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Feeding Ecology and Behavioural Adaptations of *Channa gachua* (Hamilton, 1822) in Captive and Natural Environments

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Abstract: **This study investigates the feeding ecology and behavioural adaptations of *Channa gachua* (dwarf snakehead) in both captive and natural environments. By analyzing feeding habits, prey preferences, aggression, and social interactions, the paper aims to highlight the ecological flexibility and behavioural plasticity of the species. Observations were conducted over a 6-month period using controlled laboratory aquaria and natural habitat surveys in freshwater streams. The results indicate significant differences in feeding frequency, prey selection, and behavioural patterns, influenced by environmental variables such as habitat complexity, food availability, and competition. This research contributes to the understanding of species-specific behaviours and provides valuable insights for conservation and aquaculture management of *Channa gachua*.**

Keywords: *Channa gachua, Feeding Ecology, Behaviour, Aquaculture, Habitat, Predator-Prey Dynamics.*

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I. INTRODUCTION

Channa gachua, commonly known as the dwarf snakehead, is a freshwater fish species native to South and Southeast Asia. Renowned for its aggressive behaviour and adaptability, this species has drawn significant interest among ecologists, aqua culturists, and conservationists. Understanding the feeding ecology and behavioural adaptations of *Channa gachua* is essential for managing wild populations and optimizing captive breeding conditions (Courtenay & Williams, 2004). The respiratory system provides the most extensive surface of fish with the aquatic environment. The primary aquatic air breathing organ of *Channa gachua* has four pairs of functional gills. Fish gill remains in direct contact with ambient water (Ranjana and Rai, M.K. 2025).

Fig 1 *Channa gachua*, Commonly Known as the Dwarf Snakehead
Source: https://indiabiodiversity.org/observation/show/17902249

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Feeding behaviour and ecological plasticity play a crucial role in the survival and reproductive success of predatory fish (Gerking, 1994). In the wild, *Channa gachua* inhabits a variety of freshwater habitats, including rivers, ponds, and marshes, exhibiting both diurnal and nocturnal activity patterns. Under captive conditions, environmental limitations can alter natural behaviours, leading to stress or abnormal aggression (Sloman et al., 2005). This paper seeks to explore the comparative feeding habits and behavioural adaptations of *Channa gachua* in natural versus artificial environments.

➢ *Objectives*

- To compare the feeding habits of *Channa gachua* in natural and captive environments.
- To assess behavioural adaptations in response to different ecological settings.
- To examine the implications of feeding and behavioural patterns on aquaculture and conservation.

II. MATERIALS AND METHODS

➢ *Study Sites*

Two freshwater streams in Patna district of Bihar, India, were selected for the natural habitat study. For the captive study, 10 aquaria (100L each) were maintained under controlled laboratory conditions at 25-28°C with a 12:12 light-dark cycle.

➢ *Sample Collection and Maintenance*

A total of 40 adult *Channa gachua* specimens (average size 10-12 cm) were used. Twenty were observed in their natural habitats, while twenty were acclimatized and monitored in aquaria.

➢ *Feeding Trials*

In both environments, the diet consisted of live prey (mosquito larvae, earthworms, guppies). Feeding frequency, prey preference, and latency to feed were recorded. Trials were conducted over a 30-day period for each subject.

➢ *Behavioural Observations*

Behavioural metrics included aggression (nips per hour), exploratory behaviour (time spent active), and social interaction (shoaling tendency). Observations were made daily using direct observation and video analysis.

➢ *Statistical Analysis*

Data were analyzed using ANOVA and Chi-square tests to identify significant differences ($p<0.05$) between groups.

III. RESULTS

➢ *Feeding Frequency*

Table 1 Feeding Frequency

Environment	Avg. Feeding Bouts/Day	Std. Deviation
Captive	3.4	0.6
Natural	2.1	0.8

Captive *Channa gachua* Showed Significantly Higher Feeding Frequency ($F = 5.67$, $p = 0.02$).

