On the Reproductive Biology of *Mitra idae*

(Gastropoda : Mitridae)

BY

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(3 Plates; 4 Text figures)

INTRODUCTION

Molluscan species of the genus *Mitra* are primarily tropical in distribution, although one member, *Mitra idae* Melvill , 1893, occurs off the coast of California from Crescent City south to Cedros Island, central Baja California (McLean, 1969). *Mitra idae* is typically sublittoral, although occasionally individuals are found at low tide. Frequently we have observed *M. idae* at depths of 13 m to 20 m on rocky substrata under the canopy of giant kelp, *Macrocystis pyrifera* (Linnaeus), as well as on nearshore reefs where algal cover is limited. Because of its cryptic habits, we found *M. idae* to be somewhat inconspicuous except during the reproductive season (February to July).

The biology of *Mitra idae* has not been extensively studied, although Cate (1968) described various aspects of its mating behavior from aquarium observations. We feel that unnatural habitats often preclude or alter the normal behavior of most subtidal organisms and that data should be substantiated with field observations.

This paper is concerned with the reproductive biology of *Mitra idae*. Included are observations on mating, pair selection, spawning behavior, fecundity, and early development. Our field observations were made while SCUBA diving during the spring and summer of 1969 and 1970 in the subtidal area off Point La Jolla (Lat. 39°51′30″ N; Long. 117°17′ W) and Point Loma, California (Lat. 32°42′N; Long. 117°16′ W). Laboratory studies were conducted in La Jolla, California, at the Fishery-Oceanography Center, and the Westinghouse Ocean Research Laboratory. In the laboratory the snails were maintained in fiberglass water tables which contained circulating sea water.

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MATING BEHAVIOR

The sexes in *Mitra idae* are separate, but are distinguishable in the field only during copulation. Fertilization is internal. In all of the copulating pairs we observed, the male grasped the right side or outer whorl of the female's shell (Figure *1*). The copulating female was in turn firmly attached to hard substratum. In contrast, Cate (1968) observed that on a sandy bottom in an aquarium, copulating pairs were aligned approximately parallel with neither member attached to the bottom. This behavior might have reflected the tranquil conditions in the aquarium. Because *M. idae* normally occurs in areas exposed to heavy surge, it would appear to be advantageous for one member of the pair to be attached to the substra-

Plate Explanation

Figure *1*: A copulating pair of *Mitra idae* 15 m underwater off Point Loma, California. The female is depositing a clutch of egg capsules. The male is the smaller member of the pair, and is attached to the right side of the female's shell.

Figure *2*: *Mitra idae* exhibiting grouping behavior

Figure *1*

Figure *2*

tum. Under such conditions, it would seem that only with a firm hold on the bottom could the snails maintain position and complete copulation.

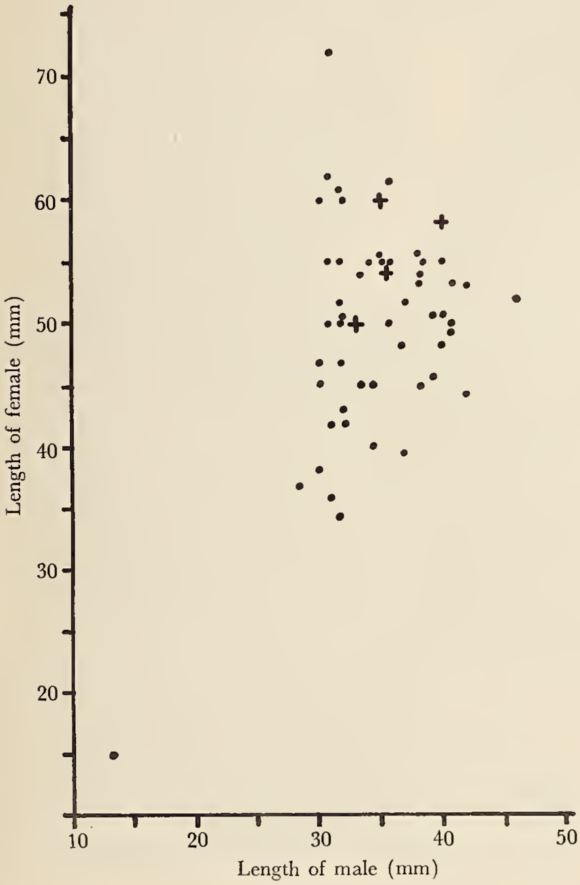

Figure 5

The size relationship between males and females in 58 copulating pairs of *Mitra idae*. The pairs were measured in the subtidal area off Point Loma, California, during June, 1970
● = 1 pair + = 2 pairs

