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Reproductive biology of *Chela fasciata* Silas – an endemic ornamental barb of the of Western Ghats of India

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ABSTRACT

Reproductive biology of *Chela fasciata*, an ornamental cyprinid fish endemic to the Western Ghats of Kerala, was studied from144 specimens (94 females and 50 males) ranging in size from 26.0 to 82.0 mm. The ovaries showed asynchronous oocyte development. The first mature female appeared at 40–45 mm total length (TL) and male at 25–30 mm TL. The size at first maturity estimated was 45.75 and 36.25 mm for females and males respectively. All females were mature at 60 mm TL and males at 45 mm TL. *C. fasciata* was found to be a multiple spawner with a protracted spawning season; the individuals spawn intermittently. Absolute fecundity ranged from 2669 to 4437 in fishes of size range 49.5 to 82 mm TL. The number and size of eggs were found to be directly proportional to the size and age of the fish. Fecundity showed a positive linear relationship ($p<0.05$) with the length and weight of both the fish and ovary.

Keywords: *Chela fasciata*, Endemic ornamental cyprinid, Reproductive characteristics, Western Ghats

Introduction

India is endowed with a rich biodiversity of freshwater fishes in the Western Ghats and the North-eastern hills. Of the 300 species of fishes so far assessed from the rivers of Kerala, 155 have ornamental value. Captive studies have been made on the desirable qualities of 90 species of fishes and captive breeding technology has been developed for 12 species (Anna Mercy, 2003). Detailed studies on the biological features of the threatened species will be very valuable in implementing any programme on conservation of the fish genetic resources (Virjenhock *et al.,* 1998). The vast amount of literature on the reproductive organs and reproduction of freshwater ornamental fishes has been reviewed by Raven (1961), Hoar (1969), Marshall (1979), Nagahama (1983), West (1990) and Jalabert (2005).

Chela fasciata Silas commonly called "Chela" or "Malabar hatchet chela" is an elegant ornamental fish of the family cyprinidae. It is endemic to the Western Ghats of Kerala and inhabits the riffles of the River Bharathapuzha at Thootha. The present study describes goandal maturity stages, length at first maturity, spawning frequency and fecundity of this fish.

Materials and methods

A total of 144 specimens of *C. fasciata* (94 females and 50 males), collected from Bharathapuzha during the period from October 2006 to November 2007, were used for the study. The size range of females and males was 37.0 to 82.0 mm and 25.0 to 56.0 mm TL, respectively. Different aspects of breeding biology were studied following the methods described by Nair and Nair (1984).

Classification of maturity stages and spawning frequency

Classification of maturity stages was done in females based on external evaluation of the gonads for colour, shape, space occupied in the body cavity, texture and blood supply. The universally accepted scale of six stages (Nikolsky, 1963) being primarily for temperate fishes, in the present study, a modified six-stage key was used based on the peculiarities of reproductive strategy such as multiple spawning and protracted spawning season of the tropical species.

The diameters of ova from ovaries in different maturity stages were measured using an ocular micrometer on a monocular microscope with 4 × 10 magnification, in order to trace the development of ova as maturation progresses. For this, ovaries were preserved in Gilson's fluid (Simpson, 1951) and mixed sub-sample was taken from different parts of each ovary to eliminate error due to differential distribution of ova stocks in different parts of the ovary. The percentage frequencies of different ova diameter classes (64 µm interval) were plotted to study the spawning frequency

Length at first maturity

The length at first maturity, *i.e.*, the size at which 50% of the population is mature, was estimated by plotting the occurrence (in percentage) of mature fishes (early ripening, late ripening, ripe and partially spent) in different length classes of 5 mm intervals. Based on the macroscopic appearance of male gonads, they were classified as immature, maturing and mature, and the latter two stages were considered for estimating the length at first maturity.

