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An observation on seasonal variations of ambient temperature in a pond under the geographical area of Darbhanga district on behaviour, feeding and breeding pattern of the major carp *Catla catla* (Hamilton, 1822)

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Abstract

This study evaluates the influence of seasonal ambient temperature variation on the behaviour, feeding and breeding pattern of *Catla catla*. Representative data were collected for five seasons over one annual cycle. An average ambient temperature varied from 18°C during winter to 32°C during summer. Feeding, swimming, surfacing, social interaction and breeding activities were carefully monitored. Behavioural activity increased with temperature up to summer, whereas reproductive activity reached its maximum during the monsoon season. Results indicate that temperature acts as a major ecological regulator of metabolism, activity level and reproductive readiness. The study highlights the significance of seasonal environmental monitoring for aquaculture and broodstock management.

Keywords: Ambient temperature, behaviour, feeding pattern

Introduction

Catla catla is one of the significant Indian major carp cultured throughout India and neighbouring countries. The species contributes substantially to inland fisheries and freshwater aquaculture. Environmental factors such as temperature, rainfall, photoperiod, dissolved oxygen and water level regulate fish physiology and behaviour. Among these variables, temperature is considered the most influential because fishes are ectothermic animal. Numerous studies (including Krüger 1982, Szumiec 1987, Pilarczyk 1998) ^[15, 19] show that unfavourable environmental and nutritional conditions and disease eliminate from 50 to 90% of one-year-old carp prematurely.

Seasonal changes in temperature alter metabolic rate, food consumption, movement, growth and reproduction. Fish generally exhibit reduced activity during colder months and enhanced feeding during warmer periods. Reproductive maturation is also synchronized with environmental conditions. In Indian freshwater ecosystems, spawning of major carps commonly coincides with the monsoon season when favourable temperature and hydrological conditions prevail. Water temperature, among other factors, plays an important role in fish survival. Both the upper and the lower lethal temperatures depend on a number of factors including the rate and range of temperature fluctuations and the age and condition of the fish (Smiek 1977, Lirski and Opuszynski 1988). As the fish aged and grow, their tolerance to low temperatures increases (D browski 1983, Lirski and Opuszynski 1988, Hamaækova *et al.* 1995) ^[10, 6].

Aquatic environmental alterations directly induce behavioral modifications in fish populations Sun, L. (2022) ^[18]. Organisms counteract environmental stress through cellular-level, so biochemical responses necessitating elevated metabolic energy production Sampaio, E.; Lopes, *et al.*, (2018), and altering organismal behavior Rodriguez-Dominguez, A (2019). Liu *et al.*, (2011) ^[11, 16] demonstrated that formaldehyde exposure triggers characteristic neurobehavioral alterations in *Danio rerio*, manifesting as erratic locomotion (erratic turning/thigmotaxis)

and restricted movement patterns; Liu, Y Lee () 2011)^[11] and additionally Brunelle *et al.* (2022) demonstrated wastewater effluent containing organic contaminants (acetaminophen, etc) induced hyperactivity in Danio rerio larvae during colder seasons (autumn-winter) Brunelle, L.D.; Huang, (2022)^[3]. Fish have been historically employed as real-time biomonitors due to their ease of aquaculture, availability, suitable specimen size, and lifespan Bownik, A. *et al*, 2021)^[2]. Furthermore, their highly developed central nervous systems exhibit sensitivity to diverse industrial pollutants (e.g., heavy metals, herbicides, neurotoxins), and their behavioral responses holistically reflect the combined toxicity of multiple contaminants in real time Green, A.J.(2018)^[8]. Therefore, monitoring fish behavior is a reliable way to understand the current water environment. In contemporary research, the quantitative analysis of fish behavior has emerged as a foundational element in various investigative domains, including biological water quality monitoring, Yuan, F. *et al*, (2018)^[20]. Additionally, the quantitative assessment of piscine behavioral patterns plays a crucial role in the design and operation of aquaculture systems Ma, Z.; Zhang, J *et al*, (2023). Overall, this analytical approach has demonstrated significant utility across multiple disciplines within the aquatic sciences. Alternative methodologies, such as opercular monitoring, among others, are more frequently used with the simultaneous implementation of monitoring technologies within a unified system This observation underscores the potential for integrating multiple monitoring approaches to improve the comprehensiveness and reliability of behavioral assessments in aquatic environments.