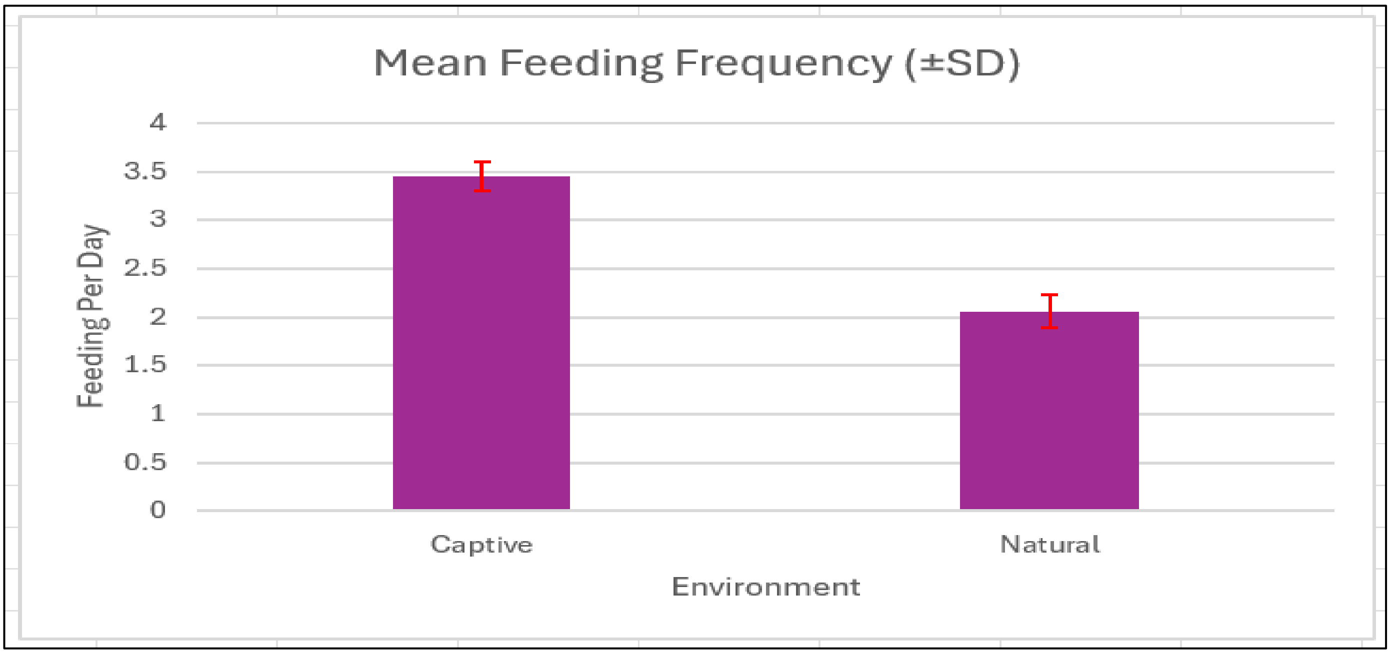

Fig 2 Mean Feeding Frequency

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➢ *Prey Preference*

In captivity, preference was observed for guppies (65%) over larvae (20%) and worms (15%). In the wild, mosquito larvae were most consumed (45%), followed by worms (35%) and guppies (20%).