Fecundity

The ovaries of 18 females (49.5-82.0 mm TL; 1.033-2.933 g body weight) were submerged whole in Gilson's fluid with appropriate labels, shaken vigorously and left to stand for 24 h so that the hardened ova were liberated easily from the broken ovarian tissue. Absolute fecundity was estimated following Hickling and Rutenberg (1936).

$$\text{Fecundity} = \frac{\text{Weight of the ovary x Average number of eggs per sub sample}}{\text{Average weight of the sub sample}}$$

Relative fecundity was expressed in terms of number of eggs per unit length and unit weight of the fish and ovary. The linear relationship between absolute fecundity and (i) total length, (ii) body weight, (iii) length of ovary and (iv) weight of ovary were computed by regression analysis after $\log_{10}$ transformation. The linear equation was fitted by the method of least squares, allowing the use of standard statistical procedures for subsequent analysis.

Sexual dimorphism

The specimens, both males and females, were studied for differences in finnage, tubercles and colouration.

Results and discussion

Classification of maturity stages and spawning frequency

Ovarian development in *C. fasciata* could be classified into 6 stages (Figs. 1a-f)

Immature virgin (Fig. 1a)

Ovaries in this stage were very small, triangular, translucent and pinkish, occupying less than one-fourth of the body cavity. Ova were not visible to naked eye. All the transparent ova in this stage measured <136 µ. The mode of the immature stock was at the ova diameter class 40-72µ.

Maturing virgin (Fig. 1b)

The ovaries were usually pinkish, translucent occupying about one–third of the body cavity. The lengths of both the lobes were equal. The ova diameter ranged from 16 to 360 µ by this stage. The proportion of the immature stock (up to 200 µ) was 85.27%, with mode at 40–72 µ. Up to an average ova diameter of 200µ the oocytes were transparent without any yolk material, representing the immature stock. The remaining

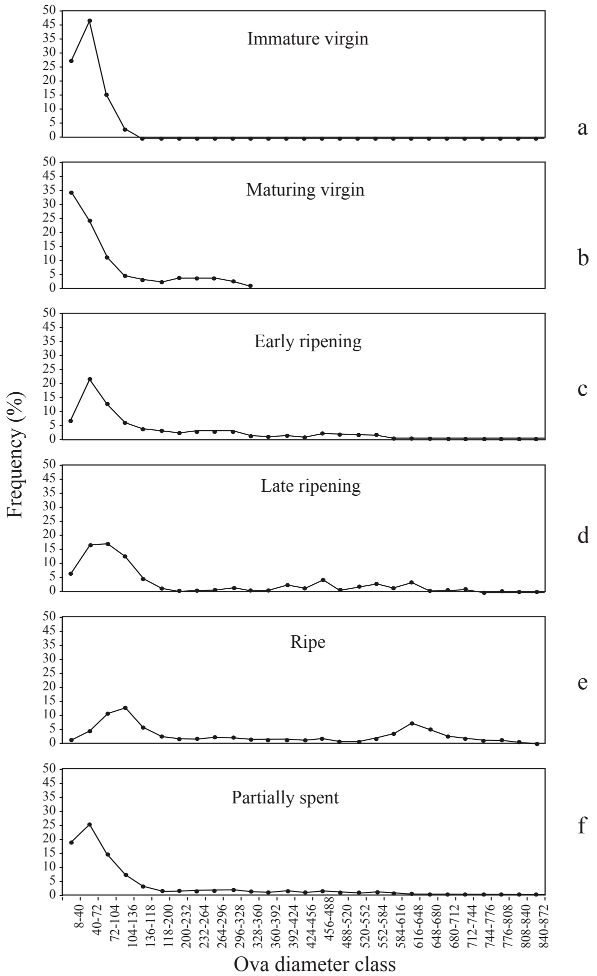

Fig. 1. Ova diameter frequency distribution in different maturity stages of female *Chela fasciata*

14.73% was from the ripening stock. The early yolk vesicle eggs appeared at an average ova diameter of 216 µ and on reaching an average diameter of 552 µ the eggs were mature. The ripening stock was thus represented by ova diameter range of 216–552 µ.

Early ripening (Fig. 1c)

Ovary creamy yellow in colour occupying half to less than three-fourth of the body cavity (indicating vitellogensis). Ovary turgid with transparent ovarian wall and ova quite visible to the naked eye. Ova diameter increased to 648 µ at this stage. All three stocks (immature, ripening and ripe) were seen in this stage. Immature stock formed 70.01%, with a mode at 40- 72 µ. Ripening stock formed 27.04% and was divided into many batches with no distinct mode. Ripe stock with a size range of 568 to 648 µ formed 2.94%.

