Mating Behavior in *Mitra idae* Melvill, 1893

BY

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(8 Text figures)

INTRODUCTION

The observations set forth in this paper are the indirect result of an experiment to learn the feeding habits and food preferences of *Mitra (Atrimitra) idae* Melvill, 1893 (see Text figure 1). The intended study of foods and feeding in *M. idae* was a complete failure; during the approximately 8 months of experimentation with various kinds of foods thought likely to tempt the animals, apparently no feeding whatsoever took place. However, the animals seemed unaffected by their apparent long fast and were as active after months of presumed starvation as when they were first collected, although they had not grown during that time, as evidenced by periodic measurements.

Figure 1

Mitra (Atrimitra idae) Melvill, 1893

Concurrent with the intended experiment, careful notes were taken on the mating behavior of these animals whenever it was observed, and it is these notes that are the basis for this paper.

MATERIALS and METHODS

A 15-gallon marine aquarium was set up on an outdoor patio with a northern exposure. Though completely open to the north, the porch was protected on the other three sides by the walls of the U-shaped house, and was covered by a translucent whitish plastic roof which admitted filtered sunlight on bright days.

Local coarse beach sand, sterilized in an oven at 400° F for one hour, comprised the bottom layer in the tank; this was covered by a layer of finer sterile sand to a total depth of about 3 inches. Sea water drawn from a marine well was filtered through a double layer of heavy filter paper before being added. These precautions were taken in order to prevent any unknown food from obscuring the results of the feeding experiment; in other words, they were the control for the unsuccessful experiment, and were not planned as a part of the mating-behavior observations.

Two filtering systems were used, one a subsurface "Miracle" filter with two outlets, and the other an outside charcoal-and-fiberglass filter with one outlet; in addition two airstones were used to ensure adequate aeration; all this equipment worked off one commercial aquarium pump. A 50-watt heater with a submerged thermostat helped to regulate the temperature; a constant temperature of 12° to 15° C was thus maintained through the winter months, this being the average thermic range in the area where the animals were collected. Approximately the same temperatures were maintained in summer through the use of frozen plastic-jelly "Scotch Ice" blocks. All filters and aeration systems were in operation for 36 hours before the animals were introduced into the tank.

Twenty-six animals, ranging in size from 35.0 mm to 56.9 mm, were placed in the aquarium February 24, 1965. They had been collected by SCUBA divers 10 days previously, in 23 feet of water off Little Dume Point, near Malibu, southern California, and kept in a large holding tank while the experimental aquarium was made ready. The habitat at the collecting grounds was a rocky reef with scattered patches of sand.

All animals were code-marked with an electric drill, following the procedure described by STOHLER (1962). The marks were later painted with white "Snopake" for easy identification during observation. Shell measurements were recorded in the hope that some rate of growth could be ascertained by the time the experiment ended. While the whitened marks did prove helpful in distinguishing the animals from one another during observation. no discernible growth increment in any animal was noted when the experiment was discontinued approximately 8 months later; this fact further seemed to verify that the animals had ingested no food during that period. Most of the animals exuded a purple fluid when they were subjected to work with the dental drill.

OBSERVATIONS

Although copulation was observed on numerous occasions, the general behavioral pattern was about the same each time; therefore this will be a composite report of the several occasions when mating was observed.

Once or twice I noted attempts at copulation being made at the water line near the filter's air outlet at the upper edge of the aquarium, but the usual place was the sandy floor of the aquarium.

In every instance the female was the larger of two coupled animals. The two most active mollusks were "No. 4," a male whose shell measured 43.45 mm by 14.50 mm, and "No. 8," a female with a shell measuring 56.90 mm by 19.60 mm – the latter being the largest of all the experimental animals. These same two individuals seemed to prefer one another to the other animals; while they were not mutually exclusive, my notes show a repetitive pattern referring to "No. 4" and "No. 8" on several occasions. This pattern does not occur among any other specified individuals. Other coupling pairs, while generally smaller, averaged the same as far as the male-female size ratio is concerned.

All animals seemed to be more or less generally active or dormant at the same times; frequently all would be buried completely out of sight in the substrate for about a week, then their siphons would appear above the surface of the sand for a day or two, and finally all of the animals would climb to every part of the aquarium at once – the most popular place evidently being the area nearest the air outlets at the waterline near the top of the tank. Here they were out of the sea water, but within the spray-zone of the aerator. This was especially interesting behavior in animals usually found in greatest abundance subtidally (see Text figure 2).