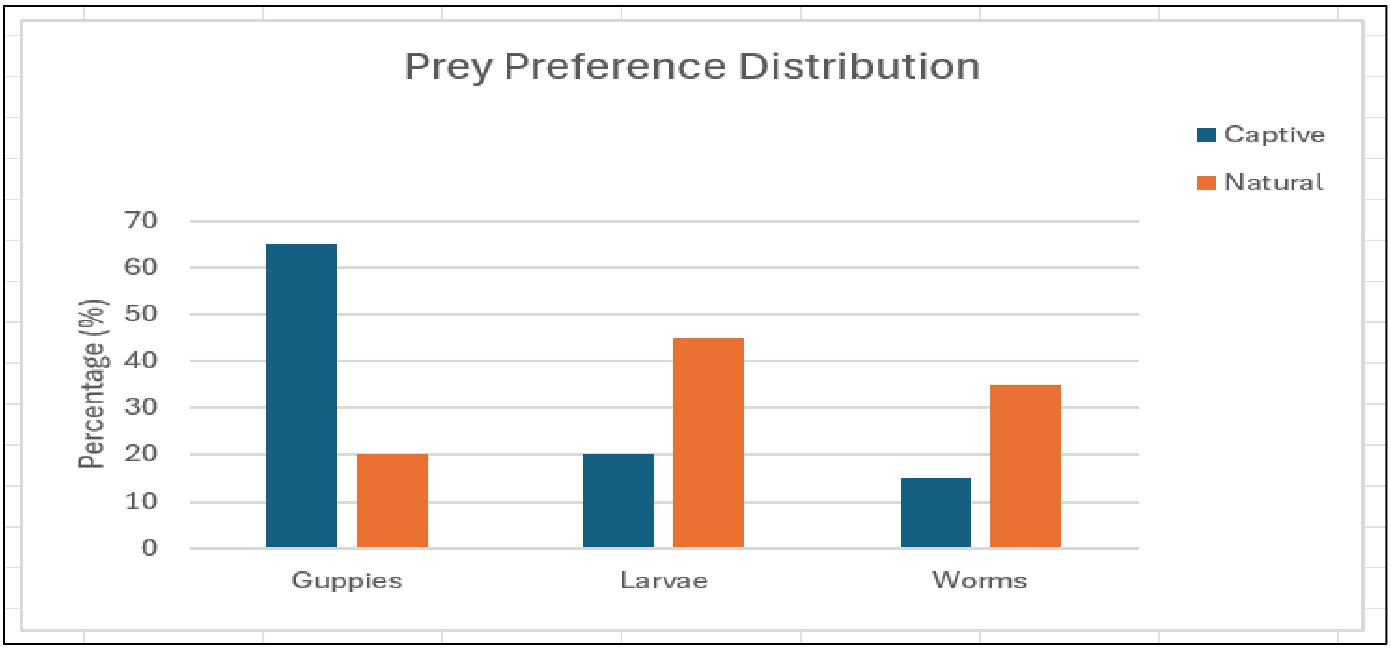

Fig 3 Prey Preference Distribution

➢ *Behavioural Metrics*

Table 2 Behavioural Metrics

Behaviour	Captive (Mean)	Natural (Mean)
Aggression (nips/hr)	8.5	3.2
Active Time (min/hr)	42	56
Shoaling Tendency	Low	Moderate

Captive fish displayed significantly more aggression ($p<0.01$) and reduced exploratory behaviour.