Late ripening (Fig. 1d)

The maximum diameter of the ova increased up to 808 µ. About 69.1% of the ova was constituted by the immature stock with mode at 72-104 µ. Ripening stock formed 18.75% without a distinct mode. The proportion of ripe stock increased to 12.14%.

Ripe (Fig. 1e)

Maximum ova diameter was 840 µ. The contribution of the immature stock was only 45.46% with mode at 104-136 µ. Ripening stock formed 23.09% with no distinct mode and ripe stock formed 31.5% with a distinct mode at 616-648 µ.

Partially spent (Fig. 1f)

Maximum ova diameter was 648 µ. The percentage contribution of the immature stock increased to 79.68% with mode at 40-72 µ. Ripening stock constituted about 17.68% with no clear mode and ripe stock which may have been the unspawned residual ova, formed 2.64%.

Ova diameter studies reveal that this species comes under category D of Karekar and Bal's classification (1960), characterised by spawning that is extended over a very long period of almost round the year with individual spawning intermittently. It is apparent from the ova diameter frequency distribution of a ripe ovary (Fig. 1e) that there are three batches of eggs representing immature, ripening and ripe ova stocks. Thus *C. fasciata* may be designated as a multiple spawner exhibiting asynchronous ovarian development, with oocytes in all stages of development being present at the same time. The oocyte size frequency distribution is continuous except in ripe ovaries, where there may be a clear separation between the ripe and yolked oocyte (Wallace and Selman, 1981), a pattern very clearly exhibited in *C. fasciata*. De Vlaming (1983) considers that most species with asynchronous oocyte development have protracted spawning season with multiple spawning. Multiple spawners are also termed partial, heterochronal, serial spawners (Holden and Raitt, 1974; Macer, 1974), implying that only part of the complement of yolked oocytes is spawned and that individuals spawn over a protracted period. The ovary undergoes repeated maturation of the ripening ova stocks followed by ovulation and spawning. The classic examples for this strategy among cyprinids are the minnows largely restricted to lake and river margins and to very shallow riffle areas (Mills, 1991). In barbs such as the six *Barbus* species of Sri Lanka inhabiting both the Kaluganga and Ginganga, spawning was observed year round and is attributed to temperature (De Silva *et al*., 1985). It has been suggested that, as multiple spawning within years can result in a much higher annual reproductive effort, strategies of early and continuous reproduction should be considered the base line condition (Burt *et al.,* 1988). This condition would be associated with less seasonal environments, early maturation, smaller body size and smaller relative ovary size presumably at the cost of a short life span, as shown by the small tropical cyprinids. *C. fasciata* is a typical tropical minnow distributed in the riffle zones of the Western Ghat river ecosystem exhibiting this type of reproductive strategy.

Length at first maturity

The first mature males appeared at 25–30 mm TL (16.6%) while the first mature females appeared at 40–45 mm (22.2%). All male fishes were mature at 45 mm TL and all female fishes, at 60 mm TL. The size at first maturity for males was 36.25 mm TL (35–40 mm) and 45.75 mm TL for females (45–50 mm) (Fig. 2).

