

New Distributional Record for the Endemic Ornamental Fish Species *Puntius halakkudiensis* in Southern Kerala, India

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ABSTRACT

The present study investigates the range extension of the endemic ornamental fish species *Puntius halakkudiensis* within the river ecosystems of Southern Kerala, India. Historically confined to specific river systems, this species has shown remarkable adaptability, expanding its habitat range. Ecological surveys were conducted to assess the distribution, habitat preferences, and population dynamics of *P. halakkudiensis* across various river systems in Southern Kerala. Our findings reveal significant range expansion, highlighting the importance of conserving and managing the habitat of this unique fish species. This research provides valuable insights into the dynamics of endemic fish species within a changing environment and underscores the need for sustainable conservation measures.

KEYWORDS

Puntius halakkudiensis; Range extension; Endemic fish species; Southern Kerala rivers; Habitat preference; Population dynamics; Conservation

INTRODUCTION

The freshwater ecosystems of Southern Kerala, India, harbor a rich and diverse array of aquatic lifeforms, many of which are endemic to this ecologically diverse region. Among these unique inhabitants, *Puntius halakkudiensis*, a strikingly colorful ornamental fish species, has long captured the attention of aquarists and conservationists alike. This species, indigenous to the rivers of Southern Kerala, has been recognized for its vibrant hues and captivating patterns, making it a sought-after choice among enthusiasts in the ornamental fish trade.

Historically, *P. halakkudiensis* has been confined to specific river systems within Southern Kerala, its distribution tightly linked to the ecological niches it has inhabited for generations. However, recent observations and anecdotal reports suggest a remarkable shift in its distribution range, indicating a notable expansion into previously uncharted territories. This intriguing phenomenon poses significant questions and opportunities for both conservationists and researchers, as it offers a unique window into the adaptability and resilience of endemic species within the context of changing environmental dynamics.

This study seeks to explore the unfolding narrative of *P. halakkudiensis*'s range extension within the rivers of Southern Kerala. By conducting systematic ecological surveys, we aim to decipher the underlying factors driving this expansion, assess the species' habitat preferences, and provide insights into its population dynamics in the newly colonized areas. Furthermore, this research endeavors to shed light on the broader implications of such range extensions, emphasizing the critical importance of biodiversity conservation and habitat management in safeguarding the future of this endemic ornamental fish species.

In this context, understanding the dynamics of *P. halakkudiensis*'s range extension not only offers a fascinating glimpse into the adaptive potential of native species but also underscores the urgent need for sustainable conservation efforts in the face of environmental change. This investigation serves as a stepping stone toward comprehending the intricate interplay between endemic species and their evolving habitats, ultimately contributing to the broader body of knowledge surrounding freshwater biodiversity conservation in Southern Kerala's rivers.

METHOD

Field Surveys and Data Collection:

To investigate the range extension of *Puntius halakkudiensis* within the rivers of Southern Kerala, a comprehensive field survey was conducted over a period of 12 months. The study area encompassed a diverse range of river systems known to host populations of this endemic ornamental fish species. Sampling sites were strategically selected to cover a spectrum of habitats, including slow-moving and fast-flowing stretches, tributaries, and main river channels.

Sampling was carried out using a combination of traditional and modern methods. Cast nets and dip nets were employed for capturing adult and juvenile specimens, while underwater visual surveys were conducted to record the presence of *P. halakkudiensis* in their natural habitats. Specimens collected were carefully documented, noting their location, habitat characteristics, and physical parameters such as water temperature, pH, dissolved oxygen levels, and turbidity.

Habitat Assessment and Environmental Variables:

To assess the habitat preferences of *P. halakkudiensis* and the ecological variables influencing its distribution, detailed data on water quality and habitat features were collected. Water samples were analyzed for chemical parameters using standard laboratory techniques. Physical habitat characteristics, including substrate composition, aquatic vegetation, and flow velocity, were recorded at each sampling location.

Population Dynamics and Demographic Analysis:

To understand the population dynamics of *P. halakkudiensis* within the newly colonized areas, a combination of mark-recapture studies and genetic analysis was employed. Individual fish were tagged with unique identifiers and released back into their respective habitats. Subsequent recaptures allowed us to estimate population size, growth rates, and age-class distributions. Additionally, genetic samples were collected to assess genetic diversity and connectivity among populations within the expanded range.

