

REPRODUCTIVE BIOLOGY OF *HEMIFUSUS PUGILINUS* (BORN)
(GASTROPODA: MELONGENIDAE)

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ABSTRACT

Monthly samples of the neogastropod *Hemifusus pugilinus* were made during a year off Parangipettai, southern India. The sex ratio (M:F) was 1:1 throughout the year except in March and July. Maximum Gonado-Somatic Index was found in January and February for both sexes. *H. pugilinus* is a continuous breeder. However, a peak spawning season occurred during the post monsoon and summer (February to May). The egg capsules of *H. pugilinus* are pouch shaped, compressed, and attached to a substratum. The exit hole is oblong and measures about 2-2.5 mm. The number of eggs per capsule varied in laboratory spawned (23-120 eggs) and egg masses from nature (41-138 eggs). The number of capsules per egg mass varied in the laboratory (38-80 capsules) and from nature (8-215 capsules). Juveniles hatch out after 40-45 days. The ranges of length and width of the juveniles were 1.400-1.600 mm and 1.040-1.100 mm respectively.

INTRODUCTION

The neogastropods are considered to be the most advanced type of the prosobranchs. All exhibit internal fertilisation and have complex behavioural patterns. The female genital system of neogastropods has evolved and specialised in accordance with the requirements of internal fertilisation and the deposition of eggs within the capsule (Fretter 1946). The reproductive biology of prosobranchs has been studied by several authors (Fretter 1953; Hargis & Clyde 1961; Manazi 1970; D'Asaro 1970, 1988). Studies regarding reproductive biology of *H. pugilinus* are sparse. Our aim is to provide detailed information on the sex ratio, Gonado-Somatic Index (GSI), spawning season, morphology of egg capsules, and the reproduction biology.

MATERIALS AND METHODS

Random sampling of 100 individuals of *H. pugilinus* were made every month from Parangipettai coastal water (11°29'N; 79°47'E) from November 1994 to October 1995. The snails were brought to the laboratory, individually weighed, the shells were broken, and the sex determined. Males were identified by the presence of a penis. Flesh and gonad weights of each animal were sepa-

rately recorded.

In order to confirm the expected 1:1 ratio the Chi-square test was applied using the formula: Sex ratio = $(O - E)^2 \times E^{-1} \times 2$; where O = Observed and E = Expected.

For the expected value, anyone of the sexes was taken as 50 and the expected ratio calculated. The gonads were carefully removed and weighed. The colour of the gonad was noted and fresh gonadal smears were examined under binocular microscope. Four maturity stages were distinguished: initial maturing, maturing, mature, and spent. Different stages of gonads were fixed in Bouin's fixative for histological studies. The monthly Gonado-Somatic Index (GSI) was calculated separately for male and female using the formula:

$$\text{GSI} = (\text{Gonad weight}) / (\text{Total weight of the animal}) \times 100$$

Gonads fixed in Bouin's fluid were dehydrated in an ascending ethanol series, cleared in Xylene, and embedded in paraffin. Sections of 5-7 μm thickness were stained with Harris haematoxylin and eosin for microscopic examinations.

The spawning was studied in the laboratory. Egg capsules were also collected in nature during the study period. The number of eggs per capsule were counted in capsules col-

lected from nature as well as laid in the laboratory. The morphology of egg capsules, and the number of egg capsules per mass were recorded. Material was both from nature and laid in the laboratory. Emergence of juveniles from the capsules was observed.

RESULTS

Sex ratio

Out of 1200 *H. pugilinus* examined 651 were females and 549 were males. The sex ratio of the population was calculated month wise. The chi-square test (Tab. 1) showed conformity with the expected 1:1 ratio throughout the year except in March and July. The P-values showed a significant deviation during these two months.