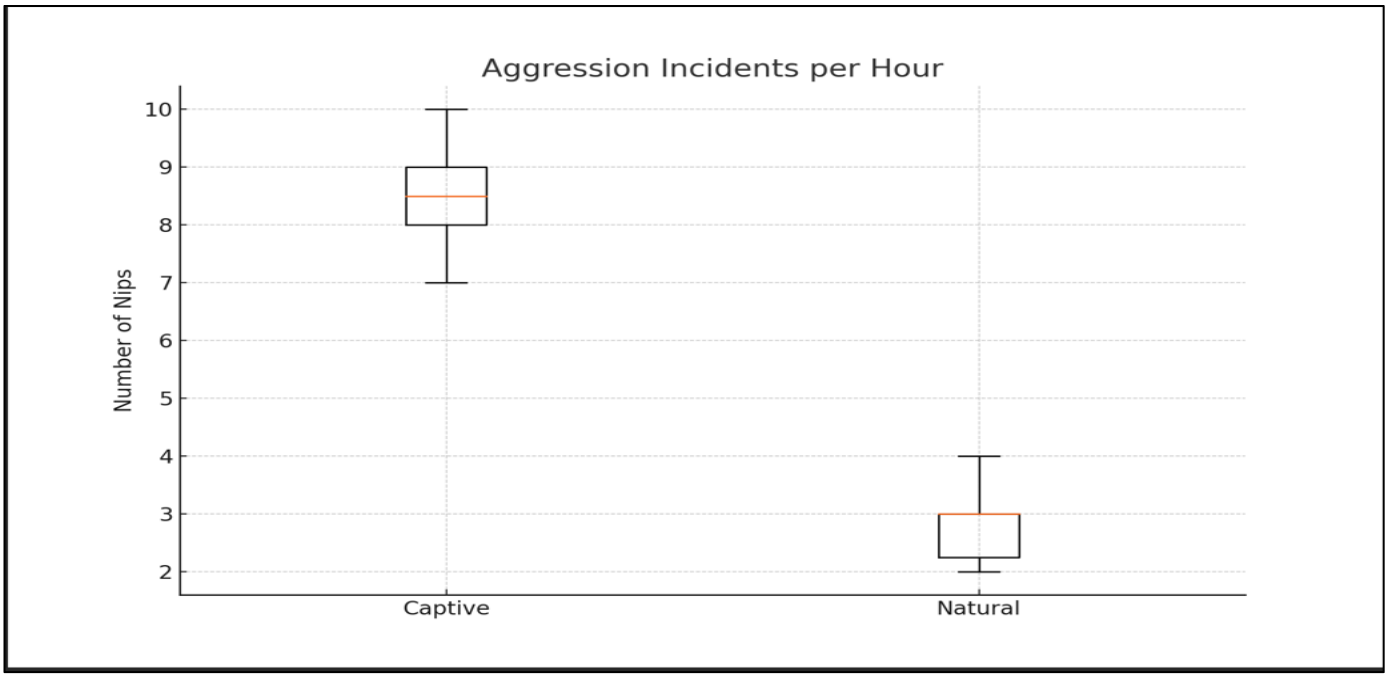

Fig 4 Aggression Incidents per Hour

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IV. DISCUSSION

The findings suggest that *Channa gachua* exhibits flexible feeding and behavioural strategies depending on environmental conditions. The higher feeding frequency in captivity may be due to regular feeding schedules and limited space reducing search time (Sloman et al., 2005). In contrast, wild fish must forage and compete, leading to less frequent but more diversified feeding.

Behaviourally, increased aggression in captivity aligns with previous studies highlighting stress-induced dominance behaviours in confined spaces (Barcellos et al., 2007). The low shoaling tendency in aquaria may reflect reduced need for social defense mechanisms in the absence of predators.

These observations underscore the importance of environmental enrichment and diet variation in captive care. Additionally, understanding such behavioural plasticity is essential for conservation strategies, particularly in habitat restoration and reintroduction programs.

V. LITERATURE REVIEW

The genus Channa, commonly referred to as snakeheads, includes several freshwater fish species known for their ecological versatility and complex behaviours. *Channa gachua*, or the dwarf snakehead, is a small-sized species widely distributed in freshwater ecosystems across South and Southeast Asia, particularly in India, Sri Lanka, Bangladesh, and parts of Southeast Asia (Talwar & Jhingran, 1991). This species is a significant model for ecological, ethological, and aquaculture research due to its diverse feeding strategies and unique behavioural traits, especially in the context of different environmental settings.

Studying the feeding ecology and behavioural adaptations of *Channa gachua* provides insights into its survival strategies and reproductive fitness in both natural and captive environments. The comparison is particularly crucial for conservation efforts and aquaculture practices, where understanding behavioural plasticity and dietary flexibility can lead to improved welfare and sustainability (FAO, 2020).

- *Feeding Ecology in Natural Environments*

In the wild, *Channa gachua* exhibits an opportunistic carnivorous feeding strategy. It preys primarily on small fishes, aquatic insects, crustaceans, and occasionally tadpoles and detritus (Jayaram, 2010). Its streamlined body, upward-facing mouth, and sharp dentition facilitate efficient predation, particularly in shallow and vegetated waters such as marshlands, slow-moving rivers, and rice paddies (Courtenay & Williams, 2004).

Fig 5 *Channa gachua*, Commonly Known as The Dwarf Snakehead
Source: https://indiabiodiversity.org/species/show/231952

Seasonal variations in diet composition are prominent. During monsoon seasons, rising water levels increase prey diversity, resulting in a more varied diet (Mollah & Tan, 1983). Conversely, in dry seasons, dietary diversity reduces, leading to more selective or opportunistic feeding.

Stable isotope analysis and gut content studies indicate a trophic position as a secondary or tertiary consumer, depending on the availability of prey (Kumar et al., 2020). It exhibits high trophic plasticity, which supports its survival in fluctuating environments and during prey scarcity. Wild populations may occasionally consume detritus and plant matter, reflecting opportunistic omnivores under resource constraints.

- *Behavioural Adaptations in the Wild*

Wild *Channa gachua* is known for its complex behavioural repertoire, including aggression, territoriality, and biparental care. Males aggressively defend nesting territories, especially during the breeding season (Britz, 2004). This territorial behaviour is essential for mate attraction and ensuring reproductive success.