The present study was undertaken to examine seasonal variation in ambient temperature and its relationship with behavioural feeding and reproductive characteristics of *Catla catla* using representative collected data observations.

Materials and Methods: The investigation has been done with seasonal observation of temperature fluctuations and its impact on behaviour, feeding and breeding pattern on *Catla catla* which is a surface feeder major carp widely used by fish farmers for fish farming in an embankment pond. Five seasonal periods were considered: winter, spring, summer, monsoon and autumn. Mean ambient temperature values were recorded on diurnal climatic conditions of Darbhanga, a district of eastern India.

Behavioural parameters included feeding activity, swimming activity, surfacing behaviour and social interaction. Activity levels were expressed as percentage occurrence. Feeding pattern analysed in average by observing feeding behaviour on surface of water in pond at a time in different seasons. Such observation taken for consideration of feeding pattern during morning in summer and monsoon and mid of the day in winter, spring and and Autumn. Breeding activity was estimated using gonadal maturity, courtship behaviour and spawning readiness. Seasonal means were tabulated and compared descriptively.

Data were analysed using percentage comparisons and graphical representation. A line graph was prepared to show seasonal temperature variation and a bar diagram was prepared to illustrate behavioural activity.

Observation: Temperature increased gradually from winter to summer and declined thereafter. Winter recorded the lowest mean temperature (18°C), while beginning of summer

(during mid of the May 2025) recorded the highest (32°C). Behavioural responses varied markedly among seasons. Feeding activity increased from 20% during winter to 45% during summer. Swimming activity also increased from 25% to 40% over the same period. Surfacing and social interaction were more frequent under warmer conditions (figure 2). Breeding activity remained minimal during winter but increased during spring and summer. The highest breeding activity (100%) occurred during the monsoon season, indicating optimum reproductive conditions.

The observed pattern suggests a close relationship between environmental temperature and biological performance. Rising temperature accelerates metabolism and increases food demand. Enhanced locomotion and feeding contribute to growth and energy accumulation. Monsoon conditions provide additional environmental stimuli including water-level fluctuations and improved habitat conditions, promoting spawning behaviour.

Result and Discussion

Temperature is a primary determinant of physiological performance in freshwater fishes. Increased temperature enhances enzyme activity, digestion and metabolic processes, leading to greater feeding and movement. The increase in feeding observed from winter to summer is consistent with established principles of fish bioenergetics.

It is also a noticeable fact that rising temperature affect the swimming speed of the fish which ultimately related with the slow metabolic rate in extreme summer. Temperature affects fish behavior in diverse ways. These include lifestyle Freitas, R.(2017)^[7] locomotor ability Pereira, E.(2019)^[14], swimming patterns Campos, D.F.:(2018)^[4], feeding, reproduction Madeira, D.(2016)^[13] predator-prey dynamics Allan, B.J.M, (2015) and most importantly, lifespan Dong, Y (2008)^[1, 5].

The concentration of reproductive activity during the monsoon period reflects the adaptive breeding strategy of Indian major carps. Moderate temperature combined with rainfall, turbidity changes and increased water volume creates favourable conditions for egg development and larval survival. Similar seasonal reproductive patterns have been reported in numerous carp species. In this Observational study, breeding pattern is remarkably influenced by monsoon season as temperature is more optimum for egg production and reproduction. (Table 1).

Reduced activity during winter can be attributed to lower metabolic demand. Fish conserve energy by reducing movement and feeding. Such responses are ecologically advantageous because food availability and physiological efficiency are often reduced under cooler conditions.