Fig. 1 represents the monthly variation in mean total weight and flesh weight of male and female *H. pugilinus*. The total weight, and weight of the soft body of females was higher than that of males in all months. The colour of the gonad varied with the maturity stages. In both the sexes, the empty sac (spent) was white. In females, the initial maturing gonad was cream in colour. It changed to light brown during the maturing stage. They became dark brown when the gonads were fully mature. In males, the initial maturing gonad was yellow, which changed into orange during the maturing stage, and finally became brown in the fully mature stage. Tab. 2 shows the percentage of different maturity stages. Mature gonads were observed throughout the year, but higher numbers were noticed during the post monsoon and summer seasons (February to

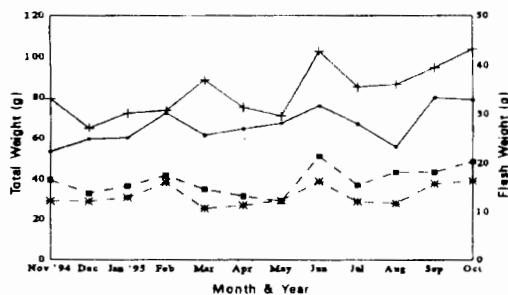


Figure 1. Mean total weight and flesh weight of *H. pugilinus* collected from Nov. '94 to Oct. '95.

Table 1. Sex ratio and Chi-square values of males and females of *H. pugilinus*.

Month	No.	% mal.	% femal.	Sex ratio Male/female	Chi-square value	P-value
Nov.	100	49	51	1:1.04	0.04	>0.05
Dec.	100	48	52	1:1.08	0.16	>0.05
Jan. 1995	100	44	56	1:1.27	1.44	>0.05
Feb.	100	48	52	1:1.08	0.16	>0.05
Mar.	100	40	60	1:1.50	4.00	<0.05
Apr.	100	52	48	1:0.92	0.16	>0.05
May	100	55	45	1:0.82	1.00	>0.05
Jun.	100	41	59	1:1.44	3.24	>0.05
Jul.	100	34	66	1:1.94	10.24	<0.05
Aug	100	47	53	1:1.13	0.36	>0.05
Sept.	100	46	54	1:1.17	0.64	>0.05
Oct.	100	45	55	1:1.22	1.00	>0.05

May). The percentage of spent gonads was very low all year round. The Gonado-Somatic Index (Fig. 2) also showed monthly variations and higher values were recorded during January and February in both sexes.

Spawning

Spawning was observed in the laboratory during March and April 1995. The capsules were attached on the sides of the plastic containers as clusters. The egg masses from nature were collected during January to August. They were found attached to stones, bivalves and other gastropod shells.

Morphology of the egg capsule

The egg capsules of *H. pugilinus* are vasi-form. The compressed capsules are placed in a single row with their broad sides opposing each other (Fig. 3). Each capsule has a distinct basal layer, which is cemented to the substratum. The basal layers of the egg capsules are overlapping, creating a continuous sheet. The capsules are yellowish-white opaque with a tough wall. The egg capsules have a pronounced concavity apically, with four radiating ridges (apical aspect). The apex has a well defined exit hole which is covered by a thin membrane. The exit hole is oblong and measures about 2-2.5 mm. On one side, the apically projecting ridges

Table 2. Monthly percentage of maturity stages of *H. pugilinus*.

Year and month	Male				Female			
	Initial maturing	Maturing	Mature	Spent	Initial Maturing	Maturing	Mature	Spent
1994								
Nov.	51.0	40.8	8.2	-	47.0	41.2	9.8	2.0
Dec.	47.9	39.6	12.5	-	40.4	44.2	13.5	1.9
1995								
Jan.	38.6	40.9	18.2	2.3	30.3	48.2	17.8	3.6
Feb.	29.2	47.9	22.9	-	25.0	40.4	25.0	9.6
Mar.	20.0	37.5	40.0	2.5	25.0	33.3	41.7	-
Apr.	26.9	30.8	40.4	1.9	33.3	25.0	37.5	4.2
May	40.0	37.8	22.2	-	40.0	34.5	23.6	1.8
Jun.	46.3	36.6	12.2	4.9	50.8	35.6	13.5	-
Jul.	54.5	38.6	6.8	-	56.1	33.3	9.1	1.5
Aug.	53.2	36.2	6.4	4.2	49.0	41.5	7.5	1.9
Sept.	43.5	52.2	4.3	-	38.9	51.8	9.2	-
Oct.	37.8	57.8	4.4	-	34.5	58.2	7.3	-

run down towards the centre of the egg capsules side, where they meet. The other side is without ridges on the side.

