# Reproductive biology of *Amblypharyngodon melletinus muriyadensis* – an ornamental fish of the Western Ghats of India

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**Abstract**
Ornamental fish industry directly depends on the fish and their ongoing availability. Fish spawn during a certain stage of their reproductive cycle some breed just once a year, while others do so at regular intervals all year long. Each species carefully chooses the best season to have the greatest number of offspring. Since all phases of fish are not appropriate for the ornamental fish market a scientific foundation is necessary for each species collection. Keecheri and Puzhakkal rivers are two important rivers of Thrissur district, Kerala. The region has immense potential with respect to ornamental fish trade. Therefore, the availability of *Amblypharyngodon melettinus muriyadensis* for the trade was assessed in this work. In this study sex ratio and distribution of mature stages was conducted to provide management cues and promotional basis for sustainable yield of ornamental fish. The study revealed female dominance over male. It was identified that the fish breed during monsoon season and mature at short length increasing their potential to produce offsprings.

**Key words**: *Amblypharyngodon melettinus muriyadensis*, reproductive biology, sex ratio, maturity stages, seasonality, Ornamental fish trade

## Introduction

The ornamental fish business is a complex one with many multiple components, procedures, and a number of stakeholders. It becomes a Multi-billion dollar earning venture when all these components function together.

However, the fish is the most crucial element, and its accessibility determines the industry's input. According to Nelson (2006), there are 27977 species of fish that are now alive. This diverse ichthyofauna is threatened by a number of ecological problems, and the business is subject to a number of restrictions. By strong scientific database, judicious collection of fish could be ensured.

The evaluation of gonad development stage is a crucial step in many investigations of fish reproductive biology. By tracking these changes at intervals of monthly, fortnightly or weekly, the cycle of gonad maturation may be identified.

A review of the literature finds that there is little information available on the reproductive biology of many ornamental fish. Nevertheless sex ratio, size at maturity, maximum and median sizes, distribution of egg sizes in mature ovaries and individual fecundities have been done to assess breeding status in cyprinids (Chelapurath *et al*., 2020, Fishelson *et al*., 1996, Dopeikar *et al.,* 2015 and Mousavi-Sabet *et al*., 2017) and works on *Amblypharyngodon mola*. (Azadi & Mamun, 2004) and Rahman *et al*., 2018) provide data on their breeding biology. However, there are no works related to *Amblypharyngodon melettinus muriyadensis*.

The study on distribution and availability of fish is a prerequisite (Swain, 2008) for sustainable yield. Therefore, studies on the temporal distribution of different maturity stages of *Amblypharyngodon melettinus muriyadensis* were done to elucidate the life history traits in order to aid in sustainable collection of the fish for the aquarium without impeaching stress upon the ecosystem. This would reveal the resource availability and reproductive trends of this species.

## Materials and Methods

Monthly samples of *Amblypharyngodon melettinus muriyadensis* have been collected from Keecheri-Puzhakkal river system during September 2011-August 2013.

*Sex ratio*

By calculating the total number of two sexes in the monthly collections, the fluctuation in sex ratio over time was examined. To analyse deviations from the predicted sex ratio of 1:1, the chi-square test was used.

$X^2 = \sum (O-E)^2 / E$

Where, O is the observed frequency of males and females and E is the expected frequency of males and females.

*Analysis of maturation of fish*

Further research on analysis of maturation of fish were primarily concentrated on females because they provide nutrition to the growing embryo, spawning occurs simultaneously in a population, and maternal function has a greater influence on

offspring production than parental role (Honey, 2011).
The fish's gonads were weighed after being dissected. Fresh ovaries were examined under a microscope for their size, colour, and shape, as well as the texture of their gonads. They were then stored in 4% formaldehyde. The fishes were grouped according to sex, length and maturity stages of ovary based on monitoring ova diameter and gonadosomatic index throughout the years.
Fish were divided into length classes with 0.5 cm intervals. At each length group, the percentage of immature, maturing, mature, ripe, and spent fish was noted. Percentage occurrence of different maturity stages month wise was also assessed.

**Result and Discussion**
A total of 527 fish were collected for the assessment of sex-ratio in *Amblypharyngodon melettinus muriyadensis*. Of this 147 were male and 380 were Females.
Table 1 provides the monthly observation of percentage proportion of male and female and chi-square values of *Amblypharyngodon melettinus muriyadensis.*
The monthly values in the sex ratio varied from 1:1.05 in November to 1:6.5 in April. Marked variation in the sex ratio was also observed in the months of March, May and June with values of 1:5.8, 1:6.14 and 1:6.28 respectively.
From February to October except August the chi square values were significant at 5% level and 1-degree freedom and the consolidated sex ratio was 1:2.58 (Table 2).
On analysis of female ovarian development, seasonal distribution of different maturity stages was estimated. The testes are tiny and filamentous, so it was easier to distinguish the maturity stages of ovary than the testes.
Five phases of development were identified by microscopic investigation of the ovaries based on ova diameter and macroscopic evaluation based on colour, appearance, texture, shape, size. The different stages identified include immature, maturing, mature, ripe and spent.

