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# Study on Reproductive Biology of some Indigenous Cat Fish

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## Abstract

The present study investigates the reproductive biology of selected indigenous catfish species *Mystus tengara, Mystus vittatus, Clarias batrachus,* and *Heteropneustes fossilis* collected from local markets in Bhopal, Madhya Pradesh, over a five-month period from August to December 2023. The research was conducted at the Department of Zoology and Applied Aquaculture, Barkatullah University, Bhopal. Monthly samples were analyzed to assess variations in total length, body weight, ovary length, ovary weight, Gonado-somatic Index (GSI), fecundity, and ova diameter to better understand the reproductive cycles and spawning seasons of these species. The maturity stages of the gonads were determined through macroscopic examination, and the GSI was calculated using the standard formula to track gonadal development. Fecundity was estimated gravimetrically by counting ova from different regions of the ovary, while ova diameter was measured using an ocular micrometer. The findings revealed distinct seasonal patterns in reproductive parameters among the studied species. Mystus tengara showed peak reproductive indicators in August, with maximum length (15 cm), weight (40 g), and ovary development. In Mystus vittatus, peak reproductive activity occurred in September, whereas in Clarias batrachus, reproductive maturity was most pronounced in October. Heteropneustes fossilis exhibited its highest GSI, ovary length, and weight in September, declining sharply by December. These variations in reproductive traits across species and months highlight their specific breeding seasons and reproductive strategies. The results of this study are significant for formulating conservation strategies and improving captive breeding programs for indigenous catfish in central India.

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# 1 Introduction

India's freshwater fish diversity includes nearly 2,500 species, primarily grouped into three major families: Cyprinidae, Siluridae, and Channidae, which thrive in various inland aquatic systems. However, a large portion of these species remains insufficiently studied (Malla and Banik, 2015). Among them, catfish classified under the order Siluriformes—represent a remarkably diverse assemblage, encompassing over 3,000 species, 478 genera, and 36 families. They account for around one-third of all freshwater fish species worldwide. In India alone, roughly 158 species of freshwater catfish exist, spread across 50 genera and 13 families. These species are found in diverse habitats, such as high-altitude streams, expansive river systems, and temporary floodplain wetlands, and they display a range of feeding behaviors, including consuming detritus and bottom-dwelling insects. Catfish are easily recognized by their unique barbels—whisker-like structures around the mouth, and unlike most bony fishes (teleosts), they typically lack scales. However, some species, like plecos, are covered in protective bony plates (Jin and Liu, 2016).

Catfish have a global presence, occupying both freshwater and coastal environments across all continents. Fossil records even show their presence in Antarctica, though they are most plentiful in the tropical zones of South America, Africa, and Asia. Comparatively fewer catfish families are found in North America and Europe. Their widespread distribution and rich diversity make them significant subjects for ecological, evolutionary, and biogeographic studies (Sullivan et al., 2006). Highly adaptable and resilient, catfish are ideal for aquaculture. They offer multiple traits favorable for fish farming, including high reproductive output, ease of artificial propagation, adaptability to natural pond conditions, tolerance of low-oxygen environments, resistance to various diseases, and effective feed conversion rates.These features contribute to their popularity and widespread use in aquaculture systems (Liu, 2008).

# 2 Reproductive Biology

Understanding reproduction is vital in fish biology for the sustainable use and management of fish stocks. Reproductive data provide essential insights into population fluctuations and help formulate effective fishery management strategies [Shalloof and Salama, 2008]. Since reproductive capacity significantly affects population productivity, it also determines how resilient fish populations are to fishing pressure and other human impacts [Ricker, 1954]. Measuring reproductive potential (RP) and recruitment is crucial, although it poses various challenges [Hilborn and Walters, 1992].

