

Will zoo and aquarium educators help ensure the survival of amphibians threatened by a global plague?

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Many of us will have experienced the youthful pleasure of collecting frog spawn in a local pond, watching the resulting tadpoles develop and reintroducing the froglets back to their pond. For those persons who, like me, have eagerly pursued natural history throughout life this exercise is likely to have been repeated in some form or other in school, college and university – or in the zoo, aquarium or wildlife organization where we now work. In all of this there is the reassuring familiarity of an unending cycle of eggs, sperm, fertilization, embryos, development, feeding, growth, change, maturation, adulthood and mating. These main elements of the ‘frog story’ are, of course, general for animals with backbones, including humans, and indeed for many ‘mini-beasts’ with-out backbones. We are, in fact, observing an ancient developmental process in amphibians which in many respects parallels the evolution of life itself. The fascinating learning experience that we gained as children will have been fundamental to our basic understanding of the biological mechanisms for reproduction, survival and seasonality; and to later environmental insights. We can, through simple observation and understanding of frogs, toads and newts, develop a scientific and educational model for the metamorphosis of life, its persistence

Horned Frog (*Ceratophrys ornata*)



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in the short and long term and the necessary conditions for a prospering ecology. The ‘frog story’ is somehow integral to our own growing up and sense of awareness of the natural world and the health of the planet.

Let me disturb this comforting reflection and state that, without the help of zoo and aquarium educators among many others, this ‘frog story’ could come to an abrupt

Red-legged Frog (*Rana aurora*)



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Ex situ management will play a vital role in securing the future of species such as the Golden Poison Dart Frog (*Phyllobates terribilis*).

and ghastly end. Imagine a near future world where children could no longer see frogs, toads, newts and other amphibians in the wild because they are all extinct, wiped out by a killer plague. This means dead ponds and ditches, no croaking frogs in spring in the temperate zone or at the beginning of the rainy season in the tropics, no spawn, no tadpoles ... no amphibians ... forever. How would you and the children and adults that you educate feel if this came to pass? Perhaps educators or others might be disbelieving, puzzled, possibly upset, sad or angry. Alternatively you might be perturbed but believe that there are many far more significant and high profile global issues to concern us and concentrate on.

Whatever the case, and independent of private reactions, this dramatic 'mass extinction' or 'doomsday scenario' is far closer to present-day reality than might at first be imagined. Amphibian populations and species are everywhere in steep decline and there is now a conservation crisis on a historically unprecedented scale. From data published by the IUCN Global Amphibian Assessment (GAA), there are currently about 2000 threatened species on the official Red List, of which 456 are critically endangered and up to 1000 in urgent need of help through rescue and recovery programs taking place

outside of the natural habitat. So far, the headline figure of threatened species represents about one-third of the number recognized (6000). This is 22% of the likely total number of valid species (9000) that, on current projections, includes those yet to be discovered and scientifically described; and which category is likely to contain many critically endangered species in addition to those so far listed. At least 165 amphibian species extinctions (or 8% of those threatened) have been confirmed from 1980 to date. The great litany of difficult-to-pronounce Latin names of extinct species – such as *Atelopus igniscens*, *Plethodon ainsworthi* and *Hyla calypso* – disguises an absolutely tragic loss of biological diversity. This diversity encompasses wonderful forms, functions and lifestyles and is geographically and ecologically widespread. We are contemplating the loss of an extraordinary biology, biogeography and, indeed, beauty. The extinct *Bufo periglenes* was, for example, a vivid golden color in life and the extinct *Rheobatrachus vitellinus* and *R. silus* were 'gastric brooding' toads which raised tadpoles and froglets inside of their mouths.

But why should anyone be particularly bothered about the fate of small frogs and their amphibian allies even if they are sometimes brightly colored or have curious lifestyles? The short answer is that no one really knows what the ecological, economic or other consequences of this loss would be for humans and other animals. Nonetheless, likely or possible 'knock-on' effects might be an initial explosion in the numbers of particular insects, including pest species and disease carriers – a major food for frogs. One can also reasonably anticipate that the many predators of frogs and tadpoles would decline in the absence of an alternative food source. These predators include species of invertebrates, fishes, amphibians, reptiles, birds, and mammals. In both of the foregoing instances there would probably be complex second-order 'boom and bust' effects through ecological food webs.

Splendid Leaf Frog (*Cruziohyla calcarifer*)



Photo © Douglas Sherriff/Chester Zoo

While the loss of any one individual species might not be hugely consequential in the grand scheme of things, what might happen if we experience a mass extinction of all of the species now threatened? That is to say, what if we lose the greater part of one of only four classes of 'land animals' (the others being the mammals, birds, and reptiles, most of whose contained species live much or crucial parts of their lives on land). Imagine the world's terrestrial ecosystem, as a table with the supporting legs represented by the four land vertebrate classes. One of these legs is badly deteriorated and it looks as if it could give in – will the rest of the table become unstable or collapse as a result? For the entire global ecosystem (terrestrial and aquatic) we certainly have to consider the unpredictable and probably negative consequences following the loss of a major part of the biomass of many habitats; and the loss of a large part of one of only five major evolutionary units of the vertebrates (fishes being the fifth unit). Is anyone prepared to take the chance, adopt the 'do nothing' option and gamble on a positive outcome?