**Table 1 Monthly variation in sex ratio of *Amblypharyngodon melettinus muriyadensis* during September 2011 to August 2013.**

| Month | % Male | % Female | Sex Ratio (M:F) | Chi-square value |
|---|---|---|---|---|
| **Sep** | 22.44 | 77.55 | 1:3.45 | 14.86 |
| **Oct** | 25.80 | 74.19 | 1:2.87 | 7.24 |
| **Nov** | 48.71 | 51.28 | 1:1.05 | 0.02 |
| **Dec** | 46.66 | 53.33 | 1:1.14 | 0.06 |
| **Jan** | 47.05 | 52.94 | 1:1.125 | 0.05 |
| **Feb** | 30.55 | 69.44 | 1:2.27 | 5.44 |
| **Mar** | 14.63 | 85.36 | 1:5.8 | 20.50 |
| **Apr** | 13.33 | 86.66 | 1: 6.5 | 32.26 |
| **May** | 14.00 | 86.00 | 1:6.14 | 25.92 |
| **Jun** | 13.72 | 86.27 | 1:6.28 | 26.84 |
| **Jul** | 38.83 | 61.16 | 1:1.575 | 5.12 |
| **Aug** | 42.85 | 57.14 | 1: 1.333 | 0.714 |

**Table 2 Consolidated data on observed sex ratio of *Amblypharyngodon melettinus muriyadensis* with chi-square values**

| n | Male | Female | Sex ratio | $X^2$ | Remarks |
|---|---|---|---|---|---|
| **527** | 147 | 380 | 1 M: 2.58F | 103.00 | * S |

* S – Significant at 5 % level for 1 df

Figure 1 indicating percentage of mature fish in different length groups show that while none of the females of the length group 61-65mm were mature in *Amblypharyngodon melettinus muriyadensis* it is evident from the figure that females first attain maturity at the length of 66-70mm. Females of length group 86-90mm showed 100% maturity.

The Figure 2 indicating percentage occurrence of different maturity stages of *Amblypharyngodon melettinus muriyadensis* shows that in the length group 61-65mm all fish were immature. In length group 66-70mm, 10.52% were in the maturing stage and in length group 71-75mm 45% were in maturing stage. Ripe ovary and spent fish were observed for the first time in length group 76-80mm. In the length group 101-105mm and 106-110mm all fish were either ripe or spent.

The monthly distribution of *Amblypharyngodon melettinus muriyadensis* (Figure 3) shows that ripe females were observed in the catch from February while spent fish were observed from March. The percentage of ripe female increased from March and reached a peak in April with 92.85%. From then on it decreased and reached the lowest in the month of September.

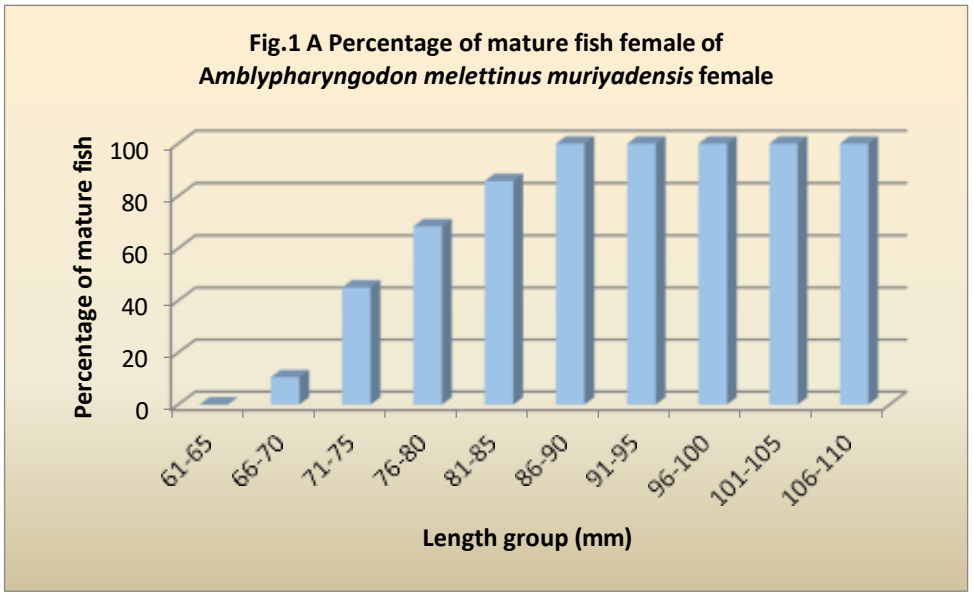
Fig.1 A Percentage of mature fish female of
Amblypharyngodon melettinus muriyadensis female
Percentage of mature fish
100
80
60
40
20
0
61-65
66-70
71-75
76-80
81-85
86-90
91-95
96-100
101-105
106-110
Length group (mm)