Studies focused on breeding seasons and influencing factors are useful for protecting juvenile fish and predicting recruitment trends [Gomez-Marquez et al., 2003]. Reproductive biology encompasses key processes such as sexual maturity, gonad development, spawning period, mating behavior, egg release, and fecundity. Various environmental and genetic factors such as photoperiod, water temperature, turbidity, depth, and food availability, can influence these reproductive processes. Moreover, the quality and viability of eggs and larvae are often related to the size and condition of the female fish, with larger or more experienced spawners typically producing healthier offspring. In species that spawn multiple times, egg size may also vary across the spawning period (Chambers and Waiwood, 1996; DeMartini, 1991; Kjesbu et al., 1996; Marteinsdottir and Steinarsson, 1998; Rideout et al., 2005b). Reproductive traits such as spawning strategy (batch vs. total spawner, determinate vs. indeterminate spawner) are species-specific, but many reproductive attributes can be flexible and vary across populations or even over time within a population. These variations are often energy trade-offs between growth and reproduction (Rijnsdorp, 1990; Stearns, 1992).

A thorough understanding of reproductive biology is crucial for the conservation of threatened species and the effective management of fisheries (Debnath et al., 2020). Key parameters like the gonadosomatic index (GSI) and fecundity play a significant role in initiating artificial breeding programs and overseeing wild fish populations (Gupta and Srivastava, 2001). The GSI is a reliable measure of reproductive status and aids in determining the timing of spawning periods (Shashi and Singh, 1998). Observing seasonal variations in gonadal development, often through the examination of morphological changes in the gonads, is a useful approach to understanding reproductive cycles (Sivakumaran et al., 2003). Identifying the breeding season is essential for implementing timely conservation actions, such as enforcing fishing restrictions.

## 3 Fecundity

Fecundity refers to the total number of mature eggs a female fish produces during the spawning season (Alam and Das, 1996). It plays a crucial role in population dynamics, sustainable fisheries, and aquaculture (Bagenal, 1978). Even within the same species, fecundity can vary widely among individuals, often due to differences in feeding success, age groups, or batch spawning behavior (Bagenal, 1957; Saliu et al., 2007). It is also influenced by body length, age, and gonad weight [Lagler, 1956]. Two fish of equal body weight may still have different egg counts, a variability possibly linked to genetic diversity, showing that different strains may mature and reproduce at varying sizes depending on their habitat and ecological factors. Environmental cues such as temperature, daylight duration, and rainfall significantly impact ovarian development and overall fecundity [Lone and Hussain, 2009].

Research indicates that reproductive cycles in fish are closely tied to environmental changes, especially in terms of food availability, photoperiod, and water temperature. Understanding reproductive patterns is essential for managing fish stocks and enhancing species-specific fishery strategies (Iram et al., 2018; Bhat et al., 2010). Since the survival and conservation of fish species depend largely on their reproductive capacity, key indicators such as fecundity and GSI become crucial for evaluating their life history and population health (Shafat et al., 2016). The aim of this study is to determine the reproductive biology of *catfishes H. fossilis*, *Mystus tengara*, *Mystus vittatus*, and *Clarias batrachus*.

# 4 Methodology

**Collection site of species**

Fish samples were collected monthly over a five-month period beginning in August 2023 to study their reproductive biology. Specimens were gathered from various markets, including Kasturba, Vijay, Bittan, Govindpura, and Piplani. After collection, the samples were transported to the laboratory and stored in a deep freezer until further examination and analysis. The purpose of sampling was to monitor the monthly changes in gonadal development. For each fish, body weight was recorded using a digital weighing scale, while gonad weight was also measured. Additionally, both standard and total body lengths were measured using a ruler.

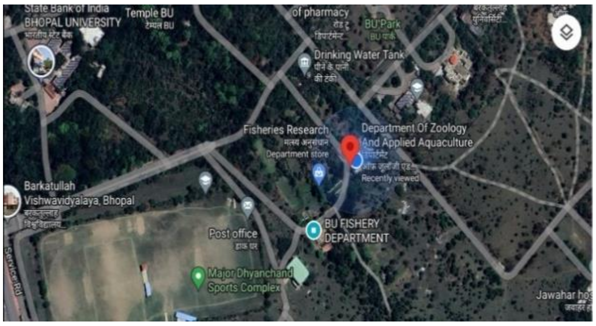
Govindpura Market

Vijay Market

*Kasturba market*

Piplani market

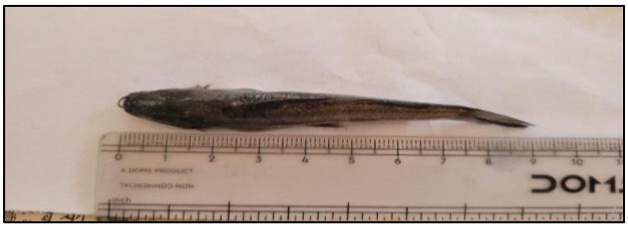
**Department Lab:** The study was carried out at the Department of Zoology and Applied Aquaculture, Bhopal (Madhya Pradesh).





