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# SPAWN AND FECUNDITY OF *CYMATIUM (MONOPLEX) PILEARE* AND *CYMATIUM (LINATELLA) CINGULATUM* (GASTROPODA: RANELLIDAE)

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## ABSTRACT

*Cymatium (Monoplex) pileare* deposited 20 egg masses under laboratory conditions. Out of these, 14 were laid during the peak spawning period of July–November and the remaining 6 egg masses during February–May. Two gastropods successively laid 2 egg masses each at intervals of 48 and 58 days respectively. On an average, there were 200 egg capsules in an egg mass with 2985 eggs in an egg capsule. The estimated fecundity of *C. (M.) pileare* was 0.585 million eggs per animal. *Cymatium (Linatella) cingulatum* laid 2 egg masses during July–August. In an egg mass, there were 167 egg capsules with 1220 eggs. The fecundity of *C. (L.) cingulatum* was estimated to 0.203 million eggs.

## INTRODUCTION

Predatory gastropods such as, naticids, muricids, buccinids and ranellids prey on commercially important bivalves. The ranellid *Cymatium (Linatella) cingulatum* (Lamarck, 1822) causes 13% mortality in edible oyster farms (Thangavelu & Muthiah, 1983) and 8 to 18% mortality in pearl culture farms (Dev & Muthuraman, 1988). Studies on the various aspects of reproduction such as laying of egg masses, egg capsules and fecundity are essential for evolving effective control measures of predators. A majority of predatory gastropods lay many egg capsules either in juxtaposition or in clusters so as to form a mass.

Initial studies on egg capsules of *Ocenebra erinacea* (Linnaeus) by Lebour (1937) led to focus on other predatory gastropods (Hancock, 1956; Mackenzie, 1961; Lin & Hsu, 1979; D'Asaro, 1986). Anderson (1959) described the egg mass of ranellid *Cymatilesta spengleri* (Perry, 1811), and Houbrick & Fretter (1969) described an egg mass of *Cymatium nicobaricum* (Röding, 1798). Alan Beu (pers. comm.) states that the specimen and spawn illustrated by Ganapti & Sastry (1973) was that of *Bursa granularis* (Röding, 1798) and not that of *C. pileare*. Purtymun (1974) indicated the spawning and larval release of *C. nicobaricum* from an egg mass laid in an aquarium. An egg mass of *C. cingulatum* from an oyster farm was described by Thangavelu & Muthiah (1983). Ramon (1991) gave an account on the dimensions of egg capsule of (the Mediterranean–West African species) *C. cutaceum* (Linnaeus, 1767) and *C. corrugatum* (Lamarck, 1816). Govan (1995) described the reproductive behaviour of *C. aquatile* (Reeve, 1844), *C. muricinum* (Röding, 1798), *C. nicobaricum* and *C. pileare* (Linnaeus, 1758). However, very little is known about the reproductive potential of ranellids (Scheltema, 1966; Govan, 1995). This paper reports on the egg masses, their dimensions, spawning season and fecundity of *C. (M.) pileare* and *C. (L.) cingulatum*.

## MATERIALS AND METHODS

From the rearing cages of an experimental pearl culture farm at Tuticorin (Lat 8° 48′N; Long 78° 11′E), 22 *Cymatium (Monoplex) pileare* (length: 31.3 to 93.0 mm) and 17 *Cymatium (Linatella) cingulatum* (length: 48 to 76 mm) were collected. These gastropods were maintained in the laboratory separately in aquaria (size: 75 × 50 × 50 cm) of 100 l capacity. The animals were provided *ad libitum* with edible oyster *Crassostrea madrasensis* (Preston, 1916) a food. Sand-filtered seawater was changed daily and mild aeration was provided. The salinity ranged from 34.6 to 35.8‰ and the temperature varied from 24.8 to 28°C. The average pH was 8.2.

During the study period from January 1992 to May 1993, the 22 specimens of *C. (M.) pileare* deposited 20 egg masses and the 17 specimens of *C. (L.) cingulatum* laid 2 egg masses. Measurements of the gastropods and egg masses were made using a vernier caliper.

The wet weight of the animals and egg masses after wiping with filter paper, were taken using an electronic balance. When a specimen deposited an egg mass, the gastropod with its egg mass was kept without disturbance in the same aquarium and other animals were transferred to another aquarium.