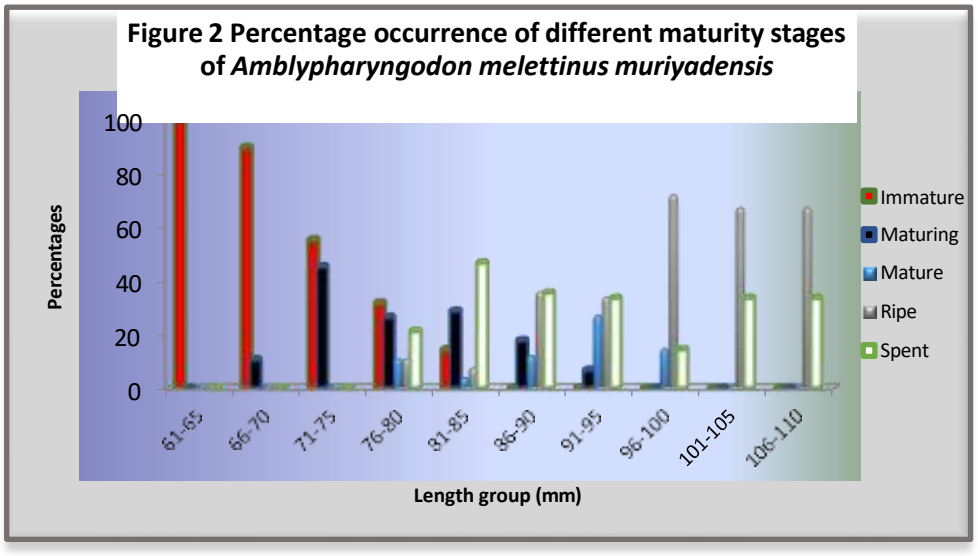
Figure 2 Percentage occurrence of different maturity stages
of Amblypharyngodon melettinus muriyadensis
Percentages
100
80
60
40
20
0
61-65
66-70
71-75
76-80
81-85
86-90
91-95
96-100
101-105
106-110
Length group (mm)
Immature
Maturing
Mature
Ripe
Spent

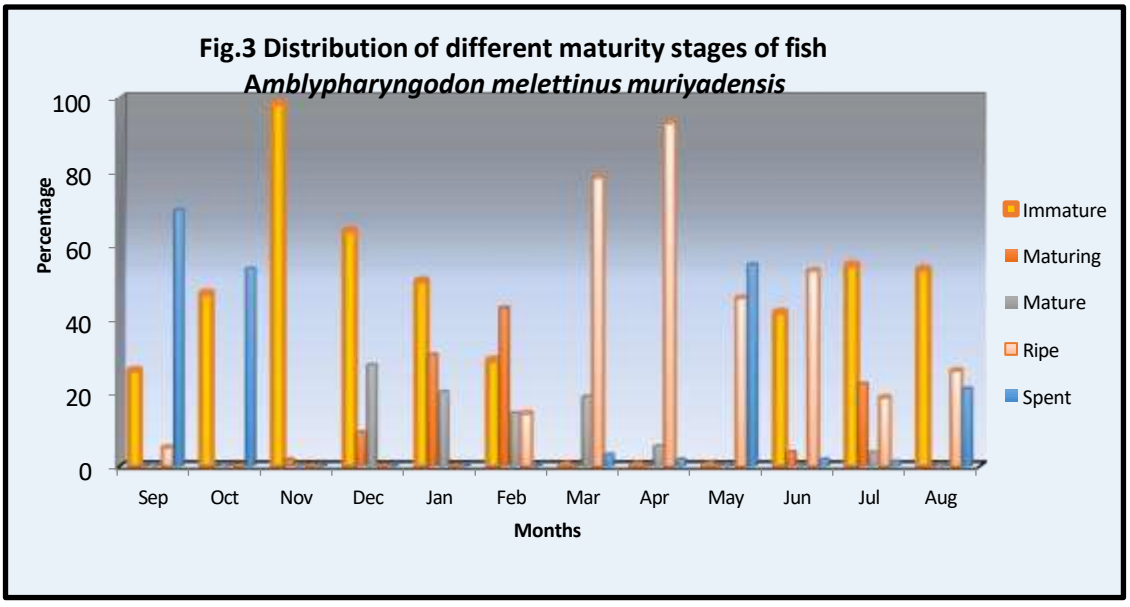
Fig.3 Distribution of different maturity stages of fish
Amblypharyngodon melettinus muriyadensis
Percentage
100
80
60
40
20
0
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Months
Immature
Maturing
Mature
Ripe
Spent

The ideal sex ratio in the nature is 1:1. According to the current investigation on the distribution of sex in Amblypharyngodon melettinus muriyadensis, females were consistently detected in greater numbers than males throughout the year, demonstrating a strong predominance of females.

