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Effects of the Amphibian Chytrid Fungus on Enzootic and Epizootic Dynamics

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Abstract – Chytridiomycosis, the disease caused by the chytrid fungus, Batrachochytrium Dendrobatidis (Bd), has contributed to amphibian population declines and extinctions worldwide. Biotic and biotic components of the environment may mitigate or exacerbate effects of pathogens on their hosts through direct or indirect mechanisms. The impact of this pathogen, however, varies markedly among amphibian species and populations.

Keywords: Amphibian Decline, Batrachochytrium Dendrobatidis, Chytridiomycosis

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INTRODUCTION

The amphibian chytrid fungus, Batrachochytrium dendrobatidis (Bd), is a widespread pathogen [16] and has been associated with amphibian population declines and extinctions around the world [17]. Infection by Bd can be asymptomatic or result in the disease of chytridiomycosis, characterized by excessive skin shedding and osmotic imbalance that can result in death [18]. Amphibians show variation to Bd susceptibility within and among populations [19] and between species [20]. The observed variation in response to Bd may result from genetic or immunological differences, as well as the presence of other environmental stressors that may increase or decrease vulnerability

REVIEW OF LITERATURE:

Chytridiomycosis, caused by the fungal pathogen *Batrachochytrium dendrobatidis* (Bd), has been called the "worst infectious disease ever recorded among vertebrates in terms of the number of species impacted, and its propensity to drive them to extinction" (1). Since it was first identified in the late 1990s (2, 3), Bd has been found in almost every region in which researchers have searched. It is now nearly global in its distribution, and it has been implicated in dramatic declines in amphibian populations worldwide (4, 5). One of the most striking features of this pathogen, however, is the variability in outcome of infection that has been observed among species, and among populations within a species. Chytridiomycosis leads to the rapid death of individuals of some species (2, 6, 7), whereas individuals of other species develop only minor infections and suffer little or no negative effects (8, 9). A number of factors, including temperature (10), innate defenses (11, 12), habitat (13, 14), and host life history traits (15), have been demonstrated to contribute to the variable outcomes of Bd infection.

BATRACHOCHYTRIUM DENDROBATIDIS INFECTIONS IN SPACE AND TIME

Batrachochytrium dendrobatidis was not detected on any of the 123 frogs sampled in January 2005. However, in December 2005, 19/141 (14%) frogs were infected and by late January 2006, infection prevalence had risen to 47 per cent (94/200). No dead *A. zeteki* were found in December 2005, but eight were found in January 2006, all of which tested positive for *B. dendrobatidis*.

Golden frogs at this study site were encountered in two microhabitat types: (i) exposed on rocks or gravel along the stream or (ii) hidden in leaf litter further (less than 5 m) from the stream. During each breeding season, the majority of frogs (92% in 2004 and 85% in 2005) were encountered on rocks or gravel in December whereas by January, after most breeding had occurred, more frogs (55% in 2004, 52% in 2005 and 65% in 2006) were encountered hidden in leaf litter. Infection rates of frogs found on rocks or gravel were not different from those found in leaf litter (December 2005: 18/78 infected on rocks or gravel, 4/39 infected in leaf litter, $n = 117$, $\chi^2_1 = 2.02$, $p = 0.15$; January 2006: 24/43 infected on rocks or gravel, 62/97 infected in leaf litter, $n = 140$, $\chi^2_1 = 0.52$, $p = 0.47$). The spatial pattern of infection was random with respect to the frog's position along each of the three transects ($n = 20$/transect, $-0.38 <$ Moran's $I < 1.6$, $p > 0.05$). Five (6%) of 86 environmental samples tested positive for *B. dendrobatidis* in January 2006 (see appendix S1 in

electronic supplementary material) suggesting that during the height of the epidemic, the fungus was common enough in the ecosystem that chytridiomycosis could potentially have been transmitted to frogs directly from contaminated substrates. A total of 11 frogs were captured and swabbed during both December 2005 and January 2006. None of these were infected in December, but by January, six (55%) had developed *B. dendrobatidis* infections [24].

Factors that influence pathogen abundance and transmission Disease dynamics in this system are a function of both host and virus processes together with environmental factors. Given that the transmission of ranaviruses largely occurs within aquatic habitats, we focus on disease dynamics within the larval population of amphibian hosts. The likelihood of exposure to ranaviruses is influenced by multiple factors including virus persistence outside of hosts. Many amphibians use pond habitats as breeding sites. These sites are characterized by variation in hydroperiod (i.e. proportion of days with water). Importantly, amphibian species differ in their preference for permanent versus ephemeral water bodies (e.g. wood frogs (Rana sylvatica) breed in temporary ponds while American bullfrogs (Rana catesbeiana) breed in permanent ponds). Although contaminated water and sediment are effective media for virus transmission within natural ponds, the virus is inactivated following pond drying [71]. Thus, species that breed in temporary ponds that dry each year may be exposed to ranaviruses less frequently, because viability of the virus among seasons outside the host is unlikely [72]. Without frequent exposure to the virus, the selective pressure on such species may not be strong enough to favour the evolution of resistance [25].

CONCLUSION:

An amphibian is determined by the complex interaction between environmental factors, pathogen characteristics and host traits and responses. Many amphibian population declines and extinctions have been associated with Bd and experimental studies have confirmed that Bd in the absence of other factors can negatively affect growth and survival in some amphibians [21].

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