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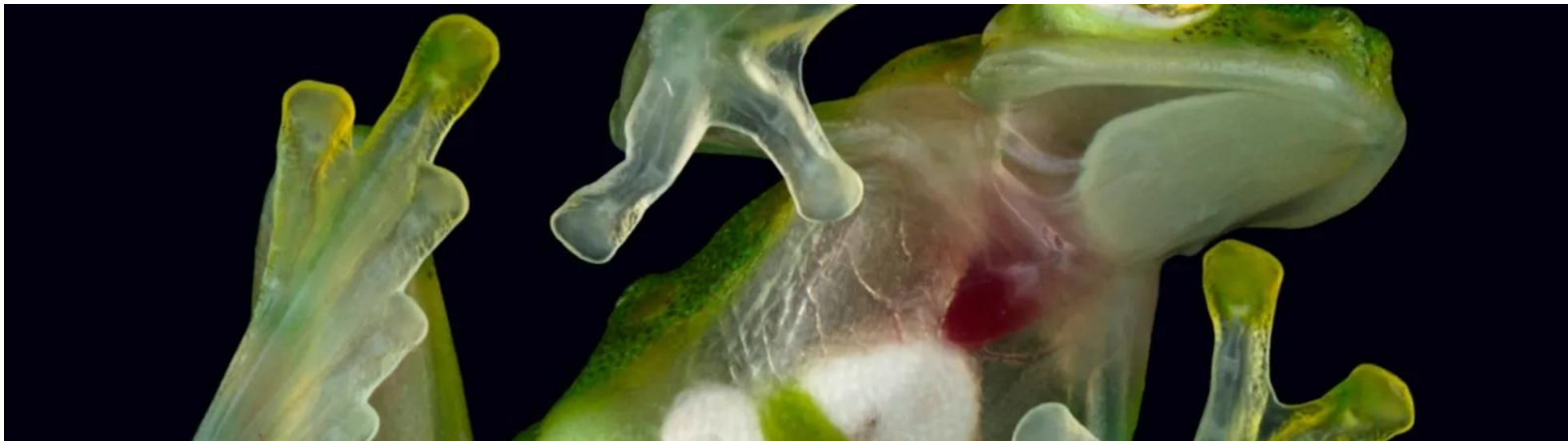
| ANIMALS |

These see-through frogs are full of surprises

These tiny Latin American tree dwellers are stellar fathers and masters at camouflage, recent research reveals.

BY ANGELA POSADA-SWAFFORD
PHOTOGRAPHS BY JAIME CULEBRAS
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The eggs of a female sun glass frog (*Hyalinobatrachium aureoguttatum*) are visible through her stomach. This image was taken in a mobile studio.

