

MOST THREATENED » THE MIDDLEMEN OF THE FOOD CHAIN



Yellow poison frogs at the London Zoo.
ZOE CORMIER FOR THE GLOBE AND MAIL



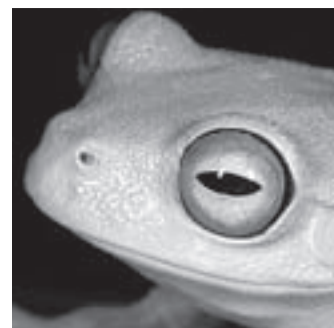
Chinese giant salamander.



Panama golden frog. THE ASSOCIATED PRESS



Surinam toad.



Red-eyed tree frog.



Hairy Frog of Cameroon.

HIGHLY ENDANGERED

CHINESE GIANT SALAMANDER
The largest amphibian in the world. Has declined massively since the 1960s. Primary threat is hunting. Considered a delicacy in China.

CHILE'S DARWIN FROG
Carries young in mouth. May already be extinct.

PANAMA GOLDEN FROG
No longer in the wild. Being bred at the Toronto and Vancouver zoos. Communicates with hand waves.

OLM
Blind. Lives in caves. May be able to live for more than 100 years and go without food for 10.

PURPLE FROG
Just discovered in 2003. Critically endangered. Wonderfully ugly.

GOLDEN POISON FROG
Most poisonous vertebrate on Earth.

WONDERFUL AND WEIRD

HAIRY FROG OF CAMEROON
Just spectacularly gross.

PAC MAN FROG
Unlike any other amphibian, possesses teeth. Actually eats mice.

AUSTRALIAN RED-EYED TREE FROG
One of many species of "red-eyed" tree frogs, or "swimsuit calendar frogs." Produces protein in skin that can block HIV.

SURINAM TOAD
Breeds young embedded in its back.

BETIC MIDWIFE TOAD
Carries eggs around in a ball around its legs.
» Zoe Cormier

An amphibious assault

Around the world, frogs and toads are falling victim to a loss of habitat, pesticides, pollution and an insidious, quick-acting fungus. And now they are going extinct faster than any other animals since the dinosaurs, **Zoe Cormier** reports

LONDON

The first images that come to mind may be unassuming brown newts or garden-variety green frogs, but amphibians cover a much grander spectrum.

Among about 6,000 species of frogs, salamanders and caecilians (legless animals, pronounced like "Sicilians") are some of the world's most bizarre animals: Giant Chinese salamanders, two metres in length; the "hairy frog" of Cameroon, which not only looks like it sports hair, but also can break its own bones to grow claws (an ability discovered just last month); the Surinam toad, which carries its eggs embedded in its back; and, even more macabre, the Sagalla caecilian, which feeds its own skin to its young.

Amphibians are also among the most colourful animals: The tiny, bright-yellow poison frog (with the spectacular scientific name *Phylllobates terribilis*) from Colombia, which is, gram for gram, the most poisonous vertebrate in the world; the black-dotted yellow frogs of Panama, which communicate with adorable hand waves; and the charismatic red-eyed tree frogs, aptly nicknamed "swimsuit calendar frogs."

These make up just a small sample of the amazingly diverse amphibians, which have the longest history on earth. They predate all other terrestrial vertebrates.

But the first group of animals to colonize the land is also the first that humans are driving off it. Amphibians are disappearing faster than any other animals since the dinosaurs: 32 per cent of all species are threatened with extinction, compared with 23 per cent of mammals and 12 per cent of birds. Almost half are in decline.

The reasons are complex and vary among species. Some are hunted for the pet trade or, as with the Chinese salamander, for their meat. The destruction of habitat, as with all animals, is a major cause worldwide. Pollution also appears to be a big factor.

But one of the most worrisome and headline-grabbing causes is a strange fungus: *Batrachochytrium dendrobatidis*, a.k.a. chytrid. Nobody quite knows how it kills amphibians – it may smother them, covering the skin they use to absorb oxygen and water, or it might release toxins. But biologists are unanimous in their belief that it is wiping out amphibians across the tropics, in the

warm and wet conditions in which they thrive, from Australia to South America. Scientists believe that it is behind the disappearance of 74 species (out of an original 110) of harlequin frog in Central America and at least 10 species of Australian frogs.