Reproductive biology

The eggs inside the capsules are being suspended in a colourless slimy fluid. The number of eggs per capsules varied in laboratory spawned (23-120 eggs) and wild collected egg masses (41-138 eggs). The eggs are large, spherical, yellowish in colour and measure about 0.65-0.68 mm. The number of capsules per egg mass varied in masses spawned in the laboratory (38-80 capsules) and wild collected (8-215 capsules).

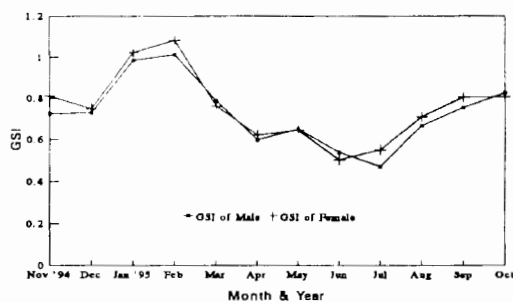


Figure 2. Mean gonado-somatic index of *H. pugilinus* collected from Nov. '94 to Oct. '95.

The juveniles hatch out through the exit hole (Fig. 3) after 40-45 days. The newly hatched juveniles possess 2 body whorls and are light brown in colour. The length and width of the juveniles ranged from 1.40-1.60 mm and 1.04-1.10 mm respectively.

DISCUSSION

The total weight and the weight of the soft body were higher in females than in males. The males may mature at a smaller size and do not grow as big as females, but the differences are usually slight except among sequential hermaphrodites (Hughes 1986). In

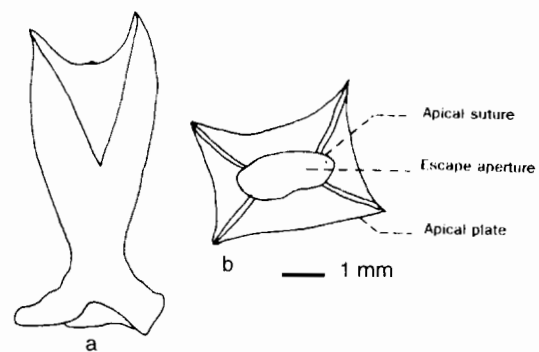


Figure 3. Morphology of egg capsules of *H. pugilinus*. (a). Side aspect. (b). Apical aspect.

some species such as *Olivella biplicata* males are larger than females (Edwards 1969).

The frequencies of males and females are theoretically expected to be equal (Fisher 1930). In the present study, the chi-square test confirmed the expected 1:1 ratio throughout the year except in March and July. In these months, the number of males are found to be higher. We have no explanation for this finding.

The presence of mature gonads throughout the year indicates the *H. pugilinus* is a continuous breeder with a peak spawning season from January through May. This was also evident by the presence of egg masses collected from the wild during January-August. In the remaining months of the monsoon season, egg masses were not collected because trawling was difficult due to rough weather.

H. pugilinus produces egg masses in clusters attached to a hard substratum. Most of the melongenids produce this type of egg masses and this has been reported for *Melongena corona* (Hathaway 1957) and *H. tuba* (D'Asaro 1970; Morton 1985).

The *H. pugilinus* capsule is very tough and this may protect the eggs and embryos from benthic predators. Inside the capsule, eggs are suspended in a viscous fluid which may play a vital role in nourishing embryos (Kohn 1983). The number of eggs per capsule depends upon the size of the parent individual (Purchon 1968), availability of food, as well as environmental conditions (Webber 1977). The fecundity of *H. pugilinus* appeared to be low. But the relatively low number of large sized eggs is in agreement with the direct mode of larval development.

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