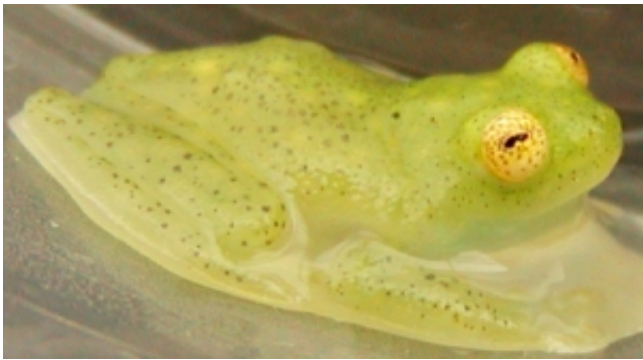


# Glassfrogs show surprising diversity of parental strategies

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Glass frog. Credit: D. F. Cisneros-Heredia/Wikipedia

Laid on leaves hanging over streams in tropical rainforests, glassfrog eggs are tasty snacks for snakes, insects and other predators until they hatch and drop into the streams to begin life as tadpoles. Until recently, biologists thought the eggs of most species were on their own during this vulnerable stage, without any help from mom or dad. In just a few species, fathers were known to care for their developing embryos, and biologists thought this paternal devotion had evolved from ancestors entirely lacking parental care.

Walking along a stream in Panama very late one night, however, Jesse Delia spotted a glassfrog mother sitting on her clutch of eggs.

Delia, a PhD student in the lab of Karen Warkentin, Boston University

professor of biology, went on to observe nighttime parental behavior among no fewer than 40 [species](#) of glassfrogs, working with research partner Laura Bravo Valencia, a graduate student at the Universidad de los Andes in Bogotá, Colombia.

The two scientists found that in many species glassfrog mothers brood their eggs during the night the eggs are fertilized, and that this care improves the survival of the eggs, while in almost a third of species glassfrog fathers stay on guard for much longer periods.

Published in *Journal of Evolutionary Biology*, with Delia as corresponding author, the research found parental care in every glassfrog species that was sampled.

Additionally, in an analysis of glassfrog evolutionary history that takes advantage of the new field data, the investigators discovered that male parental care probably evolved from female care and that "[parental care](#) gets elaborate when males take over," Warkentin says.

## **Wet work**

These discoveries were based on "a tour de force of extreme fieldwork," as Warkentin describes it. Delia and Bravo Valencia pursued their project over six rainy seasons at 22 sites along streams in Colombia, Ecuador, Mexico, Panama and Peru. The project also included field monitoring of parental behavior throughout the duration of embryonic development for 13 species—a total of 18 months walking up and down streams every night.

Some of these streams were in warm lowland forests and others up in the Andes mountains. "In Colombia, we would take buses (La Chiva) into the mountains and try to find somebody who would put us up, somewhere close to a forest, a couple hours' hike into the stream," Delia

recalls. "Streams in the Andes are really steep, with impassable waterfalls every so often, and in many sites they are cascades of freezing cold water."

In addition to observing the 40 species of frogs through the night, Delia and Bravo Valencia performed experiments on two species of frogs in Panama. The biologists began by removing glassfrog mothers immediately after the eggs were fertilized, before the mothers could sit on the eggs. Plucking out the frogs in this brief time period often required the researchers to jog up and down the stream, "so we were soaking wet all night," Delia says.

Monitoring the eggs daily until they hatched, which could take almost 20 days, the researchers found that the eggs given maternal care survived significantly better than those that did not receive care.

The key to this survival was that the frogs were soaking up water from damp spots on leaves and delivering it to the eggs. The jelly surrounding the eggs then would swell up with water and grow about four times thicker. Offering these swollen egg packages to katydids, crickets that prey on frog eggs, the biologists saw some frustrated predators. "Each embryo is surrounded by this protective layer of jelly, so when the katydid bites, it's getting mouthfuls of jelly, and it generally gives up," says Warkentin.

Bravo Valencia and Delia also tested what it would take to get glassfrog mothers to abandon their posts in the first few crucial hours. "They would gently poke and pinch and then physically push her off the eggs, and it would take all that to get most moms to leave," Warkentin says. "The moms are extremely dedicated to their task in that time period."

## **How care evolves**

"These are relatively well-studied, charismatic frogs, yet we were fundamentally wrong about the reproductive behavior of most glassfrog species," Warkentin notes. "There is still a lot to be learned from basic fieldwork. And that primary information has the potential to change how we think about larger processes, like sex role evolution."

"In glassfrogs, maternal care helps embryos survive, but they seem to do the bare minimum," she says. "It seems that fathers not only took over the job, when mothers were already doing it, but they also greatly elaborated the amount of care. Even after [eggs](#) have started hatching, fathers keep caring."

"In many animals, mothers are on duty when offspring need intensive care, whereas fathers care when it's easy or help out when more is needed. This common pattern has influenced how we think about parental sex-roles," Delia says. "Glassfrogs do the complete opposite - moms do the minimum (at least time-wise) while fathers go to extremes. Of course, glassfrogs are but one small branch on the tree of life. But the way we had underestimated the diversity of parental behavior stresses the importance of getting out to the field and watching animals behave."

"Because Jesse and Laura were spending all night on the streams, they saw things that nobody had seen before," Warkentin adds.

**More information:** J. Delia et al, Patterns of parental care in Neotropical glassfrogs: fieldwork alters hypotheses of sex-role evolution, *Journal of Evolutionary Biology* (2017). DOI: 10.1111/jeb.13059

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