the sea urchins were kept in a 2-tonne FRP tank with sand bedding planted with seagrass species *Cymodocea serrulata* to simulate the natural environment. These were fed with seagrass species *Cymodocea serrulata* and Coralline algae *Halimeda gracilis* during the one month period of investigation, to know the nature of the association between the sea urchin and crab. To assess the host specificity of the crab association with *T. pileolus*, five individuals of *Salmacis bicolor* with a test diameter range of 18.92±5.6 was released in the same tank. The identification of the sea urchin was done according to Smith & Kroh (2011), after denuding the test. For the identification of the zebrid crabs their eyestalk, rostrum, lateral carapace teeth and ambulatory legs were studied to differentiate the present species from the three known species under the genus Zebrida.

Results and Discussion

The genus *Toxopneustes* contains one of the most venomous sea urchin species, if touched by the bare hand it can inflict a severe sting through its globiferous pedicellariae. The venom causes severe pain and muscular paralysis that may last around six hours. Death from poison is unknown, but the pain can reportedly lead to accidental drowning of swimmers and skin divers (McCormack 2007). The spines are relatively short and non venomous. It is an algae feeding species which prefers to feed on coralline green and rohodolith algae. Upon examination of these urchins, there were nearly five sea urchins hosting the parthenopid crab *Zebrida adamsii* and a maximum of four crabs (Image 2) were found on a sea urchin with 88mm test diameter. There were 10 males and four females observed among the collected sea urchins. Yanagisawa & Hamaishi (1986) reported that a solitary crab *Zebrida adamsii* lives on a host from the earliest stage of its benthic life. During the breeding season males frequently move between hosts to search for mates. In the present investigation no ovigerous females were found.

The association of *Z. adamsii* with *T. pileolus* is reported for the first time from the Gulf of Mannar and has been found to be parasitic. Naked inter-ambulacral zones (Image 3) were observed which could have been damaged by the crabs. Suzuki & Takeda (1974) found the evidence that urchin tissue was being ingested by *Z. adamsii* and argued that the relationship between crab and urchin is essentially a parasitic one. During the study period, although five individuals of *Salmacis bicolor* were released in the same tank and in contact with the crab possessing *T. pileolus*, *Z. adamsii* never ventured out of *T. pileolus*. Daniel & Krishnan (1979), however, reported the association of *Z. adamsii* with *Salmacis virgulata*. It was found that the *Z. adamsii* was feeding on the tube-feet in the inter-ambulacral zone (Image 3), but inspite of this, the sea urchins were found to survive. Thiel et al. (2003) studied the different crustacean ectosymbionts on sea urchins and compiled the nature of their symbiotic relationship (Table 1). In sea urchins, tube-feet are mainly responsible for gas exchange, but whether the damage done to tube feet is within the tolerable range of the sea urchin or beyond; could not be concluded from the present observation. This observation indicates preference of *Z. adamsii* to certain species and certain size ranges (Table 2).

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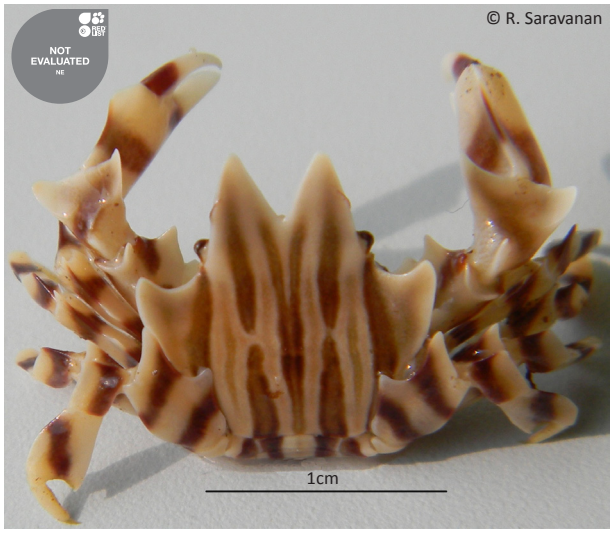

Image 2. *Zebrida adamsii* associated with *T. pileolus* collected from Gulf of Mannar

Image 3. Naked interambulacral zone

Table 1. The list of host and crab symbiont species (Thiel et al. 2003)

	Host species	Symbiont species
1.	*Tripneustes ventricosus*	*Ganathophylloidesmineri*
2.	*Anthocidaris crassispina*	*Athanas kominatoensis*
3.	*Echinometra mathaei*	*Athanas indicus*
4.	*Diadema setosum*	*Tuleariocaris zanzibarica*
5.	*Diadema antillarum*	*T. neglecta*
6.	*Strongylocentrotus spp.*	*Colidotea rostrata*
7.	*Toxopneustes pileolus*	*Zebrida adamsii*
8.	*Diadema antillarum*	*Percnon gibbesi, Stenorhynchus seticornis*
9.	*Mellita quinquiesperforata*	*Dissodactylus mellitae*
10.	*M. sesiesperforata*	*D. crinitichelis*
11.	*Meoma ventricosa*	*D. primitivus*
12.	*Echinometra lucnunter*	*Clastotoechus vanderhorsti*
13.	*Tetrapygus niger*	*Liopetrolisthesmitra*

Table 2. Seaurchin *T. pileolus* Test diameter and the number of *Zebrida adamsii* associated

	Test diameter (mm)	No. of *Zebrida adamsii*	
		Male	Female
1	35	-	-
2	40		-
3	45	-	-
4	50	-	-
5	50	-	-
6	55	-	-
7	60	-	-
8	65	-	-
9	66	-	-
10	71	2	1
11	81	2	-
12	85	3	-
13	85	-	2
14	88	3	1
15	98	-	-

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