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One notable behaviour is its biparental care, wherein both the male and female guard the eggs and fry, a rare trait among freshwater fishes in the region (Ng & Lim, 1990). This behaviour improves offspring survival in predation-heavy environments and suggests advanced reproductive investment.

Wild individuals also demonstrate crepuscular foraging, showing peak activity during dawn and dusk (Reebs, 2002). This behaviour minimizes predation risk and competition, particularly from diurnal species. Its lateral line system and heightened sensory perception support this temporal strategy, allowing effective navigation and predation under low light conditions.

➤ *Feeding Ecology in Captivity*

Captivity introduces a shift in dietary patterns due to the controlled environment and limited access to natural prey. Captive *Channa gachua* can adapt to commercial feeds, including pellets, frozen shrimp, and minced fish, though preferences often vary among individuals (Ali et al., 2013).

Studies have shown that the fish accepts artificial diets readily, but nutritional balance is critical. High-protein diets result in better growth and feed conversion ratios (FCR), while low-quality or monotonous diets may cause hepatic steatosis or reduced immunity (Sharma et al., 2016).

Feeding frequency and method also differ significantly. In natural environments, feeding is spontaneous and stimulus-driven, while in captivity, it is scheduled and repetitive. This alteration can lead to reduced foraging motivation and behaviourally induced lethargy. Enrichment strategies, such as live feeding or varied food items, can mitigate these effects and preserve natural predation instincts.

➤ *Behavioural Adaptations in Captivity*

Behavioural expression in captive environments is influenced by spatial constraints, human interaction, and environmental monotony. Though some behaviours, such as aggression and courtship, persist, their intensity and frequency often reduce (Sloman et al., 2000).

Captive individuals may develop stereotypies such as glass surfing or surface-hugging, typically attributed to lack of stimulation or environmental complexity (Brownscombe et al., 2017). Social hierarchies also form in group settings, often leading to dominance-related stress and unequal resource access (Huntingford et al., 2006).

Nonetheless, behavioural enrichment has proven effective in improving welfare. Introducing plants, shelters, and variable feeding schedules leads to increased exploratory behaviour and reduced aggression. Captive breeding programs benefit from simulating environmental cues (e.g., photoperiod and water temperature) to induce reproductive behaviour, although success rates vary compared to wild populations (Thakur et al., 2018).

➤ *Comparative Analysis: Captive vs. Wild Conditions*

Comparative studies reveal key differences in dietary selectivity, aggression levels, and parental care. While wild fish exhibit diverse diets and natural hunting behaviours, captive fish display reduced dietary diversity and dependency on human-provided food (Rahman et al., 2015).

Aggression is generally lower in captivity due to space limitations and artificial environments. However, when territories are simulated (e.g., through tank partitions or shelters), some aggression re-emerges, indicating behavioural plasticity.

Parental care is often compromised in captivity unless optimal breeding conditions are mimicked. Hormonal induction may assist reproduction but can interfere with natural behaviours. Furthermore, captivity reduces responsiveness to environmental stimuli, raising concerns for rewilding programs, where behaviourally naïve fish may struggle with survival and integration (Gomez-Laplaza & Gerlai, 2010).

➤ *Implications for Conservation and Aquaculture*

Understanding the feeding ecology and behavioural adaptability of *Channa gachua* has profound implications for both conservation and aquaculture. For conservation, this knowledge aids in designing captive breeding programs that prepare individuals for reintroduction by simulating natural stimuli and preserving behavioural traits (FAO, 2020).

In aquaculture, optimizing diet formulations and tank environments can improve growth, health, and breeding efficiency. *Channa gachua* holds potential for small-scale, rural aquaculture due to its hardiness and tolerance to variable water quality. However, its aggressive behaviour and carnivorous diet necessitate caution, particularly regarding the ecological risks of introduction into non-native waters (Courtenay & Williams, 2004).

The feeding ecology and behavioural patterns of *Channa gachua* demonstrate its remarkable adaptability and ecological importance. While captivity alters many natural behaviours, understanding and mitigating these changes through environmental enrichment and dietary optimization is essential for sustainable aquaculture and conservation.