**Department of Zoology and Applied Aquaculture**

**Length-Weight Measurement**



**Length of Fish**


**Dissection of Fish** **Removal of gonad**



**Length of Gonad** **Removal of gonad**

## Maturity stage and spawning season

The maturity stages were ascertained on the basis of the degree of development of ovaries. Cycle of gonadal maturation and breeding season has been studied by macroscopic and monthly examination of the different maturation stages of gonad. Gonads have then been grouped into different gonadal stages of development**.**

***Mystus tengara***

| **Immature** | **Maturing** | **mature** | **Spent** |
|---|---|---|---|
|  |  |  |  |

***Mystus vittatus***

| **Immature** | **Maturing** | **mature** | **Spent** |
|---|---|---|---|
|  |  |  |  |

***Clarias batrachas***

| **Immature** | **Maturing** | **mature** | **Spent** |
|---|---|---|---|
|  |  |  |  |

***Heteropneustus fossilis***

| **Immature** | **Maturing** | **mature** | **Spent** |
|---|---|---|---|
|  |  |  |  |

**Gonado-Somatic Index (GSI %)**

As fish grow, their gonads gradually enlarge and develop toward maturity. Up until the gonads reach the fully ripened stage, their growth tends to be directly proportional to the overall growth of the fish. However, once spawning occurs and the eggs are released, the gonads become spent, leading to a reduction in their weight. Consequently, the Gonado-somatic Index (GSI) increases steadily as the gonads mature, but shows a significant decline following spawning. This index was calculated, and the average monthly values were plotted for analysis. The GSI was determined using a specific formula.

**GSI = (Weight of gonad / Weight of fish) × 100.**

**Fecundity**

Gravimetrically, the fecundity of the fish was observed. During the study, the external connective tissues were removed carefully from the surface of the ovaries. With the help of blotting paper moisture of the ovaries was removed. The weight of the ovaries was recorded. Then, the ovary was carefully dissected, and samples were taken from the anterior, middle, and posterior sections of each ovarian lobe. In each portion, the mature and immature eggs were separated and counted. The fecundity of the examined fish was then assessed using the following formula:

**Fecundity = (Number of eggs in the sample × Total weight of the gonad) / Weight of the sample**.

Additionally, the diameter of the ova was measured at various stages of maturity using an ocular micrometer. **(Figure-1)**

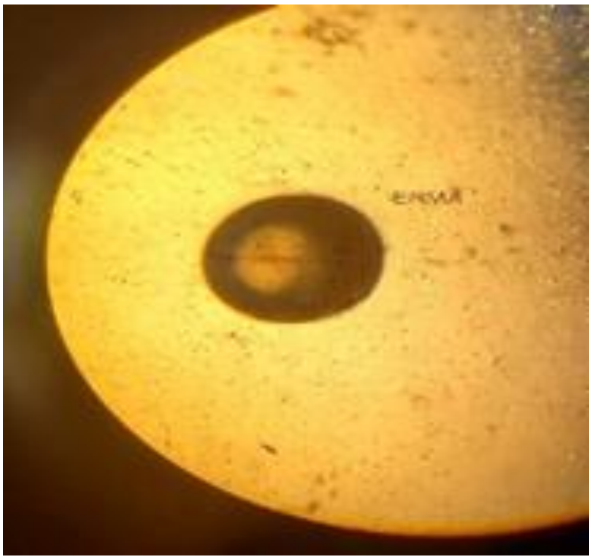


**Figure-1 Picture of Ova**

## Results

Monthly variations of fish length, weight, ovary length, ovary weight and GSI for Mystus tengara, the maximum average length of was on August (15cm). The minimum average length was on December (10cm). The maximum average weight was on August (40cm) and the minimum average weight was on November (10cm).

