

From tree holes to trash—the breeding behavior of a frog endemic to the Andaman Islands of India

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A breeding pair of Charles Darwin's Frog (*Minervarya charlesdarwini*) from the Andaman Islands of India. Credit: S.D. Biju

A team of biologists from the University of Delhi and Zoological Survey of India, Harvard University, and the University of Minnesota has

discovered a unique breeding behavior in a species of frog endemic to the Andaman Islands of India. In a new study [published](#) in the journal *Breviora*, scientists describe a combination of traits that makes reproduction in this frog unique.

The Andamanese Charles Darwin's frog, *Minervarya charlesdarwini*, belongs to the family Dicroglossidae, a large radiation of Asian frogs that comprises over 220 species. Charles Darwin's frogs naturally breed as well as deposit terrestrial eggs above the [water surface](#) on the inner walls of water-filled tree cavities or root buttresses. Hatchlings then drop into the water below and complete their development through a free-swimming tadpole stage.

The posture of the mating pair at the time of egg-laying also makes Charles Darwin's frog unique: the pair orient themselves in a vertical, upside-down posture on the tree cavity walls with their bodies completely out the water.

"Upside-down spawning is the most remarkable behavior in this frog. No other frog is known to lay terrestrial eggs inside tree holes in an upside-down position. This discovery is fundamental for understanding how the species interacts with its environments and which habitats are essential for its survival. Such specialized traits also yield insights into the evolution of reproductive modes and behaviors among anuran amphibians," said Professor S. D. Biju of the University of Delhi, who led the study and is currently a Fellow at the Harvard Radcliffe Institute and an associate of Harvard's Museum of Comparative Zoology.



A male Charles Darwin's frog calling from an unnatural breeding site: a rain-filled metal food tin littered on the forest floor. Credit: G. Gokulakrishnan

The uniqueness of this frog does not end there. Male frogs produce complex advertisement calls comprising three different call types for attracting females. They also produce an aggressive call.

When aggressive vocalizations fail to ward off competing males, physical combat begins. These fights include kicking and boxing using hands and legs, and biting of body parts or even the entire head. Males compete aggressively to mate with females.

If a male successfully mounts a female, nearby unpaired males may physically fight with the amplexant pair. They may even try to insert their head between the bodies of the pair from the back side to separate

them. The defending male often kicks the intruding males with his hind legs.

Simultaneously, and to avoid attacks, the female climbs the wall of the tree hole with the male on her back. The study suggests that the upside-down spawning behavior in this frog may have evolved as a means of preventing aggressive unpaired males from displacing the amplexant pair from behind and disrupting egg-laying.


"This finding is an example of the remarkable diversity of amphibians and reproductive behaviors that are still unknown to science, especially from unexplored regions in biodiversity hotspots of tropical Asia." said study co-author Professor James Hanken, Curator of Herpetology at the Museum of Comparative Zoology and Professor of Biology in Harvard's Department of Organismic and Evolutionary Biology.

Although *Minervarya charlesdarwini* appears to be an obligate phytotelm-breeder, the research team frequently observed frogs breeding in unnatural sites in disturbed forests, ranging from artificially watered plastic sapling bags in adjacent plant nurseries to rain-filled, discarded plastic, glass or metal containers left as trash at the forest edge. The lack of adequate breeding sites due to [habitat loss](#) and competition for [limited resources](#) may be driving the Charles Darwin's [frog](#) to breed in such unnatural sites. However, this species may not be able to survive in the face of increasing human dominance and rapidly changing landscapes on the small islands where they live.

The study calls for increased attention to the conservation of this endemic and threatened species (currently IUCN Red listed as "Vulnerable"), and to protection of its specialized and vulnerable microhabitats to maintain adequate availability of natural breeding sites.

"The frogs' use of trash for breeding is both surprising and worrying. We

now need to know its causes and long-term consequences, and devise ways to protect the natural breeding sites that are critical for survival of the species," said Sonali Garg, a Biodiversity Postdoctoral Fellow at Harvard's Museum of Comparative Zoology, who co-led the study.




A UNIQUE TREEHOLE BREEDING BEHAVIOR *of*

the threatened Charles Darwin's frog from Andaman Islands

1

First report of upside-down terrestrial spawning in frogs




upside-down position

Parallel to ground known spawning position in terrestrial spawning frogs


2

Three types of complex male calls



3

male-male interactions




4

Agonistic interactions

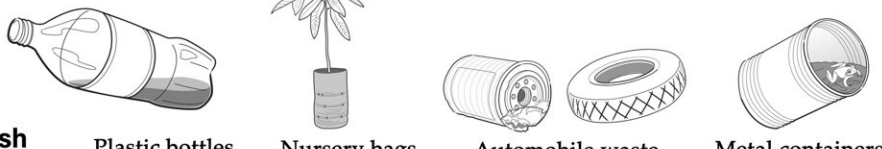
male-male combat

unpaired males* fight with amplexant pair




5

Breeding inside water-filled trash



Plastic bottles Nursery bags Automobile waste Metal containers



Biju et al. 2024. Tree holes to Trash: unique upside-down terrestrial spawning, agonistic interactions, complex mating calls, and unnatural breeding alterations in *Minervarya charlesdarwini* (Anura, Dicroglossidae). **Breviora**

Graphical abstract of the Charles Darwin's Frog's unique breeding behavior. Credit: S.D. Biju et al.

The field-based project was carried out over three years in the remote islands of the Andaman archipelago, which lies in the Bay of Bengal. Researchers spent over 55 nights during the [monsoon season](#) to study the secretive reproductive behavior of these tiny frogs. The findings are

published in "Tree holes to trash: unique upside-down terrestrial spawning, agonistic interactions, complex mating calls and unnatural breeding alteration in *Minervarya charlesdarwini* (Anura, Dicroglossidae)," which appears in the current issue (July 2024) of *Breviora*.

More information: S. D. Biju et al, Tree holes to trash: unique upside-down terrestrial spawning, agonistic interactions, complex mating calls, and unnatural breeding alterations in *minervarya charlesdarwini* (anura, dicroglossidae), *Breviora* (2024). [DOI: 10.3099/0006-9698-577.1.1](https://doi.org/10.3099/0006-9698-577.1.1)

Provided by Harvard University

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