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REPRODUCTIVE CYCLE OF A SALT MARSH SNAIL *PYTHIA PLICATA*

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ABSTRACT

The histology of the ovotestis and the reproductive cycle of *Pythia plicata* a salt marsh snail inhabiting the Pitchavaram mangroves was studied. This snail exhibits a protandrous sexual cycle. First sexual maturity is attained at a shell length of 10.0 mm. The male phase starts in November (a NE monsoon month) when the male reproductive organs are well developed. The female genital ducts start developing in January (a NE postmonsoon month). Upto the end of March (end of postmonsoon season) the bursa copulatrix is filled with mucus without any foreign sperms. The penis and the anterior part of vasdeferens are present throughout the year. Copulation takes place from April (early summer) onwards, mostly during the night. Egg laying starts from the end of June and extends upto the end of July (postsummer season to early NE premonsoon). During August and September (NE premonsoon months) the ovotestis is completely empty and devoid of the sex cells. Then this cycle is repeated during the next year.

INTRODUCTION

MANY studies are available on the reproductive cycle of the pulmonate snails (Morton, 1954; Holle and Dineen, 1957; Morrison, 1958; Russell-Hunter *et al.,* 1966; Berry, 1968; Apley, 1970; Calow, 1978; Smith, 1981; Richardot-Coulet and Alfero Tejera, 1985). Concerning pulmonates of Indian mangroves, however, the only study is the cytological investigations by Natarajan (1960). The present study investigates the reproductive cycle of *Pythia plicata* a salt marsh pulmonate snail from Pitchavaram mangroves.

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MATERIAL AND METHODS

Snails of 2.5 to 22.7 mm were collected from the Pitchavaram mangroves (11° 29′ N; 79° 49′ E) for a period of one year. 600 snails in total were dissected and the ovotestis in fresh condition, was observed under the microscope for their maturity stages and sex. The ovotestis of some other snails were fixed in Zenker's fixative, dehydrated, embedded in celloidin-paraffin, according to Peterfi's method (Pantin, 1962) and sectioned (6 μ). These sections were stained in Weigert's haematoxylin with Biebrich scarlet as counterstain.

The calendar year was divided into four seasons — January to March (Postmonsoon), April to June (Summer), July to September (Premonsoon) and October to December (NE-Monsoon) to demarkate the seasons prevailing in the study area.

RESULTS

Sexual maturity

Pythia plicata is hermaphrodite and the gonadial observations revealed that it is

