

h10 Salamanders and frogs < larva, newt, eft; tadpole >

“Sweet are the uses of adversity which, like the toad, ugly and venomous, wears yet a precious jewel in his head,” the Old Duke says in Shakespeare’s *As You Like It*.¹

Among the mass of evidence that substantiates a genetic basis for altruism, deep in [*The Altruism Equation* by Lee Alan Dugatkin] we find that for the plains spadefoot toad (*Spea bombifrons*) relatedness is literally a matter of taste: carnivorous morphs spit out their nearest and dearest but eat those least related. —Caroline Ash.²

Existing amphibians are distinctive for their highly evolved skin which, as in familiar frogs, is vascular with a respiratory function and, in some, also sweats poison. Frogs that have returned to living in salt water, maintain high levels of urea in their blood to prevent dehydration by osmosis through their thin, porous, skin.³

Tailless amphibians (order Anura) are toads (squat with short legs) and frogs (with hindlegs specialized for leaping—and when cooked, “taste just like chicken.”)⁴. For their own hungry, some mother frogs (as is true of some fish) produce unfertilized eggs for them to eat.

Frogs like modern leaping-forms were already present in the Jurassic.

In frog ancestors, skull specialization preceded limb specialization if Triassic *Protobatrachus* is typical: it had, in almost every detail, a frogs head, but its body was salamander-like.⁵

Amphibians with tails (order Urodela) are salamanders and sirens. Less familiar are limbless caecilians such as *Typhlonectes compressicauda*, and the even more specialized *Atretochoana eiselti* (formerly *Typhlonectes eiselti*) which is evolved to have no lungs, pulmonary circulation, or even internal nostrils.⁶ Alexander Kupfer, was a little surprised to see the broods of two to nine members munching on the skin on the backs of *Boulengerula taitanus* caecilian mothers. But no, Stéphan Reeb reports: “While nursing, her epidermis grows to twice its normal thickness and develops modified cells full of nutritious fats and proteins,” and they have teeth specially for peeling it off.⁷

Giant salamanders (cryptobranchids) are the Asian *Andrias davidianus*, which can grow as big as a small human adult, the Japanese *A. japonicus*, and the smaller North American hellbender *Cryptobranchus alleganiensis*. Cryptobranchids diverged from other urodela types before 160 million years ago. This is evidenced by some five species of these found entombed in volcanic ash, which had smothered them, in what is now Inner Mongolia. Neil H. Shubin and Ke-Qin Gao in 2003 have described preserved impressions of their soft tissues, including eye lenses, external gills, tadpole-like tails, and even remnants of their last meals: bellyfuls of shrimp.⁸ □

Footnote h9.1 Amphibious fishes

There are things down there still coming ashore. —Loren Corey Eiseley (1907-1977).⁶

Mudskippers are amphibious bony fishes that inhabit Old World mudflats and mangrove forests from West Africa eastward to Papua New Guinea. Extant mudskipper species, number twenty-five. A diverse group, they are classified on the basis of body traits and behavior into four genera: *Scartelaos*, *Boleophthalmus*, *Periophthalmus*, and *Periophthalmodon*.

Convergent evolutionary mudskipper specializations described by Heather J. Lee and Jeffrey B. Graham in 2002 are: “Prominent eyes, modified [so] for clear aerial vision that their ability to see underwater is diminished. Beneath each eye is a water-filled cup formed from skin folds; as a mudskipper’s eyes become dehydrated by exposure to the air, they can be retracted into this cup to be moistened. With their leglike fins, mudskippers can walk, climb, and leap when out of the water, and thanks to structural modifications in their skin and gill chambers, they are able to breathe both in water and in air.”⁷