For Mystus tengara, the maximum average Ovary length of was on August. The minimum average Ovary length was on December. The maximum average Ovary weight was on August and the minimum Ovary average weight was on November. (Table 1 & Figure-2)

**Table1: Average Fish length, Fish weight, Ovary length, Ovary weight and GSI of *Mystus tengara***

| Months | Fish length | fish weight | Ovary length | Ovary weight | GSI |
|---|---|---|---|---|---|
| August | 16.69 | 39.34 | 4.73 | 5.87 | 12.77918 |
| september | 13.05 | 27.37 | 2.3 | 2.83 | 24.26 |

| | | | | | |
|---|---|---|---|---|---|
| october | 10.07 | 9.63 | - | - | 2.13 |
| november | 9.81 | 8.79 | - | - | 2.85 |
| december | 9.5 | 9.8 | - | - | - |

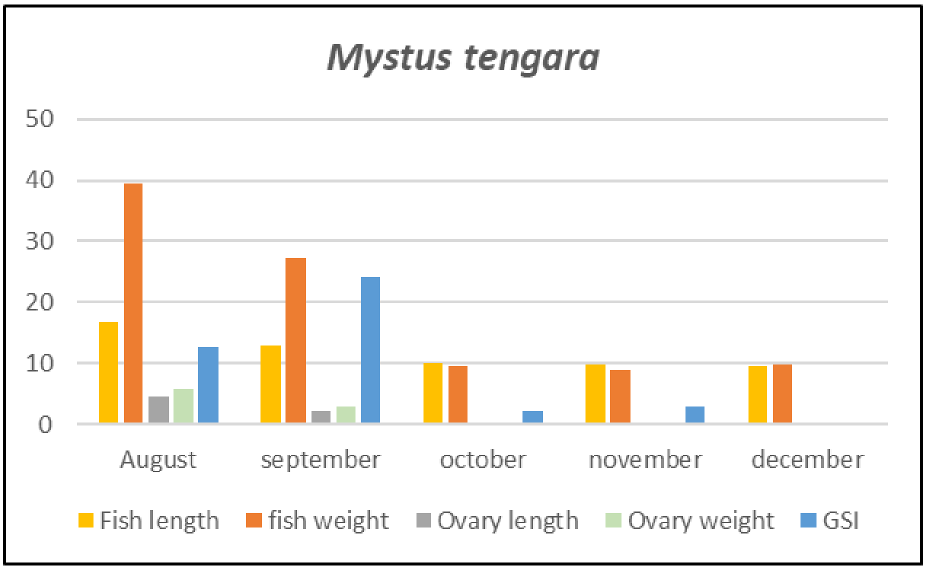



**Fig 2: Monthly variation of Fish length, Fish weight, Ovary length, Ovary weight and GSI of *Mystus tengara***

For *Mystus tengara*, the maximum average GSI was on September. The minimum average GSI was on December

***Mystus vitattus***

For *Mystus vittatus*, the maximum average length of was on September. The minimum average length was on December. The maximum average weight was on September and the minimum average weight was on November. For Mystus vittatus, the maximum average Ovary length of was on September. The minimum average Ovary length was on December. The maximum average Ovary weight was on September and the minimum average Ovary weight was on November. For Mystus vittatus, the maximum average GSI was on November. The minimum average GSI was on December. (Table 2 & Figure-3)