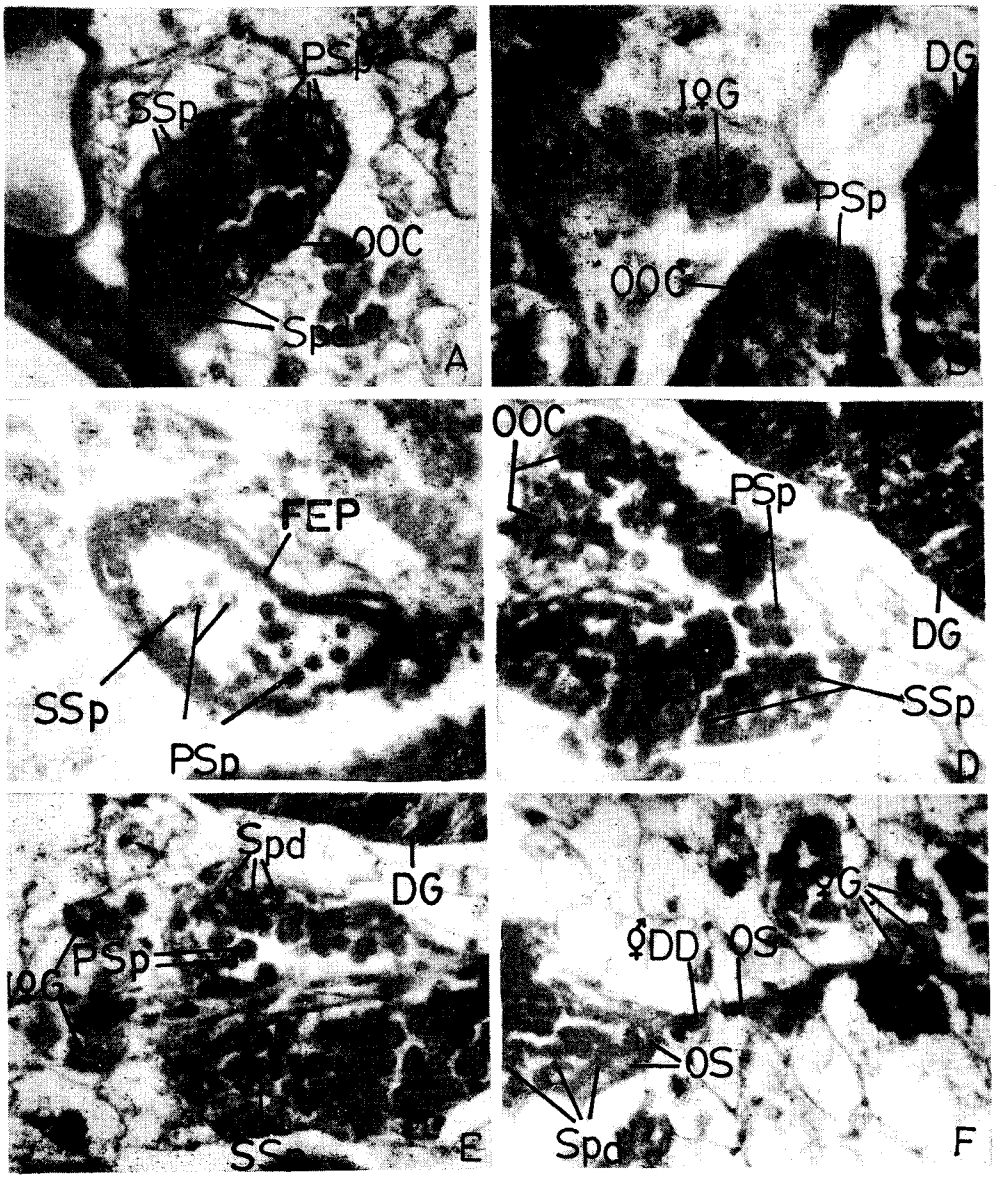

PLATE I. Development of *Pythia plicata* : A. T.S. of ovotestis showing a developing follicle (890 ×); B. A Section of a follicle with the oogonial cells (1335 ×); C. A tangential section of a follicle of ovotestis showing primary spermatocytes in different stages of meiosis (890 ×); D. Follicle showing different stages of spermatogenes is (1335 ×); E. The spermatogonial cells : Primary spermatocytes and secondary spermatocytes (A single oogonial cell is also seen) (890 ×) and F. Oligopyrene sperms passing along a ductule of the little hermaphrodite duct (890 ×). (OOC - Oocyte; SSp - Secondary spermatocyte; PSp — Primary spermatocyte; Spd — Spermatid; CT - Connective Tissue; DG - Digestive Gland; IoG - Immature Female Gonad; FEP - Follicle Epithelium; ♀DD - Ductule of Little Hermaphrodite Duct; OS - Oligopyrene sperm).

protandric *i.e.* it first starts its reproduction as male. It attains its first sexual maturity at a shell length of 10.0 mm.

Gametogenesis

The gonad of *P. plicata* is an unpaired ovotestis located in the uppermost coils of the visceral mass, embedded in the digestive gland. The ovotestis is composed of many lobules, each consisting of several oval or elongate follicles. A very narrow ductile arises from each follicle as its continuation. The ductiles unite into ducts which ultimately form the hermaphrodite duct.

A very young, developing follicle contains both oogonia and spermatogonia (Pl. I A). They occupy different sectors of the follicle wall. The oogonia are large, spherical or polygonal cells with very large nuclei that usually contain two large nucleoli (Pl. I B, C). The cytoplasm at this stage does not show any inclusions. The oogonia undergo division to produce oocytes. Further maturation leads to the formation of the ovum after meiotic divisions. The matured egg is more or less elliptical in shape. The cytoplasm is loaded with nutrients which form the inclusions. The eggs now pass along the ductiles into the hermaphrodite duct. The accessory glands such as the albumen gland and the mucus glands add the envelope layers.

The same follicle usually contains male gametocyte also. The spermatogonia consists of small cells which multiply and produce primary spermatocytes. All stages of reduction division can be clearly observed (Pl. I D). The secondary spermatocytes are smaller than the primary spermatocytes and they produce spermatids (Pl. I E) which are later transformed into sperms.