While the sex-ratio fluctuated greatly in the different months, sex ratio of the pooled monthly observations indicated remarkable dominance during the months of April, May and June. The result obtained represents a clear deviation from the hypothetical 1:1 ratio.

In the present study the sex ratio was found to be in favor of female, this was in accordance with a number of works as in *Amblypharyngodon mola* (Gupta and Banerjee, 2013, Hoque and Rahman, 2008) and *Amblypharyngodon chakaiensis* (Babu and Nair, 1983).

While there is the possibility for females to be caught more easily in the present study this predominance is attributed to be due to heaviness of gravid females and male post spawning mortality as its clear that males are absent in the length group 101-110mm in the post spawning months. This indicates that the survival of males above the length of 100mm is doubtful supporting the above propositions.

This is in accordance with many similar works. Females gain weight and become lethargic during the breeding season, making them more vulnerable (Nagendran *et al*., 1981 and Gupta and Banerjee, 2013, Gogoi & Goswami (2014), Kaushik & Bordoloi. (2022). Females also preferred deeper waters (Solomon, *et al*., 2011). This knowledge of skewed sex ratio would help collection of both sex in the most appropriate season.

In *Amblypharyngodon melettinus muriyadensis* the smallest female with mature gonads were observed in length group 66-70mm. Length group at 50% percent maturity was determined to be 76-80mm. All the fish above the length of 86mm had maturing, mature, ripe or spent ovary.

In *A.mola* the length at first maturity was 51-56 mm for males and 39-44mm for females (Suresh *et al*., 2007) and in Payra river size of sexual maturity of female *A. mola* was estimated as 4.1 cm (Ahamed *et al*., 2017) and 5.16 cm was the length at first maturity for fish from the Ganges River (Nawer *et al*., 2018)

The present study identifies 71-75mm length group as the most dominant length group and fish of this size could easily be caught. But considering the breeding biology fishery regulation could be imposed at a higher length group so that all fishes will have a chance to breed at least once in the life time.

The present study reveals that minor spawning starts from the month of March in *Amblypharyngodon melettinus muriyadensis*. In this fish breeding is a prolonged one. It is evident that the fish is ready to breed from March and ends by October with 2 peak months May and September synchronized with the south west and Northeast monsoon.

The availability of juveniles starts from June with the highest during the month of October- November indicating the breeding to have taken place in the month of May-June and August -September. Immature fish were lowest during the month of March, April and May while ripe fish dominated the months.

Maturing fish were observed in all months except March, April and May and during the month of September, October. Mature fish were found from December after a slight drop in May, June it was again found to increase in July.

Percentage of ripe fish reached a peak in the month of April. However ripe fish could be collected in great numbers from March onwards up to September indicating breeding season from March to October. Since the spent fish were largely observed only from May it clearly depicts that after the fish ripened in April spawning effectually started by May.

Gupta and Banerjee (2013) reported April to December as breeding season for *A. Mola* with two peaks during June and November. Suresh *et al*., (2007) reported a single breeding season from April to October.

In the present study immature fish of indeterminate stage were dominant in the months of June and November. The present study reveals that the right time to collect the brooders from the river system is March, April and May and they could be collected for the aquarium trade. However, it is important that during breeding season, fishing pressure should be kept to a minimum in order to protect the spawning population (Dadebo, 2003). Therefore, appropriate restrictions need to be taken to protect the population.

In terms of population dynamics fish go through two phases, growing and collapse phases. During Growing phase post breeding there is abundant juveniles and in collapse phase many die because of lack of resources so if fish are harvested during this period it will not affect population size (Swain *et al*., 2008; Ng and Tan, 1997). Juveniles are plentiful in the months from June so judiciously it could be collected during the growing phase following sustainable practices and by the end of April when the water depth decreases and rivers start to dry up collection could be conducted during collapse phase. Such a kind of fish collection would be justifiable and could bring in profits in the ornamental fish trade.

**Conclusion**

This is the first study on the distribution of different life history stages of *Amblypharyngodon melettinus muriyadensis.* The results show that ripe female began to appear in the river system in February, and spent fish began to be spotted in March. The pre-monsoon season is the ideal time to collect the brooders. The juveniles are abundant in the months from June onwards. The present study proves that the fish species studied are available throughout the year and they could be collected sustainably during the growing and collapse phase. Our findings will provide an imperative foundation to facilitate sustainable management strategy.

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