

Securing the Future of Western Ghats' Subterranean Fishes: An Integrated Conservation Approach

A comprehensive initiative to protect India's unique underground fish species through science, community engagement, and innovative technology

The Western Ghats region of India harbors extraordinary subterranean fish species—enigmatic and ancient taxa that have evolved in complete darkness over millions of years. These remarkable creatures, hidden in wells, underground streams, and aquifers, represent irreplaceable evolutionary lineages. However, they face increasing threats from habitat loss, groundwater depletion, and limited public awareness of their existence.

The project “Action for the unique and threatened freshwater fishes of the Western Ghats Region of India,” initiated by Zoo Outreach Organisation in partnership with Kerala University of Fisheries and Ocean Studies and supported by SHOAL (a programme of Synchronicity Earth and Re:wild), was launched in January 2024. The project employs an integrated framework combining cutting-edge science, outreach, education, and communication to safeguard these unique species. This multi-pronged approach addresses conservation challenges through five interconnected components: extensive field surveys, revolutionary eDNA



Horaglanis sp. collected from Chottanikkara, Ernakulam District, Kerala

detection technology, citizen science networks, community-based conservation areas, and specialized rehabilitation facilities.

Building on a Decade of Conservation Success

This initiative builds upon a strong foundation of freshwater biodiversity work that began at ZOO in 2009. Over the years, various conservation activities have been implemented across the country, including educational programs, outreach initiatives, policy interventions, research projects, Alliance for Zero Extinction species identification and conservation action, urban freshwater restoration, and the innovative Lively Waters! programme. The current

project strengthens freshwater conservation specifically in the Western Ghats region, focusing on its most vulnerable and least understood inhabitants—subterranean fish species.

Comprehensive Field Surveys Across Kerala

During the period from April to September 2025, extensive field investigations were conducted across Kerala's diverse lateritic landscapes. Research teams systematically surveyed wetlands, homestead wells, borewells, garden channels and pools, and rice fields, covering villages and towns in nine districts—Thiruvananthapuram, Kollam, Pathanamthitta, Ernakulam, Kottayam, Thrissur, Kannur, Kozhikode, and Kasaragod—yielding approximately 57 fish samples. Significant discoveries included *Horaglanis* species from Chottanikkara (Ernakulam district) and household wells in Thuruthy and Changanassery (Kottayam district). The team also documented *Rakthamichthys* specimens from Malappuram and visited critical habitats of the subterranean eel loach in Kozhikode, Malappuram and Thrissur districts and *Kryptoglanis* species in Thrissur district.

Sample collection efforts also included documenting ecological conditions at each site. In a remarkable demonstration of community support for scientific research, nine homestead wells known to contain subterranean fish were completely drained exclusively for this project. This labor-intensive effort, including the thorough cleaning of laterite wells, provided invaluable access to these elusive species' and

unprecedented opportunities for detailed study.

Pioneering eDNA Technology for Species Detection

One of the project's most innovative achievements is the development of an environmental DNA (eDNA)-based sampling and detection system specifically designed for subterranean fish species. This cutting-edge approach enables researchers to detect fish presence from water samples alone, eliminating the need for physical capture and reducing stress on already vulnerable populations.

Water samples were systematically collected from wells, paddy fields, and wetlands where subterranean fish had been previously recorded. The research team designed specialized species-specific primers for eDNA analysis and successfully standardized the extraction protocol.

The technical approach focused on the mitochondrial cytochrome oxidase subunit I (cox1) region and thirty-five sequences were carefully analyzed for primer design. Rigorous validation procedures ensured reliability. PCR reactions using the newly designed eDNA primers were tested against genomic DNA from target species to confirm effectiveness.

The primers underwent additional 'in vitro' testing against genomic DNA of co-occurring species to verify specificity and eliminate false positives. The detection protocol was completed with quantitative PCR (qPCR) analysis, providing a robust tool for environmental DNA identification.



***Horaglanis* sp. collected from Chottanikkara, Ernakulam District, Kerala**



Field team undertaking sample collection at Perambra, Thrissur District



***Horaglanis* sp. collected from Thuruthy, Changanassery, Kottayam District, Kerala.**



Community members cleaning a laterite well in Chottanikkara, Ernakulam District, to facilitate subterranean fish surveys.



***Rakthamichthys* sp. collected from Malappuram District, Kerala.**



Field team undertaking sample collection at Kaduthuruthy, Kottayam District.