P. plicata also produces atypical sperms (Pl. I F). Normal spermatocytes produce typical uniflagellate sperms which take part in fertilization. The male gametes undergo maturation first, then the female ones, and this is followed again by spermatogenesis. The cycle is thus repeated.

At no time do mature male and female gametes occur together in any follicle. Advanced stages of spermatogenesis can however be observed in the same follicle which contains early stages of oogenesis or vice versa.

Reproductive cycle

P. plicata shows a protandrous sexual cycle. Snails attain first sexual maturity at a shell length of 10.0 mm. The male phase actually starts in November, when the ovotestis is filled with sperm and the male reproductive organs are well developed; the female reproductive organs are yet to develop. The prostate gland develops to its maximum size and the bursa copulatrix is filled with mucous devoid of any foreign sperms.

In January the female genital ducts start developing. The oocytes fill the lumen of the ovotestis displaying the sperms into the hermaphrodite duct. Upto the end of March, the bursa copulatrix is empty.

The penis and the anterior part of the vasdeferens are present throughout the year.

Copulation takes place from April onwards mostly during the night hours. In each pair, one snail acts as male and the other as a female. The female genital ducts are at their greatest development while the prostate and other male genital ducts are reduced in size and appear as a mere tube running adjacent to the anterior mucus gland.

Egg-laying starts at the end of June and extends upto end of July. During August and September the ovotestis is completely empty and devoid of the sex cells. Then the cycle is repeated during the next year (Fig. 1).

DISCUSSION

Protandric type of sexual maturity is a general phenomenon observed in pulmonates. As in *P. plicata* the protandric sexual maturity was reported in *Limnaea luteola* (Seshaiya, 1927), *Leucophytia* (Morton, 1955 a), *Otina otis* (Morton, 1955 b) and *Carychium tridentatum* (Morton, 1954). In *Physa fontinalis*, from Florida, the male genital tract is retarded at the first sexual maturity (Richards, 1962); likewise the male genital tract of aphallic individuals of *Bulinus truncatus* also does not mature (de Larambergue, 1939; Wu, 1972); these appear to be representatives variable from the normal trend.

As in *P. plicata*, in *C. tridentatum* also, there is a short male phase beginning in late

