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Chytridiomycosis - a new disease of amphibians

Chytrid fungi and amphibian declines

Many amphibian population declines are obviously due to habitat degradation, but in the last twenty years there have been mysterious population crashes in protected high altitude areas where no habitat problems have been detected. This pattern is particularly evident in the montane rainforests of Queensland and Central and South America (Laurance *et al.*, 1996, 1997; Lips, 1998). In some cases, these crashes have resulted in extinction of stream-dwelling rainforest species.

A new species of chytrid fungus has been found infecting the skin of frogs dying during mass mortality events in forests in Queensland and Panama, and may be the cause of these precipitous population declines (Berger *et al.*, 1998). Chytrids are small spherical fungi that produce motile infective stages called zoospores. Some species are found free-living in soil and water where they degrade organic matter such as chitin or keratin, and others are parasites of algae, plants, nematodes or insects (Barr, 1990). Before the discovery of the amphibian chytrid, none had been found to cause disease in vertebrates. The epidemiological data support the hypothesis that this fungus has been introduced to these rainforest areas and is the cause of the population crashes.

In Queensland, seven rainforest frog species disappeared during the past twenty years (Richards *et al.*, 1993; Mahony, 1996). The first extinctions occurred in the D'Aguilar and Conondale mountains near Brisbane in the late seventies/early eighties. The amazing southern gastric brooding frog was last seen in 1979. This was an incredible species whose tadpoles developed in the stomach of the female and the newly metamorphosed froglets emerged through the mouth. In the mid eighties, frog populations in central eastern Queensland declined, and the northern gastric breeding frog (the only other gastric brooding frog in the world) has not been seen since. By then it was clear that our frogs were in trouble, and so remaining high-altitude populations were intensively monitored. In the early nineties, populations in north Queensland suffered similar sudden declines, but this time zoologists were present to witness ill, dying and dead frogs as mass mortalities occurred (Laurance *et al.*, 1996).

In many of these episodes of declines, tadpoles were seen for months after adult frogs had disappeared.

A range of causes have been proposed to explain the declines, but introduction of a waterborne infectious disease fatal to adult frogs appears the most reasonable explanation. Abnormal levels of water pollutants were not detected, water pH was stable and population changes were not associated with habitat disturbance or unusual weather (Richards *et al.*, 1993; Laurance *et al.*, 1996). Increased ultra-violet radiation can be discounted as ground-level solar ultraviolet radiation has not increased significantly at tropical latitudes, and most of these frogs are nocturnal an live in dense rainforest. The asynchronous timing of the declines and apparent spread of the declines from south to north is consistent with a new epidemic agent progressing through a naïve population. All species of frogs that suffered significant declines are stream-breeding and stream-dwelling, suggesting the problem is waterborne (Williams and Hero, 1998).

During the mass mortality in north Queensland in 1993, about twenty dying frogs were collected for diagnostic investigations (Berger et al., 1998). The species found dying included the sharp-snouted day frog, waterfall frog and common mist frog. Pathology revealed the presence of chytrid fungi in the keratinised layer of the skin, and acute, non-specific degenerative lesions in some internal organs. Bacteriological and virological studies did not identify any causative agent. The chytrid fungi appeared to be associated with minor local changes in the skin, and the reasons why frogs died was not apparent. This fungus had never been seen before, and as there was no background information available on diseases in healthy populations of these frogs, it was difficult to determine the significance of its occurrence.

Between 1995 and 1998, a network was set up around Australia to collect any sick wild or captive frogs found by zoologists, and to investigate their diseases pathologically. A range of new diseases was detected, but importantly, the

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