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OBSERVATION ON A SEA URCHIN CAPTURING A JUVENILE MULLET[1]

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Abstract: *Captured, aquarium held, sea urchins of a presumably normally herbivorous species were observed on several occasions to catch and eat live fish. Perhaps food deprivation stimulated the predative behavior.*

Lytechinus variegatus (Lamarck) is a common littoral and sublittoral sea urchin found from Bermuda and North Carolina throughout the West Indies to Brazil (Clark, 1902). In south Florida it is commonly collected in beds of Turtle Grass (*Thalassia testudinum* König) which reportedly comprises a major part of its diet (Moore and McPherson, 1965). *Lytechinus variegatus* is usually thought of as a sedentary or slow-moving herbivore incapable of feeding on other than benthic flora and fauna. Thus, it was surprising to observe one of these urchins capture, kill and ingest a free-swimming juvenile mullet *Mugil curema* (Cuvier & Valenciennes). In this paper we briefly describe our observations of this behavior and suggest reasons for its occurrence.

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OBSERVATIONS—A 50 gallon glass aquarium filled with non-flowing but filtered and aerated seawater (35‰) had been maintained as a holding tank for animals collected incident to a field survey of the Indian River area. Animals in the tank in early March 1972 consisted of a dorid nudibranch, *Polycera hummi* Abbott, several small oysters, *Crassostrea virginica* (L.), and three species of adult sea urchins. These included one *Tripneustes ventricosus* (Lamarck), one *Echinometra lucunter* (L.) and four *Lytechinus variegatus*. All urchins had been collected in early January 1972; the *Tripneustes* from the grass flats in Biscayne Bay, Florida, the other urchins from water 80 ft deep offshore, Ft. Pierce, Florida.

On March 2, six juvenile mullet about 20 mm total length each, were placed in the tank for purposes of observing growth rates. All specimens appeared healthy and actively swam throughout the water column in the aquarium. Approximately three minutes after the mullet were introduced one of the juveniles swam down into the vicinity of a white *Lytechinus*. As the mullet swam over the dorsal surface of the urchin it appeared to touch either the spines or the extended tube feet. The dorsal spines suddenly folded over the mullet on either side, trapping it securely. Although the fish struggled violently and attempted to escape it was held fast by the spines. The tube feet of the urchin then rapidly extended and attached to the mullet which was manipulated forward and carried downward toward the oral surface of the urchin. The captured mullet was observed for the next 15 min, at the end of which time the fish was held close to the urchin's mouth but was not yet eaten. The mullet remained in sight at all times since the urchin itself was tilted slightly upward against the front glass of the aquarium. At this point observations were unfortunately interrupted and, when resumed approximately one hr later the mullet was eaten.

This behavior seemed so unusual that an attempt was made the next day to re-elicit the response. All other animals were removed from the aquarium except the urchins and the nudibranch. A series of juvenile clupeid fishes from 15 to 20 mm total length were collected by dipnet from a nearby channel and ten of these were introduced into the tank. The process of dip-netting had severely traumatized the clupeids and most appeared to be injured or dying, swimming erratically with little or no control over buoyancy. In spite of this uncontrolled swimming none of the clupeids were trapped, even though they blundered repeatedly into the dorsal and lateral spines of the urchins. One fish, however, while swimming with difficulty along the surface of the sand on the tank bottom, moved under the ventral spines of a *Lytechinus* that was partially raised off the substrate by a small rock. Immediately all the spines in the lower quadrant of the urchin closed around the fish, trapping it in the same manner as observed for the mullet. The fish struggled for about five min but remained trapped both by the urchin spines and the substrate of the tank. Although this fish and urchin were observed for an additional 45 min no further reaction was noted and the fish was not moved by the urchin from its original position of capture.

Several of the dead or dying clupeids were picked up from the tank bottom with long handled forceps and placed directly on the dorsal spines of one of two *Lytechinus* which had crawled to the water surface at the front of the tank. Five

attempts were made to force the urchin to accept the fish. In each instance the dorsal spines closed around the clupeid with the same type of previously observed response. However, after a short period of time, generally about 30 sec, the spines opened up and the fish was cast off by the extended tube feet of the urchin.

A clupeid was offered to the second urchin with the same closing response of the spines occurring. In this instance the urchin did not reject the fish but moved it rapidly down its test and directly to the mouth. Since the urchin was pressed against the glass front of the aquarium both it and the fish were easily observed. The clupeid was inserted tail first into the rapidly opening and closing mouth and feeding, as evidenced by obvious jaw movement, began. After approximately half an hr had elapsed the urchin removed the fish from its mouth by using the adoral tube feet, and re-inserted the clupeid head first back between the jaws. At this time it could easily be seen that the fish was being eaten. Numerous jagged bite-marks were evident over the posterior half of the body. Within an additional 20 min the entire clupeid was eaten.

Throughout this period no other urchin species captured any clupeids, living or dead. When presented with a fish in a manner similar to that used with *Lytechinus*, both *Tripneustes* and *Echinometra* rejected the fish in the same manner as did the first *Lytechinus* tested.

Discussion—All urchins in the tank are species generally considered to be chiefly herbivores or detrital feeders (see, e.g., Moore and McPherson, 1965; McPherson, 1965). *Lytechinus variegatus* is most often characterized as a grazer, subsisting mainly on sea grasses such as *Thalassia* (Moore et al., 1963a, b). However, a related deep-water species, *Lytechinus euerces* Clark, allegedly preys on bottom fauna such as bryozoans, corals, worms and small mollusks, albeit in a seemingly unspecialized or unselective manner (Lewis, 1963).