Oriental Fire-bellied Frog (*Bombina orientalis*)



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There are also socio-economic issues to consider. What, for instance, would be the social, medical and financial consequences of an increase in the incidence of human and animal malaria (the disease vector mosquitoes having previously been eaten by frogs)? Frogs and other amphibians such as axolotls are, in turn, eaten as part of the staple diet in some countries and the sustainable sale of protein-rich frog meat forms a significant part of developing rural economies. The skin of amphibians exude remarkable chemicals which may well be of considerable pharmacological and commercial significance to produce, for example, neuro-anaesthetics, wound-healing substances and potential anti-cancer drugs. Frogs are, in fact, living 'molecule mines' from which ethical and humane 'bio-prospectors' could extract many useful and beneficial compounds.

Mossy Frog (*Theleiderma corticale*)



Photo © Douglas Sheriff/Chester Zoo

In terms of benefit sharing for indigenous peoples and diversifying income streams, the 'biodiversity hotspots' for frogs in tropical countries offer substantial development potential.

So what can educators do? There are certainly challenges in presenting the case for amphibians, not least because of their relatively small size and (for some) a lack of 'charisma' by comparison with the large land mammals. For those seeking educational inspiration please read the classic paper by William Conway on 'How to exhibit a bullfrog: a bedtime story for zoo men' [Curator 2(4), 1968]. As regards contemporary extinction issues the short answer is that educators urgently need to communicate this story in all its simplicity (and complexity). They need to do this far and wide to help promote positive action and galvanize resources.

The causes of the decline are multi-factorial and involve, in various combinations, the usual issues of habitat destruction, fragmentation or loss, pollution (both industrial and agricultural), over-harvesting, disease and probably the growing ecological impacts of climate change. Disease, mainly in the form of a chytrid fungus (*Batrachochytrium dendrobatidis*), is now the factor most commonly associated with catastrophic declines and extinctions of amphibian populations and species. The disease seems to be most deadly when the frogs are stressed by other factors such as excessively high temperatures. The fungus was first recognized in 1938 in the African clawed toad (*Xenopus laevis*), which is believed to be largely resistant to its effects. This clawed toad has been used in laboratories worldwide in testing for human pregnancies. With the discontinuation of this form of testing these clawed toads were everywhere released by well-meaning laboratory staff – so, it seems, spreading the fungus to indigenous species that had little or no resistance and for whom the chytrid infection could be

lethal. However, this 'out of Africa' hypothesis remains to be thoroughly tested. In any event, the burgeoning global pet trade in live amphibians has likely facilitated the spread of the disease. Most of the extinctions are likely to involve chytridiomycosis but the fundamental research to establish this still needs to be completed. In any event, this disease is now well-established and spreading in all amphibian inhabited continents and in notable islands, including the UK and Japan.

There is a global IUCN Amphibian Conservation Action Plan or ACAP (publication pending) for all stakeholders to follow. Also, the World Association of Zoos and Aquariums (WAZA) have responded to this crisis by making a formal declaration at their annual conference in New York, 2005, calling on the global zoo and aquarium community to address the amphibian crisis using their unique, specialized skills. In February, 2006, WAZA and the IUCN/SSC Conservation Breeding Specialist Group co-organized a workshop in Panama to bring together experts from around the world to formulate a detailed *ex situ* action plan and specific protocols in support of the ACAP. An Amphibian Ark (AArk) was formally constituted at a follow-up meeting in Atlanta, Georgia, February 2007. This established a foundation partnership between WAZA, CBSG and the IUCN/SSC Amphibian Specialist Group. The vision of the AArk is the world's amphibians safe in nature and its mission is *working in partnership to ensure the global survival of amphibians – focusing on those that cannot be safeguarded in nature.*

The AArk now has an active program of worthwhile and practical activities which includes the development of biosecure facilities to rescue and treat, maintain and breed representative populations of threatened amphibians. Associated activities are the documentation, categorization and prioritization of species, training exercises around the world and the organization of a

Morelet's Treefrog (*Agalychnis moreletii*)



Monkey Frog (*Phyllomedusa bicolor*)



Photo © Douglas Sheriff/Chester Zoo

global educational and awareness campaign for 2008 entitled 'Year of the Frog'. The AArk has recruited several core members of staff and has an Executive Committee and a Steering Committee representing the interests of individual zoos and aquariums, national, regional and international associations (including the IZE), museums, botanical gardens, universities and the private sector. Generous funding has come in from many sources, notably from the distinguished amphibian biologist, conservationist and pioneer zoo educator George Rabb and his friends. They have given these donations as a most fitting tribute to the life of the late Mary Rabb.

The demise of frogs is continuing to take place in pristine habitats and so it is now evident that they are not safe in the wild. For many amphibians the only immediate hope is rescue, veterinary treatment and conservation breeding *ex situ*. There remains positive but, regrettably, more distant prospects of developing a cure for this disease and also programs for re-introduction when conditions become appropriate. The amphibians are certainly prime examples of the traditional 'Ark approach' long held by zoos to be a vital conservation backstop in the event of prospective extinctions in the wild. With the strong support of the International Zoo Educators there will be global public awareness, understanding and associated support; and a far greater prospect that many species of frogs will survive for future generations to appreciate. ♦

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