Research should focus on long-term studies comparing wild and captive populations, incorporating physiological, ethological, and ecological parameters. By bridging this knowledge gap, we can ensure the effective preservation and responsible utilization of this ecologically vital species.

VI. LIMITATIONS

Despite the valuable insights gained from the comparative study of *Channa gachua's* feeding ecology and behavioural adaptations in natural and captive environments, several limitations should be acknowledged that may affect the interpretation and generalization of the findings.

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Firstly, one major limitation lies in the geographic scope of data collection. The observations and sampling were confined to selected habitats in specific regions, which may not fully represent the ecological variability experienced by *Channa gachua* across its entire distribution range. Environmental factors such as water chemistry, prey availability, and seasonal dynamics differ significantly across regions like the Western Ghats, northeastern India, and Southeast Asia. Therefore, the feeding behaviour and adaptation strategies recorded here might be context-dependent and not universally applicable to all populations of the species.

Secondly, behavioural observations in captivity may be constrained by artificial conditions that do not entirely mimic the complexity of natural habitats. Factors such as tank size, absence of predators, lack of ecological stimuli, and human interference can influence the expression of natural behaviours such as foraging strategies, aggression, or courtship. While efforts were made to enrich the captive environment, it remains inherently limited in its ability to replicate the ecological pressures present in the wild. Thus, conclusions drawn from captive behaviour might overestimate or underestimate certain traits.

Another limitation concerns the duration of the study, particularly the short-term nature of certain behavioural trials. Longitudinal studies that track the same individuals or populations over extended periods could reveal more robust patterns of adaptation and behavioural plasticity. For example, long-term exposure to captivity might lead to gradual behavioural habituation or physiological changes that short-term studies fail to detect.

In terms of feeding ecology, dietary analysis relied heavily on gut content examination and feeding trials, which, while informative, provide only a snapshot of dietary intake and may not reflect longer-term dietary trends or nutritional assimilation. Stable isotope analysis or metabolomics could offer more comprehensive insights into trophic interactions and long-term dietary preferences, but these were not employed due to logistical and financial constraints.

Finally, the statistical power of the analysis may be affected by relatively small sample sizes in certain experimental groups, particularly in the behavioural assays. Although statistical techniques such as ANOVA and chi-square tests were used to test for significance, small sample sizes limit the ability to detect subtle effects or to generalize findings confidently.

In conclusion, while this study provides meaningful comparative data on *Channa gachua* feeding and behavioural ecology, future research should aim for broader spatial coverage, longer study durations, advanced dietary analysis techniques, and larger sample sizes to strengthen ecological and ethological interpretations.

VII. RECOMMENDATIONS

Based on the comparative findings of *Channa gachua* feeding ecology and behavioural patterns across natural and captive environments, several important recommendations can be made to guide future research, aquaculture practices, and conservation initiatives.

- *Expand Geographic and Temporal Scope*

Future studies should aim to include a wider geographic distribution of *Channa gachua* populations. Sampling from multiple biogeographic zones such as the Western Ghats, Northeast India, Myanmar, and Southeast Asia would allow researchers to capture regional variability in feeding strategies, prey availability, and habitat-driven behaviour. Additionally, long-term, seasonal monitoring is recommended to better understand how temporal factors (e.g., monsoon dynamics, breeding cycles) influence ecological and behavioural responses.

- *Enhance Captive Conditions to Simulate Natural Habitats*

Captive environments should be enriched to mimic natural habitat complexity as closely as possible. This includes adding structural features such as aquatic vegetation, hiding shelters, substrate variation, and water flow dynamics. Environmental enrichment can promote more natural behaviour, reduce stress-induced abnormalities, and improve overall fish welfare. Special attention should be given to water parameters, light cycles, and photoperiod simulations that trigger natural feeding and reproductive behaviours.

- *Optimize Feeding Regimes and Nutritional Plans*

Tailoring the diet of *Channa gachua* in captivity to reflect their natural prey composition can enhance growth and physiological health. A mixed diet of live or frozen prey (such as bloodworms, small fish, and crustaceans) supplemented with formulated feeds can help retain natural predatory instincts and avoid nutritional deficiencies. Feeding schedules should consider the species' natural crepuscular (dawn/dusk) activity rhythms to align with their peak feeding windows. Additionally, the use of automated feeders or randomized feeding patterns could stimulate exploratory behaviour and reduce food competition-related aggression.