In mating pairs, the female *Mitra idae* was larger than the male (Figure 5). The mean shell lengths for copulating pairs were 51 mm and 35 mm for females and males, respectively. One mating pair that we observed consisted of a 13 mm male and a 15 mm female. This was the smallest pair seen during the entire study and yet it had the same female-male size relationship observed in larger mating pairs. Cate (*op. cit.*) also noted this size relationship for copulating pairs of *M. idae*. Rosenthal (1970) mentioned a similar size selection for copulating pairs of *Kelletia kelletii* (Forbes, 1850). The mechanisms involved in the selection of gastropod mates according to shell size are unknown. It is possible that pair selection is made during "grouping" activities (Figure 2), where as many as 11 *M. idae* have been observed clustered together at one time.

There are several possible advantages for a female to pair with a smaller male. Since copulation commonly occurs simultaneously with egg deposition and feeding, a larger female is able to move about more freely while searching for suitable substrata or food. Also, a smaller male is less resistant to water movement, thus allowing the female to hold position more effectively in the surge swept habitat.

Cate (*op. cit.*) observed that a large individual of *Mitra idae* exuded a cloud of clear mucus and developed a mucus "bubble sac" which attracted smaller individuals. Although we saw no "bubble sac," we did notice that copulating and spawning females emitted mucus. If a chemical attractant or pheromone exists in the mucus, it apparently continues to be effective after initial pairing, since there were often additional *M. idae* crowding around a copulating pair. Occasionally, a second male would mount another in a "piggy back" fashion prior to or during copulation (Figure 3). In similar observations on *Olivella biplicata* (Sowerby, 1825), Edwards (1968) noted that males were attracted to, and followed recently deposited mucus trails of sexually ready females. He also observed that a second male would occasionally attach to another that was already copulating. On one occasion in the laboratory, 2 male *M. idae* consecutively copulated with a female as she was laying a cluster of egg capsules. In each instance, however, neither male partner was with her for more than 24 hours. On no occasion did we see more than one male copulating with a female at the same time. In contrast, a female chestnut cowry, *Cypraea spadicea* (Swainson, 1823) was observed in the laboratory copulating simultaneously with 3 male *C. spadicea* (Chess, unpublished data).

SPAWNING BEHAVIOR AND FECUNDITY

Spawning females were observed at a depth of 18 m off Point La Jolla, California, on 8 May 1969. During weekly dives in 1970 we sighted copulating pairs of *Mitra idae* as early as 24 February; but no spawning was observed until 3 June 1970. The reason for the lag between initial copulation and egg deposition is unknown.

Laboratory studies were initiated on 8 June 1970. Sixty *Mitra idae*, ranging in length from 30 mm to 72 mm were collected from 15 m of water off Point Loma and placed into water tables containing 17.0° C sea water. Seven days later 2 females began ovipositing and 3 other pairs were copulating. Spawning continued in subtidal and laboratory situations during June and early July; however, by 20 July 1970 copulation and egg deposition had ceased altogether. After spawning activities had terminated in the field, *M. idae* became more difficult to find, apparently assuming more cryptic habits.