The length and width of egg capsules were measured through a microscope having a precalibrated ocular micrometer. To correlate the length of egg capsules to number of embryos, 5 to 12 egg capsules of different lengths from an egg mass were measured separately. The teased out contents of an egg capsule was diluted to 50 ml. After agitation, a 1 ml sample was withdrawn for counting the embryos. The average number of embryos in 3 samples of 1 ml was recorded.

To estimate fecundity, 20 egg capsules were collected at random from an egg mass and the teased out contents were diluted to 250 ml with seawater in a measuring cylinder and after thorough mixing, 1 ml of the sample was taken in a counting chamber for enumeration of embryos. This was carried out three times and the mean value was calculated. The remaining egg capsules in that egg mass were counted by sacrificing the egg mass. From the average number of embryos per egg capsule and the total number of egg capsules per egg mass, the fecundity was estimated. The regression analysis and test of significance were carried out following Sokal & Rohlf (1969).

## RESULTS

### *Cymatium (M.) pileare*

Of the 20 egg masses laid by *C. (M.) pileare*, 14 were deposited between July and November and the remaining 6 egg masses during February–May (Table 1). It took 2 days to complete the deposition of an egg mass and the egg capsules were white in colour (Fig. 1). The egg masses were cup shaped (hemispherical) with an array of spirally arranged conical egg capsules. The egg mass was covered by transparent and thin horny plates of 0.6 mm thickness. The colour of the egg capsules turned yellow on the third day (Fig. 2).

The average diameter and wet weight of the egg mass was 38.9 mm and 9.8 g respectively. There was significant relationship between the diameter of egg masses *vs* width of the gastropod (Fig. 3) and wet weight of the egg mass *vs* the weight of gastropod (Fig. 4).

An egg mass, on an average contained 200 egg capsules. Egg capsules were tubular, cone shaped with two projections on the side facing the centre of the egg mass and had a broader base with an average width of 3.9 mm. The overall average length of egg capsules was 7.3 mm. Regression analysis showed that there was highly significant relationship between the length of egg capsules and the length of gastropod (Fig. 5).

A minimum of 1150 embryos was obtained from an egg capsule of 5.3 mm and the maximum of 6275 from egg capsule of length 10.0 mm with an average of 2985. The relationships between the number of eggs to the length of egg capsule (Fig. 6) and number of eggs per egg capsule *vs* length of gastropod (Fig. 7) were found to be significant. The average fecundity was estimated to be 0.585 million eggs. By repeated spawning, two gastropods produced 1.6 to 1.9 times more eggs than by a single spawning.