Climate variability may alter these seasonal patterns in the future. Increasing temperatures and unpredictable rainfall could influence spawning success and aquaculture productivity. Continuous monitoring of environmental conditions is therefore essential for sustainable fishery management.

Conclusion: Seasonal ambient temperature significantly influences the behaviour feeding and breeding pattern of *Catla catla*. Feeding and swimming activities increase with temperature, while peak reproductive activity occurs during the monsoon season. The findings emphasize the importance of environmental monitoring for broodstock management, induced breeding programmes and aquaculture production.

Table 1: Seasonal Mean Value in Percentage

Season	Temp °C	Feeding%	Swimming%	Surfacing%	Breeding%
Winter	18	20	25	10	5
Spring	25	35	30	20	40
Summer	32	45	40	25	80
Monsoon	29	40	35	22	100
Autumn	24	30	28	15	20

India Map Highlighting Darbhanga District, Bihar

Schematic representation showing the approximate location of Darbhanga district in Bihar

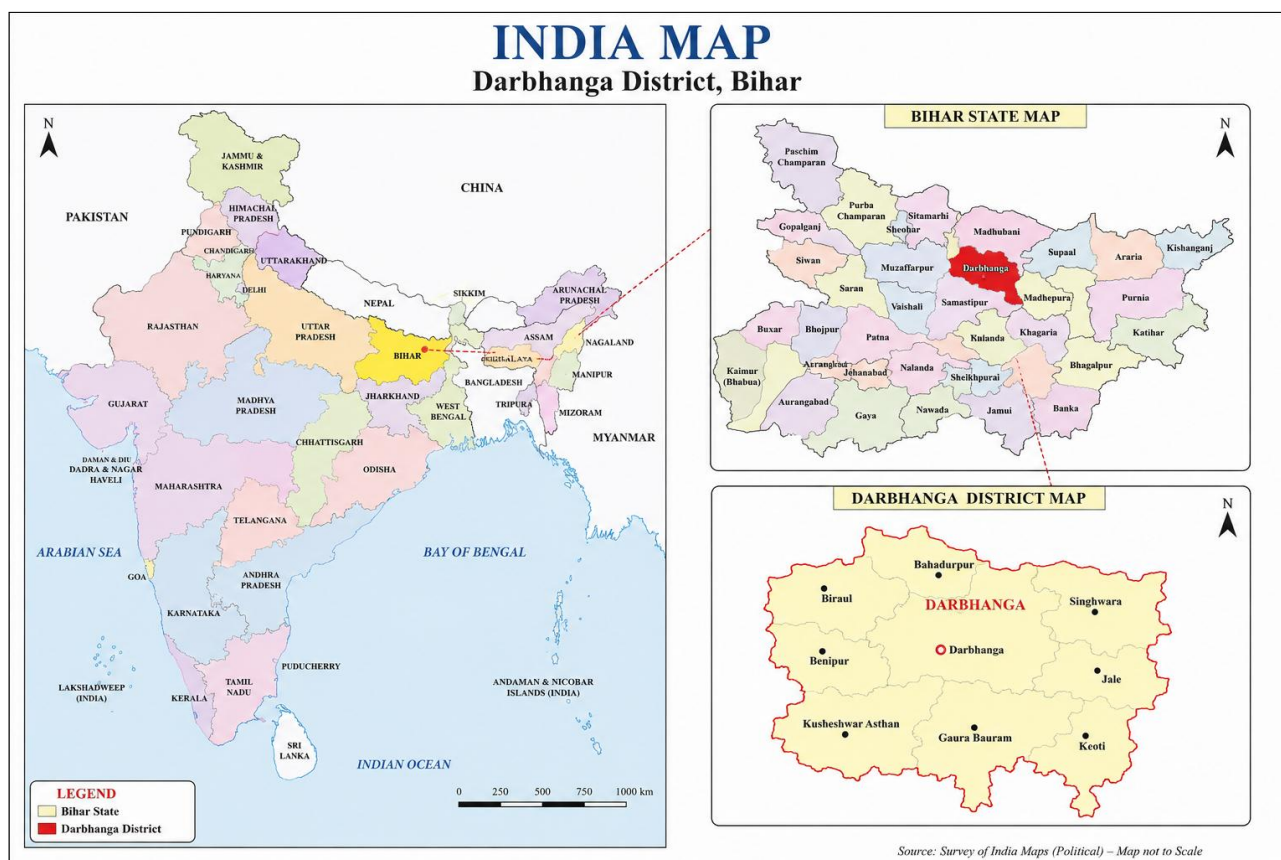


Image: A pond in the campus of M. K. College, Laheriasarai, Darbhanga where this observational study has been completed.
Duration of observation: Winter to Autumn

Impact of temperature on behaviour and feeding pattern - From Winter to autumn 2025 Darbhanga, Bihar

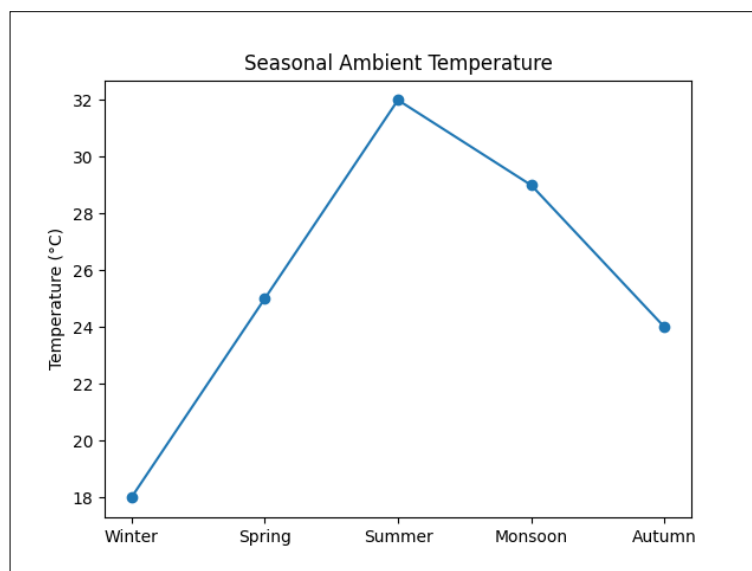


Fig 1: Seasonal variation in ambient temperature.

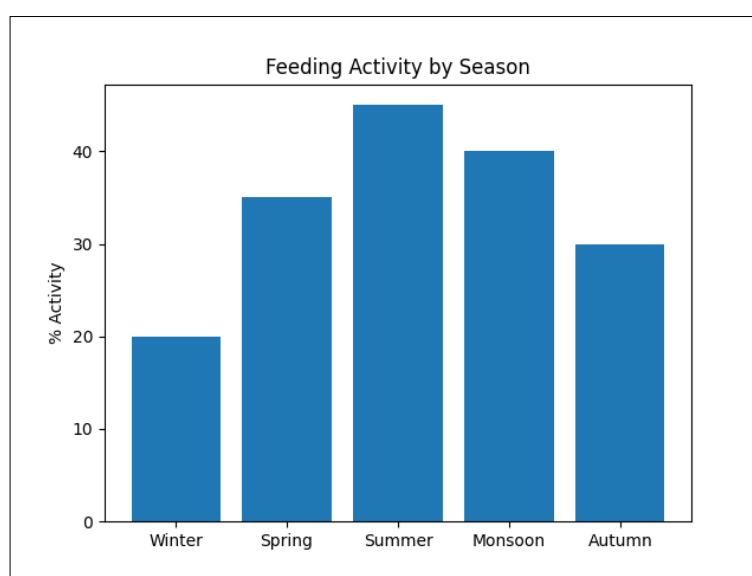


Fig 2: Seasonal feeding activity of *Catla catla*

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