Bob Johnson, curator of reptiles and amphibians at the Toronto Zoo, saw one of the fungus's first victims just before it vanished. The golden toad of Costa Rica was once so numerous that tourists would flock to witness their mating season. They were so dense on the forest floor, "we could barely walk, there were so many of them," Mr. Johnson says of a trip he made in 1987. Just two years later, they had all disappeared, driven into extinction. "It was just astonishing."

Now, Mr. Johnson is caring for one of the last populations of Panama golden frogs, the stars of the most recent David Attenborough BBC documentary, *Life in Cold Blood*. The frogs were all taken out of the wild before chytrid reached them too.

Humans may be responsible for the spread of the fungus: Scientists suspect that it came from its home in South Africa when clawed frogs were exported 50 years ago for use in pregnancy tests. (A dose of a pregnant woman's urine causes a female clawed frog to lay eggs within eight to 12 hours. The test also works on male frogs, which produce sperm in response to the injection.)

African clawed frogs are mostly resilient to chytrid, and probably carried the fungus, but frogs elsewhere have little defence. It can wipe out a species in a matter of years.

POSTER CHILDREN

The reason for their vulnerability boils down to two things: They spend part of their lives in water and part on land, so they are exposed to factors in both environments; and their skin – not scaly like a reptile's, but soft, thin and permeable – renders them more sensitive to things such as ultraviolet radiation, pesticides and disease.

As the most threatened group of animals on the planet, they are not just poster children for the biodiversity crisis, they are also harbingers of things to come. Because amphibians occupy a unique and crucial place in the food chain, their extinctions will ripple through the ecosystem and catalyze the rapid disappearance of other animals, large and small.

Their young – salamander larvae and frog tadpoles – are major bottom feeders. When they grow into adults and move onto land, they bring nutrients from the water with them.

"Usually water is a trap for biomass," says McGill University zoologist David Green, one of Canada's foremost authorities on amphibian declines. Things flow from land into water easily in rain, but amphibians, which move back onto land as adults, are one of the very few things in nature that move nutrients in the reverse direction, back onto land. "That's a very important job," Prof. Green says.

Moreover, as adults, they consume huge numbers of insects, then themselves are consumed in huge numbers by larger animals, such as birds and mammals. If we take these middlemen out of the food chain, the consequences could be disastrous. Insect populations could explode, while birds and mammals may disappear.

Yet, despite their importance, conservationists are struggling to raise the funds they need to save them.

"A charismatic bird or mammal will easily draw in money, but it is hard to get funding for amphibians," says Helen Meredith, who is leading the Zoological Society of London's EDGE amphibian-conservation program.

The London Zoo is caring for and breeding a number of spectacular amphibians, including the golden poison frog, and is sponsoring projects overseas for highly endangered amphibians such as the giant Chinese salamander (hunted for its meat in China, where it is considered a delicacy) and the spectacularly ugly purple frog of India, discovered just last year.

EDGE – meaning "evolutionarily distinct and globally endangered" – has found that 85 of the most distinctive and endangered 100 amphibian species are receiving little to no conservation attention. "Amphibians have been pushed into the shadows," Ms. Meredith says.

"But in terms of conservation dollars, you can accomplish so much more than investing in any of the large 'charismatic' mammals," says Kevin Zippel, director of Amphibian Ark, a branch of the World Conservation Union, which is supporting captive breeding programs.

Breeding amphibians is comparatively simple. They are small and fairly easy to take

care of. "For just \$50,000 to \$100,000, you can save an entire amphibian species from extinction. Compare that to the amount it costs to rent one panda for a year from China: \$1-million, and that doesn't even include housing, food and staff."

Amphibian Ark is trying to raise \$50-million for the captive management of 500 species. "If each of the world's largest zoos just took on one species each, we'd be done," Mr. Zippel says.

"Though we aren't saying that having these species in glass boxes is an acceptable form of conservation – it's just an option for the future," he adds.

ARKS TO TOMBS

But unless more effort is put into restoring their wild habitats, the "arks will only become tombs," says ecologist Alan Pounds, who has been documenting the decline of golden toads and harlequin frogs in Central America since the 1980s. "We can't save the world with captive breeding. We have always thought that if we have parks and reserves, then we can do what we want with the rest of the planet – and that is not true."

He says the spread of chytrid in the mountains of Costa Rica is tied to global warming. His research, published in the journal *Nature*, indicates that the fungus causes more frog deaths in warmer years, when the hilltops – normally cool – become more hospitable to the fungus.

And it is happening not just in the mountains of Central America: Other researchers have tied the spread of the fungus in midwife toads in Spain to a warming climate.