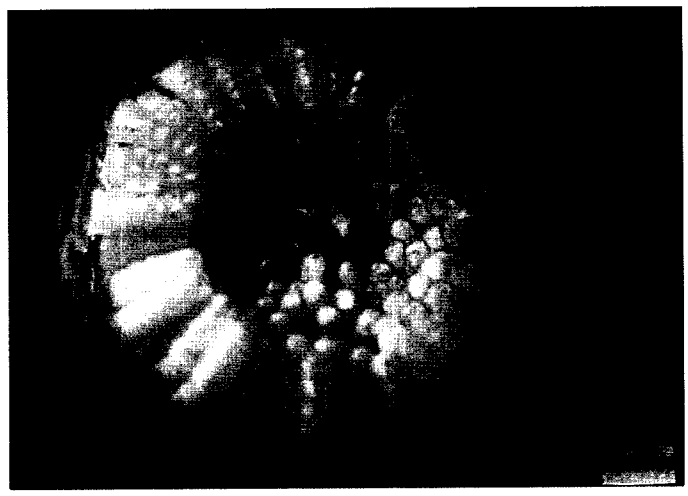

**Figure 1.** *Cymatium (Monoplex) pileare.* Vertical view of just laid egg mass; scale bar = 5.9 mm.

**Table 1.** Dimensions of egg masses and fecundity of ranellids.

| Date of egg mass deposition | Gastropod | | | Egg mass | | | No of eggs/ egg capsule | No. of embryos in egg mass | Fecundity (no. of eggs) |
|---|---|---|---|---|---|---|---|---|---|
| | Length (mm) | Width (mm) | Weight (g) | Diameter (mm) | Wet weight (g) | No. of egg capsules | | | |
| *C. (M.) pileare* | | | | | | | | | |
| 12 Feb 92 | – | – | – | – | – | 182 | – | – | – |
| 1 Jul 92 | 93.0 | 43.7 | – | 40.3 | – | 165 | 2050 | 315,000 | 961,074* |
| 23 Jul 92 | 85.4 | 41.3 | – | 41.3 | – | 180 | 2880 | 617,940 | 1,623,730** |
| 11 Aug 92 | 91.5 | 42.3 | – | – | – | – | 4638 | – | – |
| 11 Aug 92 | 77.5 | 39.1 | 36.5 | 38.5 | – | 190 | 2463 | 467,970 | 467,970 |
| 18 Aug 92 | 85.6 | 42.8 | 49.7 | 40.5 | 16.8 | 175 | 3010 | 526,750 | 526,750 |
| 27 Aug 92 | 93.0 | 43.0 | 62.7 | 45.0 | 11.8 | 198 | 3263 | 646,074 | – |
| 5 Sept 92 | 76.8 | 37.3 | 36.2 | 37.9 | 7.0 | 223 | 2328 | 519,144 | 519,144 |
| 9 Sept 92 | 85.7 | 43.0 | 50.5 | 43.2 | 12.6 | 230 | 4373 | 1,005,790 | – |
| 2 Oct 92 | 92.8 | 46.2 | 62.2 | 47.0 | 6.0 | 164 | 3448 | 565,500 | 565,500 |
| 9 Oct 92 | 86.0 | 42.6 | 49.6 | 43.4 | 13.8 | 243 | 3700 | 899,100 | 899,100 |
| 10 Oct 92 | 76.4 | 40.4 | 37.1 | 40.6 | 9.2 | 267 | 2366 | 631,722 | 631,722 |
| 8 Nov 92 | 92.6 | 44.1 | 62.9 | 45.1 | 13.9 | 219 | 3058 | 669,702 | 669,702 |
| 17 Nov 92 | 85.8 | 44.4 | 50.9 | – | – | – | – | – | – |
| 18 Nov 92 | 85.6 | 42.2 | 50.4 | 42.8 | 12.8 | 272 | 3950 | 1,068,960 | 1,068,960 |
| 14 Mar 93 | 56.4 | 29.4 | 12.9 | 31.4 | 5.8 | – | – | – | – |
| 24 Mar 93 | 53.0 | 27.4 | 11.8 | 28.2 | – | 133 | 1175 | 156,275 | 156,275 |
| 29 Mar 93 | 60.0 | 27.3 | 16.2 | 29.1 | 4.8 | 167 | 2068 | 345,356 | 345,356 |
| 5 Apr 93 | 56.0 | 27.8 | 11.8 | 28.6 | 2.6 | – | 1550 | – | – |
| 5 May 93 | – | – | – | – | – | – | – | – | – |
| $\bar{x} \pm$ SD | 79.6 | 39.1 | 40.1 | 38.9 | 9.8 | 200.5 | 2895 | 602,520 | 585,048*** |
| | ± 13.9 | ± 6.5 | ± 18.9 | ± 6.2 | ± 4.5 | ± 40.4 | ± 980 | ± 256,568 | ± 259,331 |
| *C. (L.) cingulatum* | | | | | | | | | |
| 1 Jul 92 | 72.4 | 39.6 | – | 40.6 | – | 175 | 1131 | 197,925 | 197,925 |
| 12 Aug 92 | 72.5 | 40.4 | 33.4 | 37.6 | – | 160 | 1310 | 209,600 | 209,600 |
| $\bar{x} \pm$ SD | 72.45 | 40.0 | 33.4 | 39.1 | – | 167.5 | 1220.5 | 203,763 | 203,763 |
| | ± 0.07 | ± 0.06 | – | ± 2.1 | – | ± 10.6 | ± 126.6 | ± 8,255 | ± 8,255 |

* Repeated spawning: combined spawnings dt 1 July 92 and 27 Aug. 92
** Combining the spawnings of 23 July 92 and 9 Sept. 82
*** For average fecundity, repeated spawning was not included.