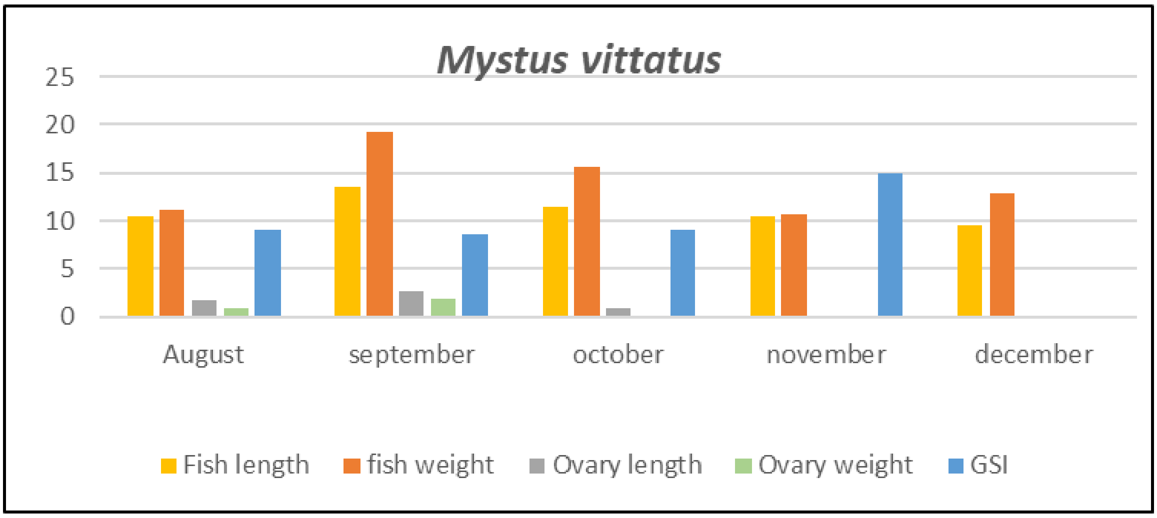



**Fig 3: Monthly variation of Fish length, Fish weight, Ovary length, Ovary weight and GSI of *Mystus tengara***

**Table 2: Average Fish length, Fish weight, Ovary length, Ovary weight, and GSI of *Mystus vittatus***

| Months | Fish length | fish weight | Ovary length | Ovary weight | GSI |
|---|---|---|---|---|---|
| August | 10.55 | 11.16 | 1.7 | 0.87 | 9.11 |
| september | 13.45 | 19.25 | 2.725 | 1.82 | 8.568 |
| october | 11.4 | 15.64 | 0.99 | - | 9.126 |
| november | 10.53 | 10.71 | - | - | 14.99 |
| december | 9.51 | 12.87 | - | - | - |

**Table 3: Average Fish length, Fish weight, Ovary length, Ovary weight, and GSI of *Clarias batrachus***

| Months | Fish length | fish weight | Ovary length | Ovary weight | Average GSI |
|---|---|---|---|---|---|
| August | 18.67 | 75.95 | 2.1 | 4.5 | 12.925 |

| | | | | | |
|---|---|---|---|---|---|
| september | 23.04 | 196.82 | 5.36 | 8.17 | 4.108 |
| october | 23.97 | 173.07 | 6.4 | 12.6 | 8.01 |
| november | 22.3 | 161.83 | 3.1 | 6.5 | 3.665 |
| december | 23.83 | 154.65 | - | - | - |