But chytrid occurs in many places without being lethal. McGill's Prof. Green has found it in about 13 per cent of amphibians from five Canadian provinces. "Canada would have to get warmer and wetter" for the fungus to become lethal, he says. "We may start to see that."

Even if this doesn't happen, frogs all over Canada are disappearing. Leopard frogs on the Prairies are vanishing, and nobody quite knows why. Fowler's toads may be driven out of their only range, in Southern Ontario, where they are mowed over by beach grooming machines sent to remove cigarette butts. Chorus frogs in Quebec, along with their songs, are fading because of suburban development.

The precise causes can be hard to pin down, but many

studies have implicated UV radiation, low doses of pesticides and agricultural pollution. Most ecologists believe that it is rarely one single factor that is responsible, but the combination of threats.

Ecologist Pieter Johnson at the University of Colorado published a landmark study in 2007 in the Proceedings of the National Academy of Sciences (PNAS) demonstrating that the combination of fertilizer runoff in ponds and the flatworm parasite *Ribeiroia ondatrae* may be responsible for the high prevalence of amphibian mutations that we see all over the United States and Canada (up to 70 per cent of frogs in some wetlands grow multiple arms and legs). High levels of fertilizers in ponds spawn blooms of algae, which in turn foster an explosion in snails which carry the parasites.

Many other studies have found such "synergistic effects." Researchers from Oregon State University have shown that the combination of UV radiation and fertilizer pollution kills seven times more frogs than either alone.

Ecologist Rick Relyea at the University of Pittsburgh, who studies pesticides, reported in 2001 in the PNAS that subjecting tadpoles to the fear of a caged predator in their tank, combined with low levels of the pesticide carbaryl, caused grey tree frog tadpoles (found in Canada) to die when neither factor alone killed them. "Many people were shocked and amazed," he says.

He has an upcoming paper in the journal *Ecological Applications* that will show that combinations of low doses of pesticides – non-lethal on their own – are "highly lethal."

But Prof. Relyea cautions that we cannot be sure pesticides are causing frog declines in the wild – more research is needed. "The problem is that an awful lot of effort goes into assessing the benefits of these chemicals, but not the costs." We just need to be smarter about how we use pesticides, he says, such as spraying them in minimal amounts and at times of year when amphibians are less vulnerable – for example, after the tadpoles have grown into frogs.

If pesticides are responsible for deaths in the wild, the impact could be more widespread than we realize. Ecologists from the University of Toronto reported last year that pesticides in the soils in Costa Rica were actually more concentrated higher up the mountains than lower down closer to plantations, carried

aloft by breezes and deposited onto the mountaintops when mists form at high elevations.

CHEMICAL COCKTAILS

There is an important lesson to be learned here: Being so sensitive, amphibians are sending us a warning signal. For good reason, they are known as our canaries in the coal mine. "If we lose the amphibians, then we lose our best detection system to see what's going on with the world," EDGE's Ms. Meredith says.

And not only that, we also lose "our tools for future drug production," she says. Frogs harbour incredible cocktails of chemicals in their skin that are being investigated by medical researchers. The lethal poisons of arrow frogs may be harnessed for antibiotics, and seem to yield effective painkillers hundreds of times more powerful than morphine. The wood frog, widespread in Canada, can freeze solid and survive, and is being probed for clues to preserve frozen organs during transplant. Salamanders, which can regenerate their limbs, may some day help us to grow lost digits. And it was discovered just three years ago that certain red-eyed tree frogs produce a protein that can block HIV infection. "On the back of some toad somewhere is the compound that will do wonders for you, but we don't know which one it is yet," Prof. Green says.

Already we have lost amphibian species to extinction that may have been able to help us. In the 1970s, scientists discovered a species of frog in Australia that gestated its eggs in its stomach, using special hormones to shut down its digestive system. It could have held the clues to treat ulcers, but it has not been seen in decades.

Before the 3,000 amphibians in decline suffer the same fate, is there anything we can do? When we are trying to fight the battle on so many fronts, is there any way to win the war? We need to deal with every single issue at once: climate change, excessive use of agricultural fertilizers and pesticides, depletion of the ozone layer and, above all, habitat degradation.

But the case isn't hopeless, Prof. Green says, as long as we take action now. "We have to give amphibians some credit," he says. "They are not so vulnerable and fragile. It's just the combination of factors that they cannot cope with. They are tough as boots if you give them a chance."

» Zoe Cormier is a science writer based in London.