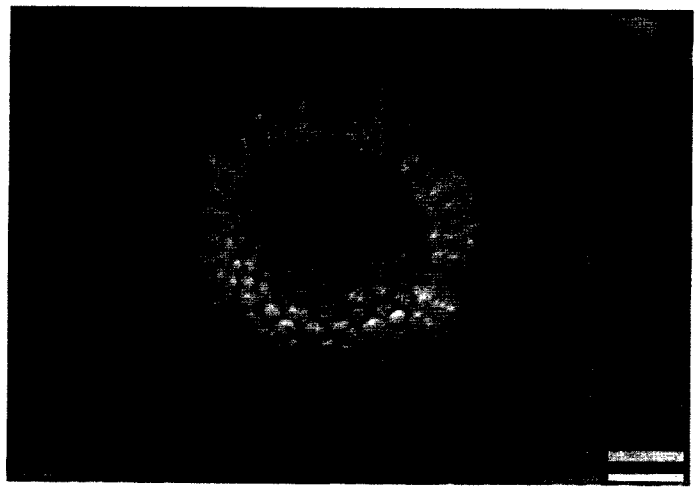

**Figure 2.** *C. (M.) pileare egg mass.* The colour of egg capsules turned yellow; scale bar = 9.0 mm.

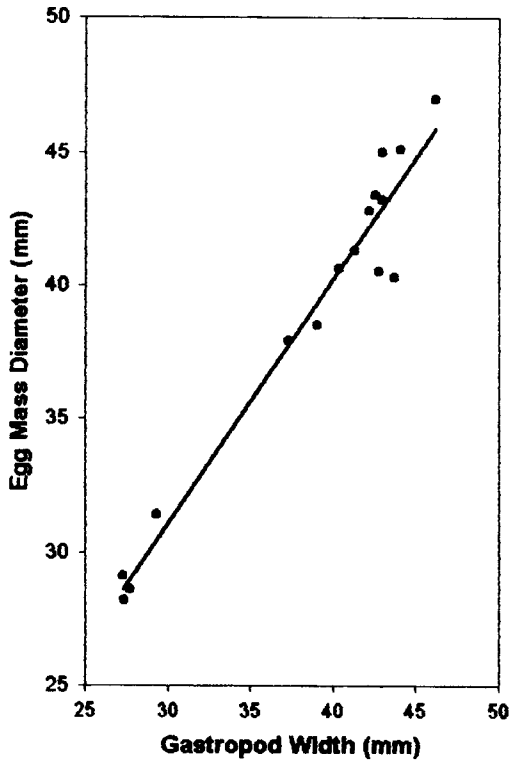


**Figure 3.** *C. (M.) pileare.* Relationship between width of gastropod and diameter or egg mass. Y = 0.1765 + 0.8913X (r = 0.9656; p < 0.001).

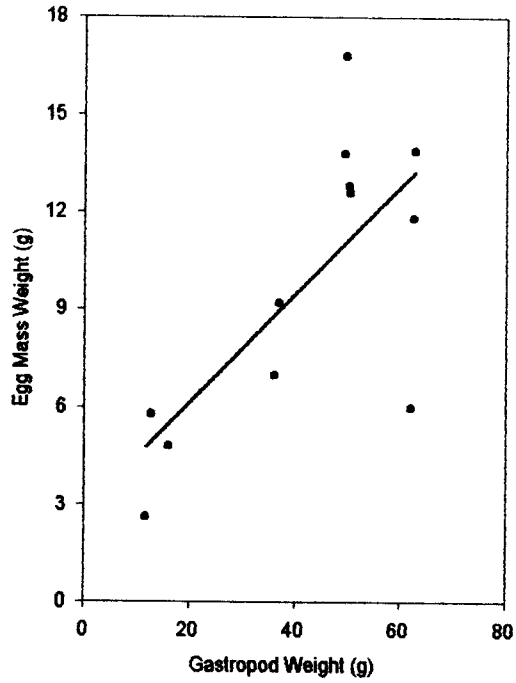


**Figure 4.** Relationship between weight of *C. (M.) pileare* and the wet weight of egg mass. Y = 0.1870 + 0.7202X (r = 0.6506; p < 0.05).

*Cymatium (L.) cingulatum*

*C. (L.) cingulatum* (Fig. 8) laid two egg masses during July–August. the shape and duration of laying the masses were similar to those of *C. (M.) pileare*. The egg capsules were tubular with a broad base and with no projections on the side walls. There were 168 capsules in an egg mass. With an average length of 7.4 mm, each egg capsule contained 1220 eggs and the fecundity was 0.203 million eggs (Table 1).