***Horaglanis* sp. collected from a household well in Thuruthy, Changanassery, Kottayam District.**

This molecular detection system represents a significant advancement in monitoring methodology, offering a non-invasive, efficient approach for detecting and monitoring subterranean fish populations across wide geographic areas.

Expanding Conservation Through Citizen Science

Recognizing that effective conservation requires broad public participation, the project has established an extensive citizen science network throughout Kerala. By actively engaging local communities, the initiative has dramatically expanded geographic coverage and monitoring capacity, particularly in previously understudied areas. This approach enhances data collection while fostering conservation awareness and promoting responsible management of subterranean ecosystems.

To build awareness and facilitate participation, the team developed and distributed comprehensive outreach materials, including high-quality fish photographs, user-friendly identification keys, and informative educational brochures. These materials are disseminated through multiple channels—WhatsApp groups, social media platforms (Facebook, YouTube, and Instagram), and traditional print media—ensuring wide reach across different demographics and age groups.

Strategic outreach targets local institutions where communities naturally gather: Panchayat offices serve as information hubs, village libraries provide learning resources, and health centers offer additional platforms



Community awareness program at the Village Office, Sasthamcotta, Kollam District.



Community awareness workshop at Parammal library, Kozhikode (Calicut).

for environmental education. Training sessions and interactive workshops have been conducted at various locations, for example, the Parammal library in Calicut and the village office in Sasthamcotta, Kollam. These capacity-building activities are designed to

sustain long-term community involvement and ensure genuine bottom-up engagement in conservation efforts.

The citizen science network continues expanding throughout all districts of Kerala, deliberately targeting diverse ecological zones to achieve comprehensive statewide coverage. Through partnerships with local governance bodies and strategic social media campaigns, the project is building a robust network of informed citizens actively contributing to biodiversity monitoring. These grassroots efforts are essential for expanding scientific knowledge about subterranean fishes, particularly given the critical importance of local ecological knowledge in detecting and understanding these cryptic species.

Community-Based Conservation Areas in Development

Following 22 months of intensive surveys (concluding at the end of November 2025), the project will launch a series of targeted workshops and awareness programs at priority localities. These community gatherings will engage local villagers and government administrators in collaborative planning to develop and implement community-based conservation areas.

This participatory approach recognizes that sustainable conservation requires local ownership, stewardship and active community involvement in natural resource management. By making conservation a shared responsibility, the project aims to create lasting protection for critical habitats beyond the project timeline.



SHOAL team visit to subterranean eel loach habitat in Kerala



SHOAL team visit to *Kryptoglanis* sp. habitat in Kerala.

Establishing Specialized Rehabilitation Facilities

Significant progress has been made in establishing a dedicated fish rehabilitation facility for subterranean species. The foundational infrastructure is now nearing completion, and the team is focused on developing optimal management protocols that ensure low-stress holding conditions and minimize mortality rates in captivity.

The facility design carefully replicates natural habitat conditions appropriate for these specialized freshwater fish. Maintaining suitable environmental parameters requires constant attention to water quality, temperature, and light conditions that

match their underground origins. Concurrent research examines feeding habits and behaviour patterns, providing crucial insights for successful captive maintenance.

This rehabilitation facility will serve multiple essential functions: it provides a safety net for highly threatened populations, enables detailed biological studies otherwise impossible in wild conditions, creates opportunities for public education and awareness, and potentially supports future reintroduction programs when restored habitats become available.

A Comprehensive Strategy for Long-Term Protection

The conservation of subterranean fishes demands innovative approaches that address both their biological vulnerability and their invisibility to public consciousness. Through integrated efforts combining field surveys, molecular detection methods, citizen science engagement, community-based conservation, and rehabilitation facilities, this project is creating a comprehensive framework for protecting these enigmatic and ancient taxa. The progress achieved during this reporting period—close to 60 specimens collected across nine districts, a functional eDNA detection protocol, an expanding citizen science network, nine completely surveyed wells through exceptional community cooperation, and a developing rehabilitation

facility—represents substantial advancement toward securing the future of the enigmatic and threatened subterranean fishes of the Western Ghats.

Success in conserving these species depends not only on scientific innovation, but equally on building lasting partnerships with the communities who share these landscapes. The preservation of subterranean fishes, survivors from ancient times living in perpetual darkness, requires collaborative action that bridges scientific expertise with traditional ecological knowledge and local commitment.

As field surveys continue, eDNA protocols are refined, community networks expand, and conservation areas take shape, this multi-faceted approach demonstrates that even the most cryptic and overlooked species can be effectively protected when diverse stakeholders unite around a shared conservation vision.

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