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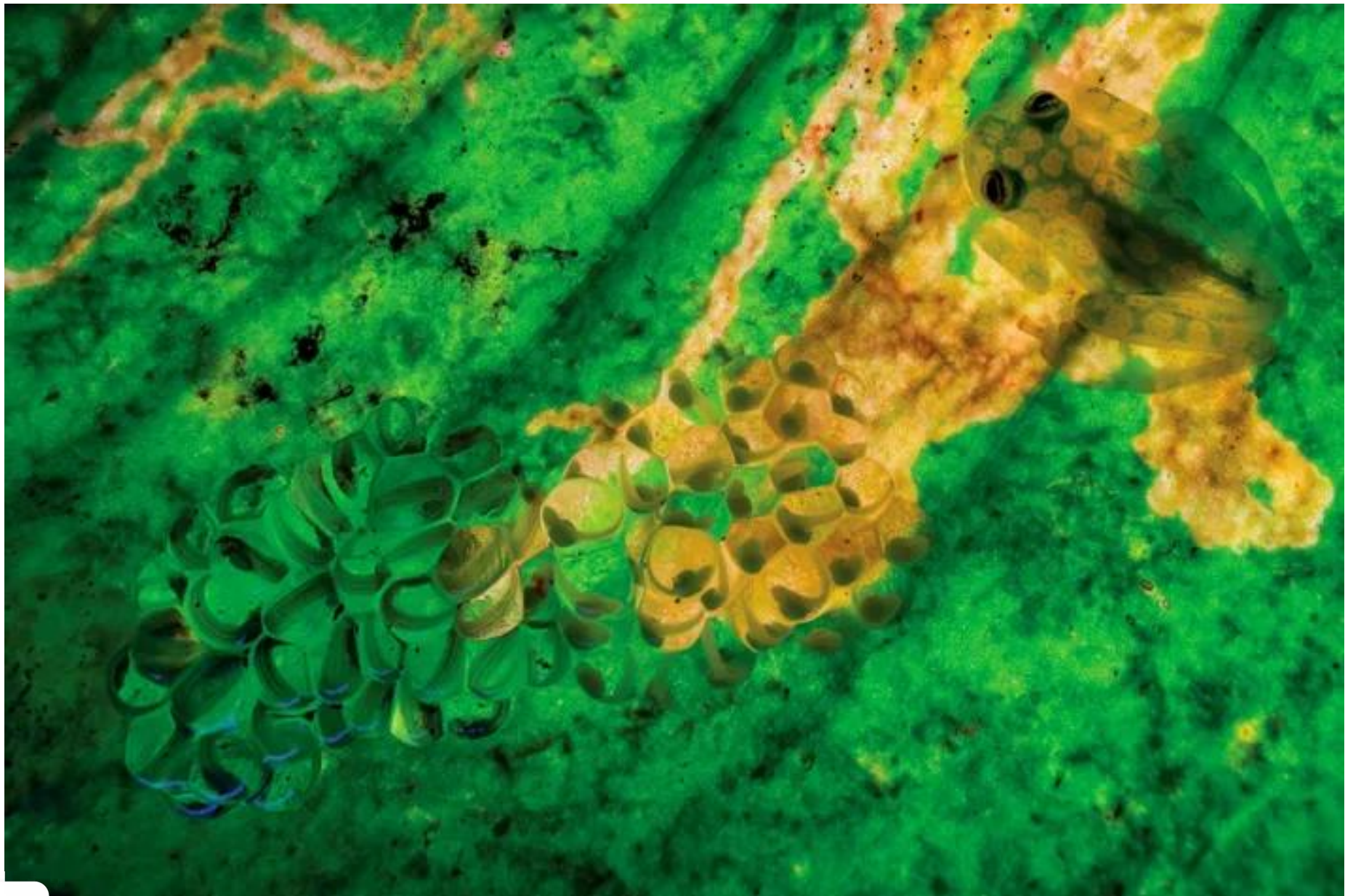
On a moonless summer night in Ecuador's Andean foothills, a tiny bachelor glass frog sits on a leaf overhanging a stream. He has chosen the best real estate to try to impress a female, advertising his presence with a high-pitched call.

The problem is that location alone isn't going to cut it. The yellowish green amphibian has been watching what mated male frogs do, so when he spots an abandoned clutch of eggs, he stays next to it for hours, pretending to guard it. Then a remarkable thing happens: He begins to attract female voyeurs, who apparently are tricked into thinking he's an experienced father.

"It is the first time we report such behaviour for frogs and toads," says Anyelet Valencia-Aguilar, a behavioural ecologist at Switzerland's University of Bern. She has recorded what appears to be deception in one glass frog species in Brazil and believes that the same may be happening in at l



deception in one glass frog species in Brazil and believes that the same may be happening in at least two species in Ecuador.



A male reticulated glass frog (*Hyalinobatrachium valerioi*) hangs upside down on a leaf next to its eggs in Costa Rica's cloud forest. One theory suggests that the spotted pattern on the frog's back mimics the eggs, confusing predators.



PHOTOGRAPH BY JAIME CULEBRAS

Valencia-Aguilar's research is one of several new findings about the biology of these alluring amphibians, named for their translucent skin.

There are 156 known species of glass frogs living throughout the neotropics, mainly in the northern Andes and Central America. Recent advancements in optics, genetics, and molecular biology are giving researchers a revealing look into the lives of these tiny tree dwellers, some of which are smaller than a paper clip.

Juan Manuel Guayasamin, an evolutionary biologist at Universidad San Francisco de Quito in Ecuador, has described 56 species of amphibians in recent years, including 14 glass frogs. "It's an important, a never-ending, job," he says. "These tiny wonders keep surprising us."

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This newly discovered glass frog in the *Hyalinobatrachium* genus measures less than an inch long. The amphibian is unique because of its high-pitched whistle and the black dots covering its body, which could act as camouflage in its rainforest environment.

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Scientists have discovered, for example, that male glass frogs in some species are stellar parents—a rare trait among vertebrates. Males of at least 24 species not only protect their eggs from predators but also actively care for them—sometimes for weeks.

After the female deposits her clutch of 20 to more than 100 eggs, depending on the species, the male fertilises them with his sperm. While the embryos develop, males of some species, such as the sun glass frog (*Hyalinobatrachium aureoguttatum*) and the northern glass frog (*Hyalinobatrachium fleischmanni*), sit atop their egg clutch “like a chicken,” keeping the eggs hydrated until they hatch into tadpoles, says Jesse Delia, a biologist at the American Museum of Natural History in New York City.