## DISCUSSION

For the first time, mass deposition of 20 egg masses by *C. (M.) pileare* was observed under laboratory conditions. The spawning periods observed in this study was in accordance with field observations made in commercial oyster farms (July–December) (Thangavelu & Muthiah, 1983) and in pearl oyster farms (January–July) Chellam, Velayudhan, Dharmaraj, Victor & Gandhi, 1983; Dev & Muthuraman, 1988). Seventy percent of the egg masses were laid during July–November which indicates this period as peak spawning period for *C. (M.) pileare*. Further, this extended spawning period agrees with

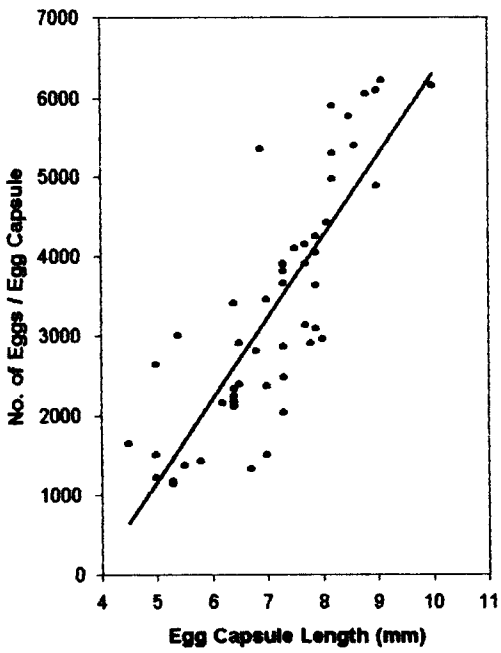


**Figure 6.** Relationship between length of egg capsule and number of eggs per egg capsule in *C. (M.) pileare*. Y = 0.1.6776 + 2.1229X (r = 0.7809; p < 0.01).

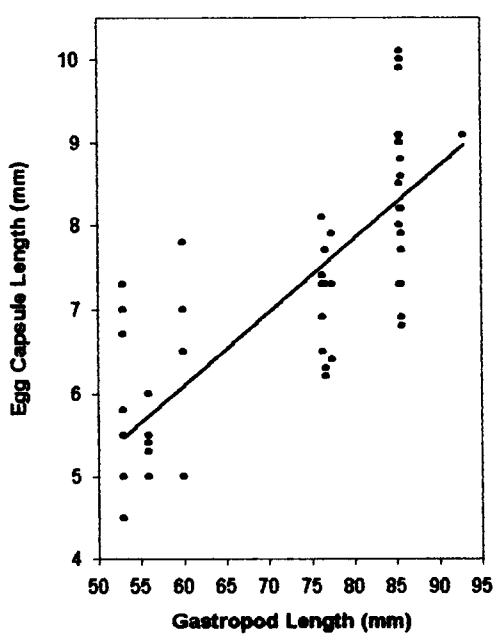


**Figure 5.** Relationship between length of *C. (M.) pileare* and length of egg capsule. Y = 0.7097 + 0.840X (r = 07813; p < 0.01).

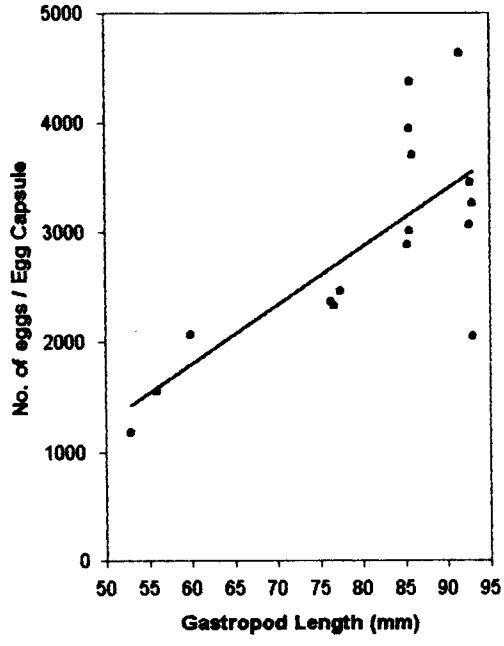


**Figure 7.** Relationship between length of *C. (M.) pileare* and number of embryos per egg capsule. Y = 0.3256 + 1.6365X (r – 0.8113; p < 0.01).

**Figure 8.** *C. (L.) cingulatum* incubating egg mass; scale bar = 10.0 mm.

the observations of Muthiah, Sundararajan, Srinivasan & Vaithinathan (1987) indicating that the extended spawning is the reason for the wide range of sizes and the irregular progression of modal size of ranellids occurring in a commercial oyster farm.