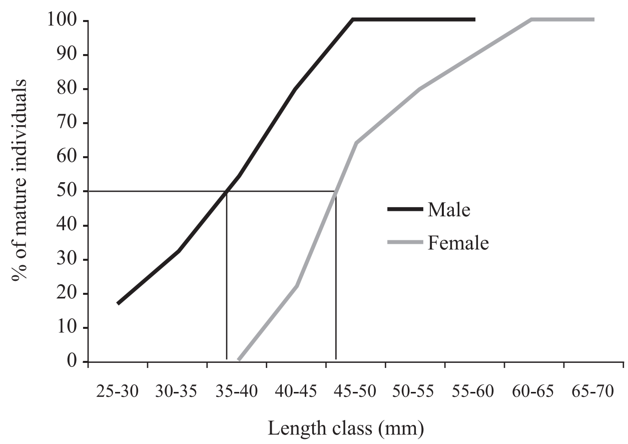

Fig. 2. Length at first maturity in *Chela fasciata*

The largest female obtained measured 82.0 mm TL and the largest male, 59.5 mm TL. De Silva *et al.* (1985) observed that females attained sexual maturity later than the males and was between 50 to 65% of their maximum size, in six *Barbus* species of Sri Lanka. This is a kind of reproductive strategy to enhance existence of the race by increasing fecundity, which is directly related to the size of the female fish (Keenleyside, 1991). The females spend more energy first on somatic growth and then on gonadal growth and maturation. However, early maturation of the males diverts their energy reserves towards gonadal development and maturation at a relatively smaller size. Similar observations have been reported in many freshwater fishes like *Labeo boggut* (Selvaraj *et al*., 1972), *Barbus sarana* (Murthy, 1975), *Nemacheilus triangularis* (Ritakumari and Nair, 1979) and *Puntius denisonii, Puntius filamentosus, N. triangularis* and *Nemacheilus semiarmatus* (Mercy *et al.,* 2005).

Fecundity

The ovary weight ranged from 112 to 253 mg and ovary length ranged from 1.10 to 2.70 cm. Absolute fecundity ranged from 2669 to 4437 (49.5-82.0 mm TL and 1.033-2.933 g body weight) and relative fecundity ranged from 501.91 to 587.74 per cm body length and from 1512.9 to 2617.6 per g body weight of fish and from 15.20 to 22.91 per mg ovary weight and 1643.55 to 2468.41 per cm ovary length. In the European minnow, *Phoxinus phoxinus* with a maximum size of 78.0 mm, the maximum estimated egg production was 3172 eggs (Mills, 1987). Studies shows that repeat spawners have larger fecundity than recruit spawners. The number of eggs released increases with age and size ranging from 2704 for 49.5 mm fish to 4438 for a fish of size 82 mm. Similar studies have been done on six *Barbus* species of Sri Lanka (De Silva *et al.,* 1985) and on *Danio malabaricus* (Mercy *et al*., 2005). With increase in body length, the relative fecundity per mg ovary weight ranged from 23.83 to 15.2 in *C. fasciata*. This indicates an increase in size and weight of eggs from the small recruit spawners to the large repeat spawners. The fecundity was most significantly correlated with gonadal weight in six *Barbus* species of Sri Lanka (De Silva *et al*., 1985). Hempel and Blaxter (1967) reported similar findings for the Atlantic herring (*Clupea harengus*) and Hislop (1975) for the haddock (*Merlanguis aeglifinnus*).

The relationship between absolute fecundity and i) total length, ii) body weight, iii) length of ovary and iv) weight of the ovary are given in Table 1. Fecundity increases with increase in length and weight. All the linear relationships were statistically significant ($p<0.05$).

Table 1. Relationship between fecundity and length and weight of fish and ovary

Variant (X)	Equation Log Y= Log a + b Log X	Correlation coefficient (r)
Total length (cm)	Log F= 2.750 + 0.973 Log TL	0.963 *
Body weight (g)	Log F = 3.403 + 0.477 Log BW	0.950 *
Ovary length (cm)	Log F = 3.374 + 0.622 Log OL	0.925 *
Ovary weight (mg)	Log F = 2.290 + 0.548 Log OW	0.909 *

* Significant ($p<0.05$)

Sexual dimorphism

It was observed that the body colour in males intensified during spawning. Mature females are comparatively larger in size as they mature late. The males were rather smaller and slender, while the females had broader abdomen due to the presence of ripe ovary within. For captive breeding experiments, the ripe females were identified by checking the soft, bulged belly. In males of *Chela dadyburjori* during the breeding season, four to six minute wart-like protruberances on the opercle are seen (Mercy *et al*., 2007). However, this is not seen in *C. fasciata*. Sexual dimorphism in this species is not marked, and identification of the sexes has to be done mainly by checking the soft, bulged belly during the ripe condition of the female. Similar observation was made in *Danio malabaricus* (Sterba, 1953; Mercy *et al*., 2005).

A complete understanding of the reproductive biology of a fish is required for developing captive breeding technology. *Chela fasciata*, is a much sought after fish in the international ornamental fish market, and the results of the present study will help in its captive breeding for commercial production.

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