Embryos of the Wiley's glass frog (*Nymphargus wileyi*), endemic to Ecuador's eastern Andes, hang from the tip of a fern leaf. When the eggs hatch into tadpoles, they'll fall into the stream below to continue their development.

PHOTOGRAPH BY JAIME CULEBRAS

“The father searches for dew on leaves, sucks it up into his urinary bladder through a highly vascularised region of the belly, and then transports it to the babies,” he says. “We don't know if they transfer water via pee through their belly skin.”



Some 25 million to 35 million years ago, when the first glass frogs evolved, mothers likely did all the work, Delia says. Then, about eight million to 25 million years ago, some males took over parenting, though why is a mystery.

“Every time it switched to fathers, care got longer and behaviourally more diverse compared to females, who abandon eggs well before they are ready to hatch,” he says—perhaps because females were focused on making more eggs for their next clutch.





An arachnid eats eggs of the emerald glass frog (*Espadarana prosoblepon*) in northwestern Ecuador's Río Manduriacu Reserve. Parents of this species do not care for their young, leaving the eggs vulnerable to predation.

PHOTOGRAPH BY JAIME CULEBRAS

Meanwhile, new research is shedding light on how the glass frog's fabled see-through belly forms. Carlos Taboada, a biologist at Duke University in North Carolina who works with Delia, suspects that young glass frogs physically rearrange the insides of their cells and tissues to become transparent adults.

"It's not just skin and its lack of pigments. You need transparent muscles and internal structures that scatter light in as few angles as possible," Taboada says. Fluid between the tissue cells also may contain a substance that allows light to travel in a straight trajectory, reducing opacity, he says.

Taboada is studying another mechanism that may allow glass frogs to blend into the green leaves on which they doze during the day.





The Manduriacu glass frog (*Nymphargus manduriacu*) was scientifically described just a few years ago. The rare yellow-spotted frog is an opportunistic hunter, waiting until its prey—a small insect or spider—walks by, and then pouncing.

PHOTOGRAPH BY JAIME CULEBRAS

He calls it “a biological mirror: a kind of shield or covering of crystals in many of their tissues which reflects up to 50 percent of the light that normally reaches them. Those crystals amplify the [light] signal, and the frog’s green looks brighter.”

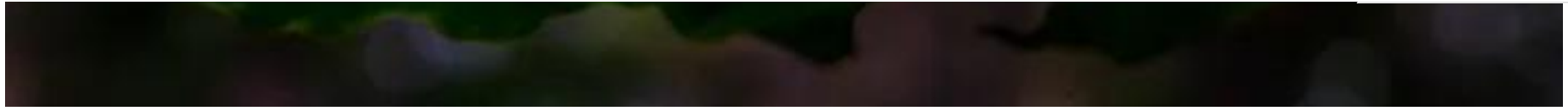
The glass frog’s transparency has another benefit: It disguises its familiar shape to would-be pre



as birds, spiders, and snakes.

“We call this type of camouflage edge diffusion,” says Justin Yeager, an evolutionary biologist at Universidad de las Américas in Quito. “We made accurate replicas of these frogs out of gelatine, some of them really opaque and some of them really translucent. And it turns out the opaque ones get eaten more.”





A female Magdalena giant glass frog (*Ikakogi tayrona*) covers her eggs in the Sierra Nevada de Santa Marta region of northeastern Colombia. This one-inch-long species is unusual in that mothers care for their embryos.

PHOTOGRAPH BY JAIME CULEBRAS

Many scientists studying glass frogs are motivated by the fact that some of their subjects are disappearing—and fast.

Agriculture, cattle grazing, and mining projects in the Andes are taking over the frogs' already fractured forest homes. The ranges of some species, such as the Manduriacu glass frog (*Nymphargus manduriacu*), are down to a single river basin.

The International Union for Conservation of Nature lists 10 glass frog species as critically endangered, 28 as endangered, and 21 as vulnerable to extinction.

“As soon as they are discovered, many species are declared endangered,” Guayasamin says.



A male sun glass frog's heart beats visibly through its chest in western Ecuador. Males of this species are actively involved in protecting and caring for their embryos.

PHOTOGRAPH BY JAIME CULEBRAS

Yet there could be an advantage in conserving such isolated populations, he says. He hopes that governments, private companies, and nonprofits could be inspired to work together to set aside these frog-rich patches of land as reserves, ensuring that these delicate creatures have a solid chance at survival.

“*Ranas de cristal* is how they are called in Spanish,” Guayasamin says, “which is great, because it conjures agility and beauty in one.”



Angela Posada-Swofford is a Colombian American journalist based in Miami Beach, Florida. **Jaime Culebras** is based in Ecuador; his photography highlights at-risk reptile and amphibian species.

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