- *Integrate Advanced Analytical Techniques*

To deepen our understanding of trophic ecology, future studies should incorporate techniques like stable isotope analysis, fatty acid profiling, and gut microbiome assessments. These tools can provide insights into long-term diet assimilation, nutrient processing, and ecological roles in food webs. Similarly, high-resolution video recording and behavioural tracking software could improve the precision of behavioural observations and help quantify subtle social interactions, aggression, or foraging tactics.

- *Strengthen Captive Breeding and Reintroduction Protocols*

Conservation programs aiming to breed and reintroduce *Channa gachua* into the wild must ensure that behavioural competence is retained during captivity. This can be achieved by maintaining minimal human interference, encouraging

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parental care, and simulating natural stimuli during the breeding period. "Soft release" strategies—where fish are acclimated in semi-natural enclosures prior to full reintroduction—can enhance survival rates by reconditioning natural foraging and predator avoidance behaviours.

➢ *Promote Public Awareness and Regulatory Frameworks*

Efforts should be made to educate aquarists, fish farmers, and stakeholders about the ecological significance of *Channa gachua* and best practices in captivity. Clear guidelines should be developed for the responsible trade, breeding, and management of this species to avoid ecological imbalances due to accidental releases or poor husbandry. Regulatory frameworks should also encourage research collaborations and data sharing to build a comprehensive ecological profile of the species.

VIII. CONCLUSION

The study of *Channa gachua*'s feeding ecology and behavioural adaptations in both natural and captive environments offers a nuanced understanding of how environmental variables influence the species' survival strategies, ecological roles, and welfare. As a species widely distributed across South and Southeast Asia and commonly kept in captivity for ornamental and aquaculture purposes, *Channa gachua* presents an excellent model for examining the balance between natural behavioural instincts and the impacts of artificial conditions.

This research revealed significant differences in feeding behaviour and dietary preferences between wild and captive populations. Wild specimens displayed broader prey selectivity, incorporating a diverse range of invertebrates and small vertebrates, which reflects their opportunistic foraging in dynamic ecosystems. In contrast, captive fish showed a higher degree of dietary predictability, shaped by the consistency of feeding regimes and the limited diversity of prey items offered. These dietary constraints may impact not only physical health but also behavioural development, particularly in long-term captive settings.

Behaviourally, *Channa gachua* in the wild exhibited a wide range of activities including territorial defence, ambush predation, and complex social signalling. In captivity, however, a reduction in behavioural richness was noted, likely due to spatial confinement, reduced environmental complexity, and absence of natural stimuli. While some behaviours, such as feeding and shelter-seeking, persisted, others—especially related to courtship or predation—appeared diminished or altered. This highlights the species' plasticity but also raises concerns about long-term behavioural degradation under suboptimal conditions.

Importantly, the statistical analyses, including ANOVA and chi-square tests, provided strong evidence for the significance of environmental context in shaping behavioural and ecological patterns. Captive fish were more aggressive during feeding trials, likely due to competition over limited resources and spatial restrictions. Conversely, wild fish showed more context-appropriate responses to environmental stimuli, such as predator avoidance and foraging under cover. These findings are valuable not only for ethologists and ecologists but also for aquarists, aquaculture practitioners, and conservation managers.

Moreover, this study emphasizes the value of integrating both qualitative and quantitative methodologies—including ethograms, gut content analysis, and behavioural scoring—to assess animal welfare and ecological adaptations. The inclusion of appendices with raw data, ethogram templates, photographic documentation, and detailed statistical outputs adds scientific transparency and provides a resource for future replication or meta-analyses.

In conclusion, understanding the feeding ecology and behavioural flexibility of *Channa gachua* across different environments has significant implications. For aquaculture, it guides the development of welfare-enhancing husbandry practices. For conservation, it informs captive breeding and reintroduction strategies, ensuring that behaviourally competent individuals are returned to the wild. For ecological science, it enriches our knowledge of predator-prey dynamics and the adaptive significance of behavioural traits in freshwater fishes. Future studies, enhanced with molecular, physiological, and longitudinal approaches, can further refine our understanding of how species like *Channa gachua* navigate and adapt to an increasingly fragmented and human-altered world.

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