In the reproductive behaviour of *C. (L.) cingulatum*, a male was found mounted on the right side of the female similar to the pairing of sexes observed by Govan (1995) for *C. aquatile*, *C. muricinum*, *C. nicobaricum* and *C. pileare*. Whereas, in *C. (M.) pileare*, 2 or 3 males were found in aggregation with a female till the completion of laying an egg mass.

The observation of two specimens of *C. (M.) pileare* depositing a second egg mass reveals the intermittent nature of spawning. Similar repeated spawning has been reported in *C. nicobaricum* at 41–44 days interval (Purtymun, 1974).

The dimensions of egg capsules of these two ranellids did not differ greatly as is also true of the size of the egg capsules of *C. cutaceum* and *C. corrugatum* (Ramon, 1991). The egg capsules of *C. (M.) pileare* in having two lateral projections were distinctly different from those of *C. (L.) cingulatum*. D'Asaro (1986) emphasized the taxonomic importance of the shape of egg capsules, since it is species specific. The difference in the shape of egg capsules among these sympatric species of *Cymatium* may be due to a pedal moulding mechanism. Fretter & Graham (1962) were of the opinion that a pedal moulding mechanism in higher prosobranchs could produce specific differences in the shape of egg capsules.

On average, *C. (M.) pileare* produced 200 egg capsules with 2985 eggs in each and *C. (L.) cingulatum* 168 egg capsules with 1220 eggs in each. This is higher than that of 45 egg capsules each with 12.5 eggs in *Urosalpinx cinerea* (Say, 1822) (Galtsoff *et al.*, 1937); 55 egg capsules with 14 eggs each of *Eupleura caudata* (Say, 1822) (Mackenzie, 1961); 100 egg capsules each with 400 eggs in *Cymatium nicobaricum* (Houbrick & Fretter, 1969) and 92 egg capsules each having 250 eggs of *Purpura clavigera* (Küster) (Lin & Hsu, 1979). The fecundity of *C. (M.) pileare* is almost equal to *C. nicobaricum* releasing 0.66 million larvae from an egg mass (Purtymun, 1974). The fecundity of *C. (L.) cingulatum* 65% less than the fecundity of *C. (M.) pileare*.

The correlation coefficients obtained between length of *C. (M.) pileare* and length of egg capsules ($r = 0.7813$; $p < 0.01$) and the number of eggs per egg capsule ($r = 0.9099$; $p < 0.01$) were highly significant. As the length of *C. (M.) pileare* increased from 53 to 85.6 mm, fecundity increased 3.6 times. Carriker (1955) observed that older specimens of *Urosalpinx cinerea* produced egg capsules with more eggs than younger and smaller individuals. Purchon (1977) and Webber (1977) also reported that fecundity of gastropods depends on adult length and environmental factors.

By substituting the values (length of egg capsules = 0.8060 + 0.0879 length of gastropod) in the relationship of the number of eggs to the length of egg capsules ($Y = -3830.8125 + 1006.2707\ X$), the equation between number of eggs (Y) = −3019.7583 + 89.24 length of gastropod (X) was obtained. The slope of the

linear regression indicates an increase of 89 eggs per egg capsule for 1 mm increase in length of the gastropod shell. With an average of 200 egg capsules per egg mass, the total increase of eggs works out to 17,800. The reproductive potential of *C. (M.) pileare* is much higher than *Purpura clavigera* where Lin & Hsu (1979) estimated an increase of 1288–2926 eggs per 1 mm increment of its shell length.

The laying of eggs in capsules, incubating the egg mass, and extended and repeated spawning leading to high reproductive potential are some of the strategies resulting in successful and wide distribution of ranellids in bivalve farms. Of course, their planktonic larvae is another important strategy that enables these species to reach oysters suspended in cages rather than attached to a natural substrate (Govan, 1995). Loosanoff (1957) suggested immersion of egg masses in saturated salt solution for 3 to 5 minutes to kill the embryos. In the absence of effective control measures, manual removal of these gastropods from rearing cages needs to be intensified during the spawning periods of ranellids. The string method of rearing, in lieu of rearing oysters in cages and trays which provide suitable enclosures for ranellids to deposit egg masses, will be of use in reducing ranellid predation on bivalves.

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