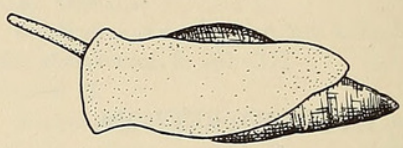

Figure 2

Bottom of foot of *Mitra idae* in normal crawling position, as viewed through glass wall of aquarium

It was frequently observed that the periods of greatest activity, especially sex activity, corresponded within minutes to a high tide in Los Angeles Harbor, despite the fact that the animals had been collected from a subtidal habitat. There seemed to be no correlation between the active or dormant periods and the introduction of food items; the animals simply continued whatever they had been doing when food was put into the tank, ignoring the food completely or moving in an other direction to avoid contact with it.

PRELIMINARY SEX ACTIVITY

The first unusual behavior to be noted, other than the normal moving around in the aquarium, was the exudation of a cloud of clear mucus from one of the larger animals, which later proved to be a female. When occurring up high in the tank at the waterline, this appeared as a mass of tiny clear bubbles trapped in a cloud of clear, colorless mucus roughly the same length as the animal's shell, but sagging somewhat heavily in the water like a small plastic bag full of carbonated water (see Text figure 3). Other, smaller animals quickly gathered around this area, evidently drawn by some powerful attractant; these later proved to be the male individuals. On a few occasions I deliberately moved the male animals as far away as possible from the "bubble-sac;" without exception they responded by moving rapidly back toward the mucus sac (and incidentally toward the female individ-

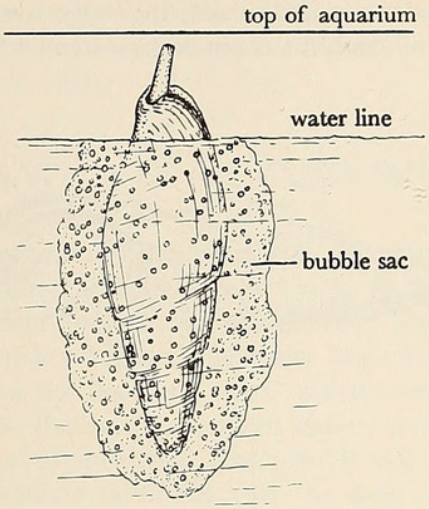

Figure 3

Typical "bubble sac" of female *Mitra idae* seen clinging to aquarium wall at water line

ual), often even taking shorter routes by crawling up and along suspended air-hoses (like walking a tightrope) rather than to take the slower but more normal route of crossing the sand floor and climbing the glass walls of the aquarium. No animals were ever seen to climb along the air-hoses at any time other than when a female was exuding a "bubble-sac." Whatever the attractant was, it seemed to disperse very rapidly to all corners of the aquarium, probably through the currents set up by the filter- and aeration-systems.

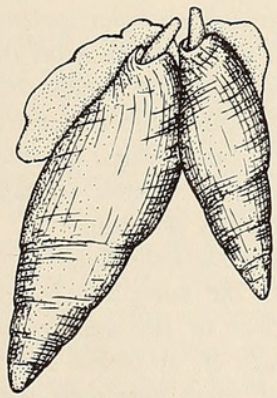

Figure 4

Copulatory positions as viewed from above
Left, female; Right, male

In the upper corners of the tank at the points where the air outlets emerged and the animals frequently congregated, observations were not easily made due to the position of the tank against a house-wall and the presence of a metal rim on the tank which obscured my view of the animals. It is possible that copulation did sometimes occur at this location (see Text figure 4), but with less success than on the sandy floor of the tank or beneath the substrate. Some animals were seen to drop from the waterline to the floor at times, possibly from the weight of several individuals clinging to one female. At such times no further sexual activity was noted.

At times females could be seen exuding the "bubble sac" while at rest on the substrate. The first noticeable action would be for the female to stand erect, with foot fully extended and shell raised high so that a large portion of the body above the foot could be seen – apparently an unusual position except at times of pre-sexual activity (see Text figure 5). This upper body area seemed

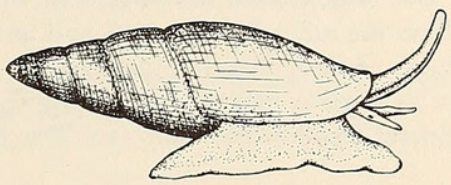

Figure 5

Typical female of *Mitra idae* in what is apparently a "courtship" position. Note the swollen body, elevated shell, and extended siphon

tumid, swollen and more translucent than the solid milk-white color usually observed in an animal at rest; it also exhibited a pale pinkish color that seemed almost a blush originating deep inside the body.