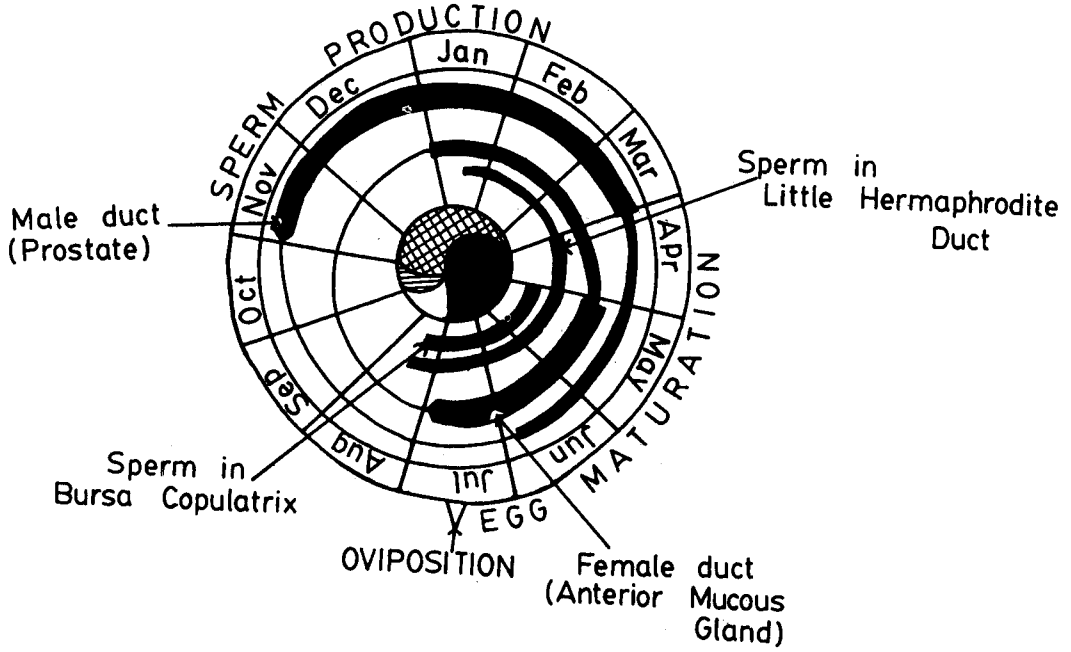

Fig. 1. Seasonal cycle of the gonad and accessory genital organs. The central area represents the condition of the gonad, the region with checks showing premeiotic stages in spermatogenesis, the region with only lines later stages in the production of the male gametes and black representing ova. The concentric circular area indicates the presence of sperms in the little hermaphrodite duct and in the bursa copulatrix.

histologically, the male genital system developed completely before the female genital system had even started to develop (Duncan, 1959). *Stagnicola elodes* is also a protandric pulmonate snail (Rudolph, 1980).

But *Melampus bidentatus* is a simultaneous hermaphrodite in contrast to the reported protandry throughout the family Ellobiidae (Apley, 1970). In the planorbid snail *Gyraulus* June and continuing until the end of August by which time the ovotestis is fully occupied by the oocytes followed by a longer female phase (Morton, 1954).

Morton (1955 a) demonstrated that in the marine ellobiid snail *Leucophytia* there is a male phase in autumn and winter and preceding female phase in spring and summer with cessation of breeding activity in July.

In *P. plicata* there is no disappearance of penis or vasdeferens during the female phase as observed in *Leucophytia* (Morton, 1955 a). However in *Carychium* (Morton, 1954) the penis and the anterior vasdeferens are not wholy present all through the year; instead they are reduced and disappear during the female phase. But in *P. plicata*, the prostate, one of the male genital ducts is found intact even in the female phase as observed in *Carychium* (Morton, 1954).

P. plicata starts egg laying from the end of June, but the egg laying is intensive in July. It attains its first maturity at a shell length of 10.0 mm. Walton and Jones (1926) reported that in *L. truncatula* the egg masses are laid in March and are hatched in an average of 20 days; the young snails resulting from this spawning ovipositing during the first week of July. Smith (1981) found that *L. truncatula* attains sexual maturity (when reared in isolation) at a mean shell length of 4.42 ± 0.17 mm. It starts laying egg at this length (4.42 mm). Walton and Jones (1926) found the size at egg laying to be 4.0 to 4.5 mm while Kendall (1953) found the same 4.5 mm for the same species.

Morton (1954) correlated the growth of *Carychium* in the field with the sexual cycle and reported that the snails hatched in June undertake their sperm production in July of the following year. Duncan (1959) reported that in *Physa fontinalis,* a Mediterranean species collected from Traparnaud during 1954, there were two breeding seasons in that year, the second was very much smaller, occurring in September and October. The majority of the snails, however, do not reproduce at this time and overwinter instead. However in Surrey Canal at Camberwell, Southeast London, the same species breed from late April and the breeding snails can be collected until December. He has also observed that in *P. fontinalis* from Stanmore pond, sexual maturity was not always related to the shell size. For instance even a very small (5 mm) animal occasionally produced capsules and the subsequent dissection of the snail showed fully matured reproductive system. He observed that in summer oviposition started as soon as the snail attained sexual maturity.

According to Berry (1968) the ellobiid snail *Cassidula* reaches its first maturity at a length of 18 mm. Apley (1970) has reported that the salt marsh snail *M. bidentatus* attains its sexual maturity (when gametogenesis first occurs) at a size of approximately 5 mm shell length. Plummer (1975) observed that *Archachatina (Calachatina) marginata* attains its first maturity between 150 and 180 days with a peak egg production between 210 and 270 days. According to Hodasi (1979) *Achatina (Achatina) achatina* attains first sexual maturity at the age of 21 months during which period the animals come across two intervening seasons of aestivation; he had also found that the breeding season extended from April to July. Peter Pawson and Ronald Chase (1984) studied the life cycle, growth characteristics and reproductive activity in *A. fulica* by raising the snail in the laboratory and found that it attained sexual maturity at the age of 5 months with a peak egg production between 210 and 270 days. Richardot-Coulet and Alfero Tejera (1985) suggested that the population of *Armiger crista* has two or even three different breeding seasons, in its annual cycle, the first one in spring, second one in late spring or early summer and the third one in autumn.

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