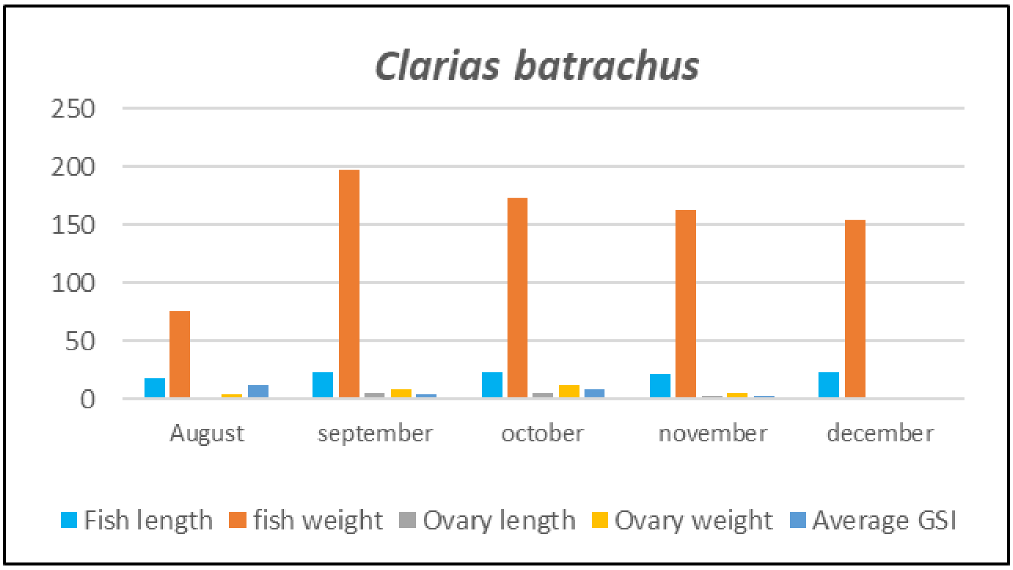



**Fig 4: Monthly variation of Fish length, Fish weight, Ovary length, Ovary weight and GSI of *Clarias batrachus***

For Clarias batrachus, the maximum average length of was on October. The minimum average length was on August. The maximum average weight was on September and the minimum average weight was August. In Clarias batrachus, the maximum average Ovary length of was on October. The minimum average Ovary length was on December. The maximum average Ovary weight was on October and the minimum average Ovary weight was on December. For Clarias batrachus, the maximum average GSI was on October. The minimum average GSI was on November.

**Table 4: Average Fish length, Fish weight, Ovary length, Ovary weight, and GSI of *Heteropneustes fossilis***

| | Fish length | fish weight | Ovary length | Ovary weight | GSI |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| August | 20.45 | 54.99 | 5.05 | 12.17 | 5.14 |
| september | 21.7 | 70.64 | 5.33 | 21.9 | 14.303 |
| october | 21.7 | 70.64 | 5.3 | 9.91 | 9.27 |
| november | 16.21 | 13.93 | - | - | 11.93 |
| december | 17.23 | 14.35 | - - - | | |

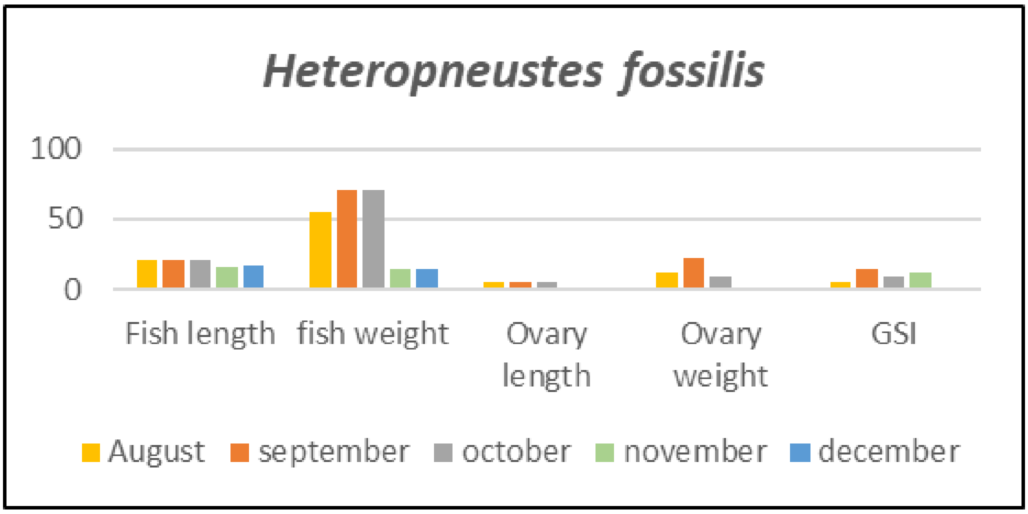



**Fig 5: Monthly variation of Fish length, Fish weight, Ovary length, Ovary weight and GSI of *Heteropneustes fossilis***

For, *Heteropneustes fossilis* the maximum average length of was on September. The minimum average length was on November. The maximum average weight was on September and the minimum average weight was November. *Heteropneustes fossilis* The maximum average Ovary length of was on September. The minimum average Ovary length was on December. The maximum average Ovary weight was on September and the minimum average Ovary weight was on December. For Heteropneustes fossilis, the maximum average GSI was on September. The minimum average GSI was on December.

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