It is possible that the attractant material would first be released at about this stage, for it was noted that several of the other animals would become active, extending their siphons far longer than normal, actively searching and testing the water – both males and females. Males moved fairly rapidly toward the performing individual. After remaining in this position for a period of about 5 to 10 minutes, the female would turn the right edge of her foot toward the nearest male, and curl it upward with a twisting, rolling motion that brought a small mass of loosely agglutinated sand with it. It seems that sand-grains adhere to the "bubble sac" when they come in contact with it. This twisting action usually continued for about another 10 minutes or so, until the female would

sometimes be buried under a self-made sand pile; frequently only a small area of black shell would be visible under the loosely-packed sand mass.

COPULATION

At this point the male would align its shell in a position approximately parallel with that of the female, and on the female's right side. The female's shell would be underneath and to the left, with the aperture toward that of the male; the male's foot would be fully extended toward his left side, providing full contact between the outer lip of the female's shell and with the left anterior portion of the male's foot about opposite the adapical end of the female's shell aperture. The verge would appear rather rapidly from a point directly posterior to the head and eyes of the male, probe two or three times under the left side of the female's shell above the foot, and finally come to a stop. The verge emerged from the anterior end of the male's body, on the right side so that the right eye-stalk was usually in contact with it throughout the copulatory act. The verge usually measured somewhat shorter in length than the animal's siphon; it had an extremely swollen, more or less shapeless appearance, and was about twice as thick in diameter as the siphon; it was a pale, translucent bluish-white color (see Text figure 6).

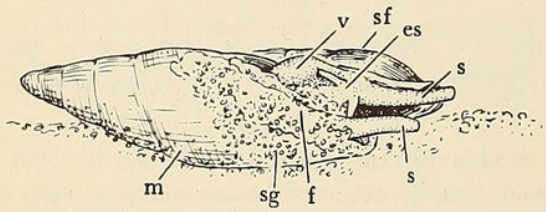

Figure 6

Relative positions of male and female *Mitra idae* during copulation
v: verge s: siphon sg: sand grains adhering to "bubble sac"
es: eye stalk f: foot of male m: shell of male
sf: shell of female

Upon first contact with the male's verge, the female quickly withdrew her body a short way into the shell, then partly extended it again. After insertion of the verge, the female continued her twisting motion, turning further onto her back and bringing up more of the agglutinated sand to partially cover both mollusks, somewhat like a blanket. At about this time, both siphons gradually became shorter and less active, resuming their normal appearance. After remaining in this position for about an hour to an hour and a half, the verge was quickly withdrawn and could be observed as a small white fleshy flap

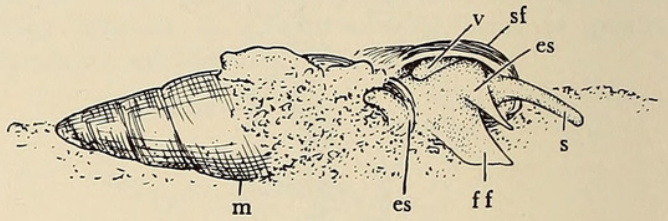

Figure 7

Post-copulatory positions of male and female *Mitra idae*
m: shell of male sf: shell of female v: verge es: eye stalk
ff: foot of female, starting to right itself s: siphon

under the male's shell as he raised and lowered it a few times preparatory to moving away (see Text figure 7). The translucent appearance and bluish color had disappeared, and the verge was the same color as the foot and body of normal adults.

ADDITIONAL OBSERVATIONS

It was evident that mating sometimes occurs beneath the sand substrate, as well as on the surface, and occasionally at or above the waterline of an aquarium. On one occasion I carefully moved a partially buried mating pair to the surface for easier observation, whereupon the male quickly discharged into the water rather large amounts of what may have been sperm, in a stream of fairly solid whitish flakes which soon disintegrated and were carried off by the water current. On this occasion, copulation was interrupted and the animals separated of their own accord. At other times, however, I was able to move mating animals to a better vantage point without disturbing the copulatory procedure.

On another occasion it was noted that two males were trying to mate with the same female, one of the males being atop the surface of the sand as noted above, and other buried beneath it. It seems improbable that the mating act of the third specimen was completed at this time.

