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ON THE PREDATION OF CORAL BY THE SPINY STARFISH ACANTHASTER PLANCI (L.) IN THE SOUTHERN RED SEA*

by

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According to WELLS (1957, p. 612) there are no records of animals which feed solely on the soft parts of living scleractinian corals, although a number of fish (CLOUD, 1959; HIATT and STRASBURG, 1960), polychaetes (MARSDEN, 1962, and asteroids (HYMAN, 1955) are known to be occasional coral browsers. The worm *Hermodice carunculata* described by MARSDEN (1962) in Barbados, and GLYNN (1963) in Puerto Rico, as feeding on living corals is, according to our observations in Jamaica, only a facultative coral predator preferring other sources of food when they are available. MORTENSEN (1931), working in Java, reported that the giant spiny starfish *Acanthaster planci* (L.) feeds on corals by "sucking off all the soft substance, leaving the white skeleton where it had been at work", but detailed studies were not made on the extent and specificity of this predation.

During the Israel South Red Sea Expedition on March-April 1962, the author had an unexpected opportunity to investigate further the specialised feeding behaviour of *Acanthaster planci* (TORTONESE, 1953). The observations described below were made on shallow patch reefs near the islands of Entedebir and Um Aabak, situated in the Dahlak Archipelago, distant about 50 km SSE of Massawa, Ethiopia, at an approximate position of 15°43′40″ N by 30°54′40″ E. At the time of the expedition the weather was calm, with light westerly breezes in the afternoon. The surface water temperatures averaged about 29.3° during the middle of the day.

Acanthaster planci attacks coral by enveloping as much of the colony with its arms as its size permits, then the gastric sac is everted through the mouth and spread over the coenosarc. The initial response of the scleractinian is a voluminous secretion of viscous mucus accompanied by generalised extrusion of mesenterial filaments in large numbers, but within 15 to 30 minutes, the tissues begin to swell and release clouds of greenish brown slime wherever the coral is touched by the

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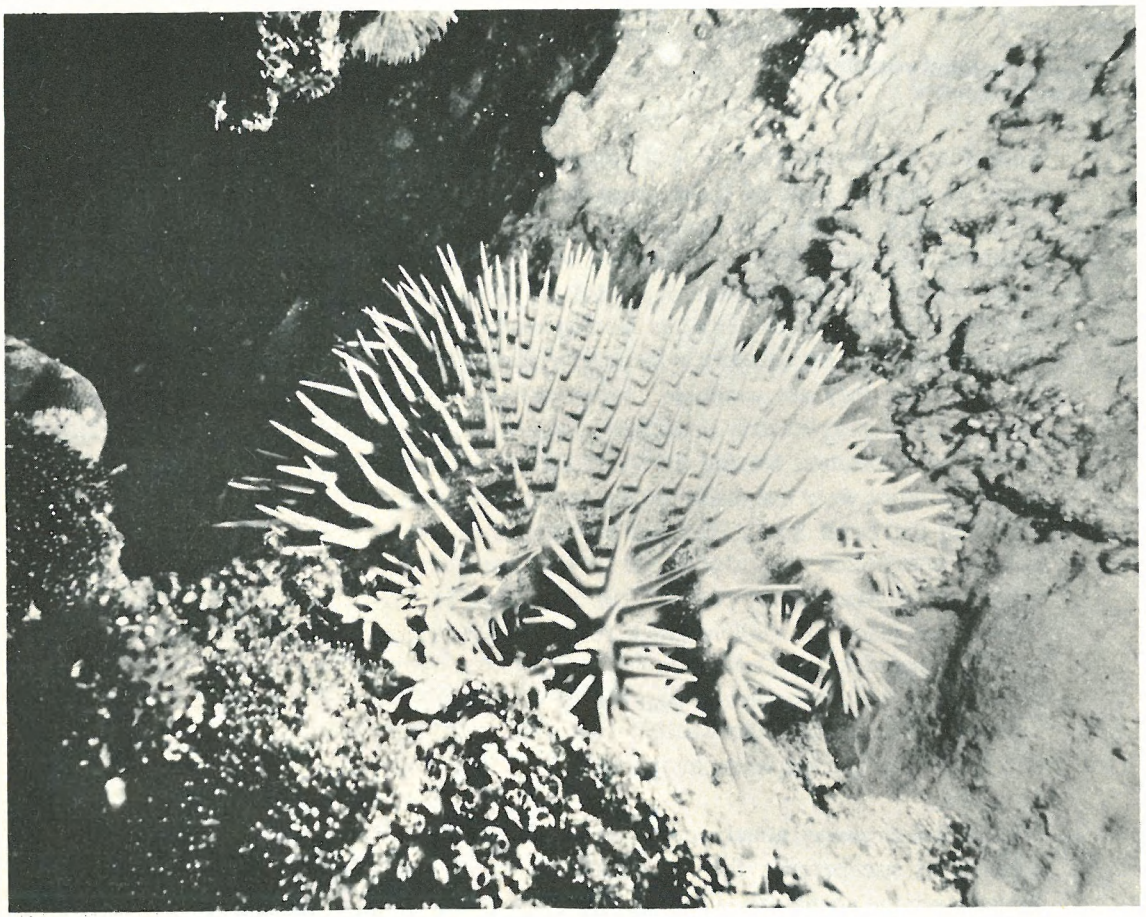

Figure 1.