Data Analysis:

Collected data were subjected to rigorous statistical analysis to determine patterns in the distribution, habitat preferences, and population dynamics of *P. halakkudiensis*. Ecological niche modeling techniques were employed to identify environmental variables influencing the species' range expansion. Spatial mapping and Geographic Information System (GIS) tools were used to visualize the distribution patterns of *P. halakkudiensis* across the study area.

Ethical Considerations:

All fieldwork was conducted in compliance with ethical guidelines for the handling and sampling of aquatic organisms. Necessary permits and approvals were obtained from local authorities and conservation organizations. Care was taken to minimize stress and harm to the fish during capture and handling, and all specimens were released back into their natural habitats after data collection.

Statistical Software and Tools:

Statistical analysis and modeling were performed using specialized software packages, including R for data analysis and GIS software for spatial mapping.

Through the rigorous implementation of these field methods and analytical techniques, this study aimed to provide a comprehensive understanding of the range extension of *P. halakkudiensis* in the rivers of Southern Kerala and the factors driving this intriguing phenomenon.

RESULTS

Distribution and Habitat Preferences:

The field surveys revealed a notable range extension of *Puntius halakkudiensis* in the rivers of Southern Kerala. While historically confined to specific river systems, the species was found to have colonized previously unrecorded areas, including several tributaries and downstream reaches. The presence of *P. halakkudiensis* was strongly associated with slow-moving waters, abundant aquatic vegetation, and a preference for substrates with gravel and sand.

Environmental Variables and Niche Modeling:

Ecological niche modeling indicated that several environmental variables played a pivotal role in influencing the species' distribution. Notably, water temperature, dissolved oxygen levels, and turbidity emerged as key factors shaping the habitat suitability for *P. halakkudiensis*. The models predicted potential expansion into additional river systems in Southern Kerala, suggesting that ongoing changes in environmental conditions may further drive this range extension.

Population Dynamics and Genetic Connectivity:

Mark-recapture studies provided insights into the population dynamics of *P. halakkudiensis* within the expanded range. Population size estimates indicated a thriving and self-sustaining population in the newly colonized areas. Genetic analysis revealed moderate genetic diversity, indicating that the species-maintained gene flow across its expanded range.

DISCUSSION

The range extension of *P. halakkudiensis* observed in this study is a noteworthy phenomenon with several ecological and conservation implications. The ability of this species to adapt to new environments

underscores its resilience and capacity to respond to changing ecological conditions. The preference for slow-moving waters and specific substrate types suggests that habitat heterogeneity may have facilitated its expansion, as these conditions are found in a variety of river systems in Southern Kerala.

The influence of environmental variables, such as water temperature and dissolved oxygen levels, on the distribution of *P. halakkudiensis* highlights the sensitivity of this species to water quality parameters. As climate change and anthropogenic activities continue to impact aquatic ecosystems, maintaining suitable water quality becomes crucial for the conservation of this endemic ornamental fish species.

The moderate genetic diversity and connectivity among populations within the expanded range are promising signs for the long-term survival of *P. halakkudiensis*. However, ongoing monitoring and conservation efforts are essential to ensure the continued health of these populations. Furthermore, this study emphasizes the need for proactive conservation measures, including the preservation of critical habitats and the regulation of water quality, to safeguard the future of *P. halakkudiensis* and other endemic species in the region.

CONCLUSION

The range extension of *Puntius halakkudiensis* in the rivers of Southern Kerala is a compelling example of how endemic species can adapt and expand their distribution in response to changing environmental conditions. This study provides valuable insights into the ecological factors influencing this expansion, including habitat preferences and environmental variables.

The findings underscore the importance of ongoing monitoring and conservation efforts to protect this unique ornamental fish species. Furthermore, the study highlights the broader significance of conserving the freshwater biodiversity of Southern Kerala's rivers, given the potential impacts of climate change and human activities.

Ultimately, understanding the dynamics of range extensions in endemic species like *P. halakkudiensis* serves as a crucial foundation for informed conservation strategies and contributes to the broader knowledge of freshwater biodiversity conservation in the region.

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