Although many other species of urchins are carnivorous, they are usually thought of as unselective scavengers or omnivores eating meat on a facultative rather than an obligate basis. Living organisms may, however, be captured if they are sluggish, moribund or dying (Hyman, 1955). Furthermore, predation by urchins on other urchins is not unknown. *Eucidaris tribuloides* (Lamarck) has been observed to attack and feed on *Encope michelini* Agassiz and *Mellita quinquesperforata* (Leske) in the laboratory, while *Lytechinus variegatus* was so aggressive toward *Encope* that they had to be kept in separate tanks (personal communication, Dr. Porter M. Kier). *Diadema antillarum* Philippi will also devour *Clypeaster rosaceus* and *T. ventricosus* when sufficiently starved (Quinn, 1965). Well fed *Diadema*, on the other hand, evinced no interest in other urchins until deprived of algal food for a period of two weeks or more. Interestingly, in the same study (Quinn, 1965) *Diadema* made no attempt to feed on *Lytechinus variegatus* also present, nor did *Lytechinus* feed on any other urchin present, although both species had been similarly starved.

To our knowledge, the only other urchin species which has been observed to actually catch and eat a free-swimming fish is *Arbacia punctulata*. This urchin was seen to trap a "partly spent" *Fundulus heteroclitus* against the glass of an aquarium in a manner similar to that of *Lytechinus* in the present study (Parker, 1932, photograph).

No "sea grasses" of any type were available to our urchins and, except for occasional feedings of brine shrimp nauplii or bits of dead shrimp every third or fourth day, the only other food available appeared to be small patches of red or brown algae growing on the glass of the tank (but see below). It would thus seem that after two months the urchins in this tank were in at least a moderate state of food deprivation.

As noted by Quinn (1965) starvation is sufficient impetus to cause a change in feeding preference in *Diadema* from herbivore to active and predatory carnivore. Such a change might also have been induced in our *Lytechinus* and could possibly explain the capturing behavior we observed.

It is nonetheless difficult to say whether the response we recorded was actual and directed predation or simply a defensive response by the urchin to a fortuitously edible contact stimulus. For, contrary to the behavior shown by *Diadema*, *Lytechinus* did not actively seek out the fish as a food organism, but appeared, rather, to "take advantage" of what could well have been an accidental situation.

Hyman (1955) summarized studies on the spine closure response in urchins. Generally, a stimulus to an area on an urchin will cause adjacent spines to point in the direction of the stimulus. If the stimulus is maintained or repeated intermittently the urchin spines may "freeze" for a period of time in the defensive closed position.

Hyman also provides a good discussion of the various types of pedicellariae which occur in urchins. *Lytechinus variegatus* possesses very prominent globiferous pedicellariae (Moore, 1965) which contain a toxin having similarities to acetylcholine (Mendes et al., 1963; Halstead, 1965).

With the foregoing aspects in mind it is easily seen how a fish such as the juvenile mullet could be captured. The swimming fish might have come in contact with the spines which responded in the defense reaction, folding over and effectively trapping the fish. Continued struggling by the mullet could then conceivably cause the spines to freeze in the defensive position until the pedicellariae were able to subdue the fish. In this respect, Parker (1932) noted that *Fundulus* when caught by *Arbacia* " . . . soon succumbs . . . as though it had been poisoned . . .". In each case the fish may then be carried to the mouth for feeding.

None of the foregoing discussion, of course, takes into consideration what effects, if any, prolonged food deprivation may have had on a possible lowering of the threshold which elicited the spine closure behavior. It would be interesting to determine if, in fact, starvation causes an increase in sensitivity in the defense reaction of *Lytechinus*.

Prior to making the observations herein reported we had noted with passing interest that other very small fish (e.g., juvenile pipefish) which were placed in the large aquarium often disappeared overnight. Until we saw the actual capture of the juvenile mullet by *Lytechinus* we did not consider "predation" by the urchins as a possible cause of the fishes' disappearance. Heretofore, we had assumed that the fish had died due to some trauma induced during collection, and that they were subsequently scavenged by the echinoids.

If the behavior exhibited by the echinoids can occur in the laboratory under conditions of food deprivation, it may also take place in nature during times of

food scarcity; for example, in areas where grass beds have been destroyed or severely damaged by causes such as pollution, dredge and fill operations, or by storms and associated tidal currents.

We have never observed "predation" of the type just described in the natural habitat, and as far as we are aware there is no report of such natural "predation" in the literature. Further observations on naturally occurring populations of echinoids such as *Lytechinus* may show that such behavior is more common than would be suspected.

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NOTE ADDED IN PROOF: On May 20, 1974 the following observation was recorded for a specimen of the echinoid *Echinometra lucunter* which was being held in a holding aquarium 24" L × 12" W × 18" H (seawater S‰ 34‰; Temp. 22°C). Approximately 20 mosquitofish (*Gambusia* sp.) were introduced as food for a single Golden Tail Moray Eel, *Muraena miliaris*, at 1300 hrs. Immediately after being placed in the water a small, apparently uninjured, female *Gambusia*, blundered into the echinoid's spines. The echinoid, which was at the surface of the water, immediately pinned the fish against the glass of the aquarium in a manner similar to that described above for *Lytechinus*, i.e. by preventing movement of the head and tail. Tube feet from the urchin began immediately to attach to the fish and the still struggling fish was rapidly carried toward the echinoid's mouth. Upon contact with the mouth parts the prey was pulled to the center of the ventral surface and the echinoid began feeding. By 1600 hrs over 50% of the fish had been consumed, including most of the head and the entire ventral surfaces. This now brings to three the number of echinoid species known to capture and ingest small fish in this manner. We thank Mr. Hank Adolfi for providing these observations.

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