Underwater photograph of *Acanthaster planci* in feeding position. The specimen is sitting on a colony of *Porites*, 15 cm across. This starfish was kept under observation for twenty days during March-April, 1962. The picture was taken at depth of 1.5 meters in an inshore patch reef west of Landing Bay, Entedebir.

stomach of the starfish. After about one hour the polypary layer decomposes into semi-fluid shreds leaving exposed white patches of the intact skeleton beneath. Dissolution is so complete after three hours that the tissue is removed even from the inside of the coral calyces; nevertheless, many tubiculous worms and boring barnacles survive for a time after the death of the host. The damage to the coral is confined to the area in contact with the gastric mucosa of the starfish, no effect is produced by the tube feet in the arms, suggesting that enzymatic action of the stomach juices is responsible for the rapid disintegration of the polypary tissues, not mechanical stripping.

The typical appearance of a feeding *Acanthaster* is seen in the underwater photograph in Figure 1. The coral, a round head of *Porites* with a radius of about eight centimetres, was covered by the body of the starfish and was stripped of all tissue in six hours. As far as could be determined *Acanthaster* showed no predilection for any one coral species, nor was colony shape a factor since branching forms were attacked as often as massive or discoid ones. However, small heads less than 20 cm across were more frequently selected than larger ones; corals too big to be wholly enveloped by the starfish were seldom preyed upon.

Corals killed by *Acanthaster* were as a rule concentrated in limited patches rather than distributed at random over the reef. Careful searches in such localities almost always revealed a single *Acanthaster* hidden in a crevice. This suggested that the individual starfish restrict their feeding activities to circumscribed territories. In order to test this possibility one of the starfish was kept under constant observation in its natural habitat for twenty days. During this time the animal confined itself to a triangular area measuring $5 \times 3 \times 3$ metres along the sides and 1 to 2 metres deep. The site was inspected three times per day, in the early mornings, at noon and in the late afternoons. The position of the starfish and the number of newly dead corals was recorded daily. In twenty days this *Acanthaster* attacked and stripped 15 colonies of seven species ranging in size from five to fifteen centimetres across. An attempt was also made on a large *Lobophyllia* but out of several dozen large po'yps present only eight were killed and eaten.

Feeding took place mostly at night but sometimes continued to 0900 hours. By day the *Acanthaster* retreated into a dark crevice where it stayed immobile for between twelve and seventy-two hours before coming out to feed again. In many cases, the attacks on corals were not witnessed because they occurred during the hours of darkness, but a tally of freshly killed colonies the next morning always gave an accurate account of the night's toll. Additional studies are necessary to determine whether the rates of predation observed in this individual are typical for the species as a whole, if there are seasonal fluctuations, and whether *Acanthaster* feeds on prey other than corals.

I consinder it unlikely that the prolonged residence of *Acanthaster* in very restricted areas is due to sluggishness: the crawling speed of five individuals was tested and found to be between five and ten meters per hour over bare sand; it would therefore appear that these animals are potentially capable of moving great distances in a single night. The fact that this did not occur suggests that the feeding behaviour of *Acanthaster* is territorial. I have no information as to the length of time any given territory may be occupied nor it is known whether individual starfish defend their home base against intruders; single occupancy was the rule in 31 out of the 35 starfish kept under observation for various lengths of time; a brief transitory association of two individuals was noted on only two occasions.

CONCLUDING REMARKS

The failure of large coral reefs to develop in the area of Entedebir, Um Aabak, Sula Bay and other localities visited by the Israel South Red Sea Expedition is paradoxical, especially as the great amount of zooplankton in the water and the general hydrographic conditions seem ideal for the establishment of such communities at the present time. The occurrance of enormous fossil coral reefs of Pleistocene age in this region indicates more favourable conditions for reef growth in the recent geological past. It is usual to explain such declines in reef building activity in terms of large scale phenomena such as climatic and hydrographic changes, sedimentation, oscillations of the sea level, regional crustal movements, etc., but local biotic factors are as a rule overlooked. It is well known that the formation of a coral reef system is contingent on the deposition of a shallow primary framework by scleractinian corals and lithothamnioid algae. This in turn depends on the population density of the major reef building species which must grow near enough together to form a closed structural framework of large colonies. It is possible that an active coral predator such as *Acanthaster* may effect a decisive reduction in the population density of the hermatypic biota by seeking out and destroying enough of the fast growing young coral colonies to keep down the rate of framework deposition to a level where no net reef accretion can occur.

The failure of most previous investigators working in coral reefs of the Indo-Pacific area to report on extensive coral destruction by *Acanthaster planci*, even though the species occurs throughout the area, may be due partly to the fact that it is a nocturnal predator, and its effect may not be so noticeable in areas of more intense reef-coral growth. The observations and conclusions in this paper are preliminary, a further study of the ecology and feeding habits of *Acanthaster planci* is recommended in view of the strong probability that this species may, under certain conditions, be an important factor limiting the growth and development of coral reefs.

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