The presence of living *Crepidula onyx* Sowerby, 1824 on the shell of a female *Mitra idae* (a not unusual occurrence) seemed a deterrent to copulation, although it did not completely prevent it. The male *Mitra* would, while

"feeling" a female's shell with its siphon, quickly withdraw it when coming in contact with the *Crepidula*'s shell, evidently being able to sense the difference between the two kinds of shell.

TERMINATION OF THE EXPERIMENT

The experiments were terminated and the animals still remaining alive were put into alcohol in November 1965, when an unidentified red-colored bacterial growth invaded the filter systems and the entire aquarium, completely covering the floor and sides, and the animals as well. For a time the bacterial growth seemed controllable through the use of medicinal penicillin. It was difficult, however, to regulate the amount of the drug correctly, and in our attempts to strike a balance between barely controlling the obnoxious growth and giving too much penicillin to the animals (several of the *Mitra* died on one or two occasions when the drug was used), we found it impossible to continue.

EGGS

No eggs were ever laid by any female *Mitra idae* in the aquarium during the course of the experiment, despite the numerous copulatory acts observed during the several months of the experiment.

In the field, observations made by SCUBA divers (Dr. R. C. Fay, personal communication) revealed that *Mitra idae* were laying eggs during July and August, 1965. These eggs were laid on a shell substrate at a depth of 25 feet in the open ocean off southern California, in approximately the same area where the experimental animals had been collected.

A year or two earlier, an unsuccesful attempt had been made to hatch egg capsules of *Mitra idae* in a laboratory at the University of California, Berkeley. At that time, a specimen of *Mitra idae* collected by R. Ames in 30 feet of water at Mission Point, Carmel (Monterey County), was maintained in a jar of sea water in a cold room at 14° C. An airstone was kept in the jar for aeration, but no food was offered at any time during the nearly 3 months the animal was under observation. Approximately one and a half months after capture, the animal deposited a large egg mass on the side of the jar (see Text figure 8). About one month later, one additional egg capsule was deposited. Although at this time motion could be observed in the first-laid capsules, indicating embryonic life in the unhatched veligers, none of the eggs in any of the capsules ever hatched.

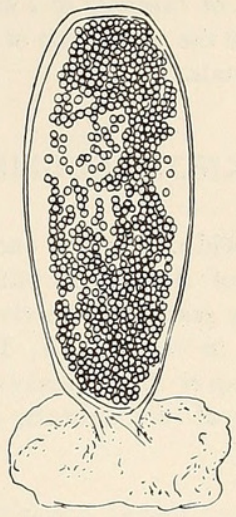

Figure 8

Egg capsule of *Mitra idae*

CONCLUSIONS

During the course of eight or nine months, observations were made on the mating behavior of 26 animals of *Mitra idae* MELVILL. Based on these observations, it seems evident that the following conclusions may be made:

1. Males are able to locate females by some sensory means when attracted by a substance emitted by the female in a mucus "bubble sac."
2. The attractant provided by the female is evidently dispersed by means of water currents.
3. Females use their muscular foot and the "bubble sac" in a twisting motion to pick up sand from the substrate, ultimately nearly covering themselves and sometimes the mate as well with loosely agglutinated sand.
4. Observations made during this experiment confirm the fact that *Mitra idae* is a dioecious species, and that fertilization is internal.
5. There seems to be a relationship between the timing of mating action in *Mitra idae* and the exact hour of local high tides even when the animals are a considerable distance from the ocean.

6. *Mitra idae* is able to subsist in a healthy condition without food for a period of at least 8 to 9 months.
7. Either the state of captivity or a lack of food, or both, may have inhibited the production of fertile eggs and the growth of the animals.

ACKNOWLEDGMENTS

Many persons provided help and encouragement toward the carrying out of this experiment; to all of them I wish to express my gratitude. Crawford Cate was helpful and encouraging in many ways; Dr. Rudolf Stohler assisted in setting up of the original experiment, including the code-marking of the animals, and offered several suggestions for possible foods; Dr. and Mrs. Rimmon C. Fay were extremely helpful in providing animals, various kinds of marine organisms which we tried as food, and fresh sea water, as well as personal observations on these animals in their natural habitat; Saul L. Fox, M. D., very kindly donated the medicinal penicillin, and Mrs. Emily Reid adapted Kodachrome slides into the excellent text figures illustrating the experiment.

LITERATURE CITED

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