During the entire period of observation, water temperature in the laboratory aquaria ranged between 16.0° C and 17.5°C, while field bottom temperatures varied between 9.0° C and 13.0° C. The synchronous termination of reproductive activities in both field and laboratory situations (despite a 3.0° C to 8.5° C temperature variation) suggests the possibility that factors other than temperature influence reproductive behavior in *Mitra idae.* ORTON (1920) indicated that most marine invertebrates seem to require higher than normal temperatures for spawning. ROSENTHAL (1970) found that *Kelletia kelletii* which were maintained in laboratory tanks commenced spawning during the same month as did members of this species inhabiting the subtidal area, despite a 4.0° C to 5.0° C difference in temperature. Based on laboratory observations, CATE (1968) suggested a "relationship between the timing of mating action in *M. idae* and the exact hour of local high tides." However, we observed that *M. idae* copulate and deposit egg capsules in the laboratory during all hours of the day or night, irrespective of the local tide conditions.

Mitra idae have been observed laying egg capsules on a variety of substrata in the subtidal area. Rocks, discarded mollusk shells, and dead holdfasts of kelp plants were utilized most often by ovipositing females. In the laboratory, egg capsules were deposited on rocks, bricks and the sides of the fiberglass water tables; however, pieces of glass which were placed into these same water tables were not utilized. Subtidal areas with vertical relief appeared to be the most frequent sites of egg capsule deposition off Point Loma. At no time did we find *M. idae* depositing egg capsules on the sand.

Mitra idae were frequently seen laying adjacent to or among egg capsules deposited earlier by conspecifics. Egg capsules from different females are often distinguishable because capsule size varies proportionally with the size of a laying female (Figure 6). On one occasion we observed the egg capsules of *M. idae, Kelletia kelletii, Shaskyus festivus* (Hinds, 1844) and the egg mass of the tectibranch *Navanax inermis* (Cooper, 1862) attached to an eroded shell of *Astraea undosa* (Wood, 1828). The possibilities exist that either *A. undosa* shells are very desirable as a substratum for ovipositing, or that the occurrence of one egg capsule acts as a stimulus, either chemically or tactually, for further egg laying by other gastropods. D'ASARO (1966) found that sometimes 2 or more females of different species of *Thais* would add capsules to a common egg mass. ROSENTHAL (1970) indicated that spawned egg capsules of *K. kelletii* may act as additional stimuli to other mature females which encounter these capsules on the substratum. The determination of egg clutch size in the field was difficult because *M. idae* tends to lay adjacent to egg capsules deposited previously by conspecifics. In one instance, however, 250 egg capsules of similar size were found in a cluster. A lone female was within this cluster and we believe that all of the egg capsules were laid by this one individual. In the laboratory, a single female *M. idae* deposited 91 egg capsules in 4 days. Another female (72 mm) laid 32 capsules in less than 24 hours.

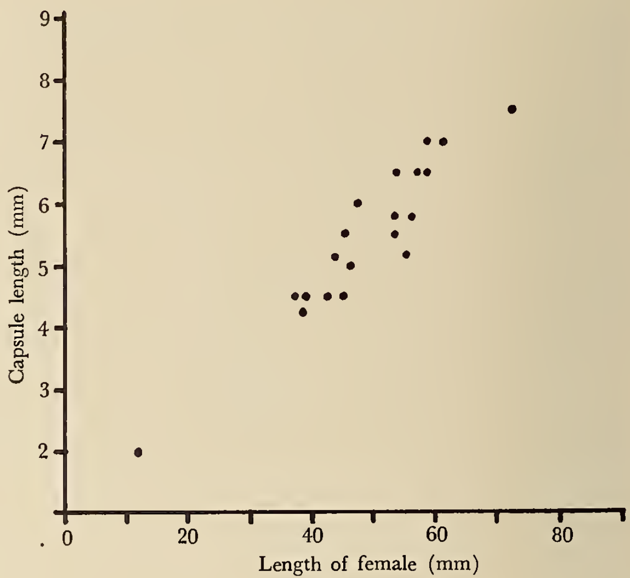

Figure 6

The relationship of female shell length to egg capsule height (correlation coefficient = 0.91)

Although our data indicate that larger ovipositing females have higher fecundity than smaller females, we could not determine the total number of capsules deposited by these different sized females. The relationship of ovipositing-female shell length to egg capsule height was linear with a correlation coefficient of 0.91 (Figure 6). A 72 mm female with 8.0 mm capsules and an 11 mm female with 2.0 mm capsules were the extremes for this relationship. Most ovipositing females were 40 to 55 mm