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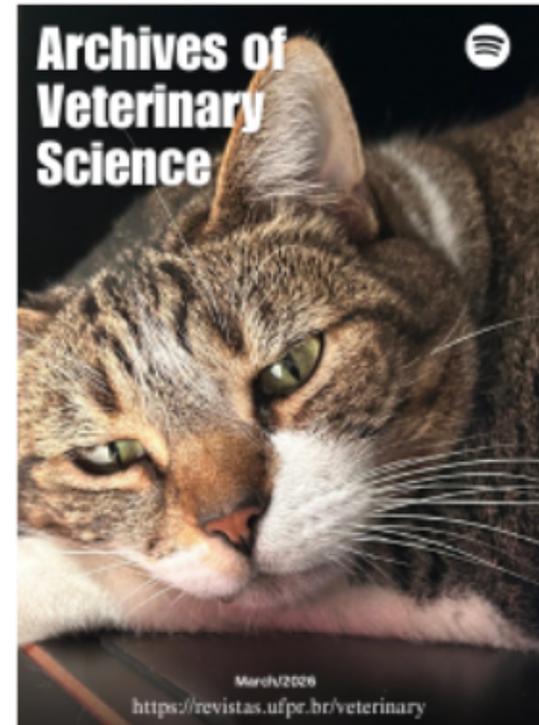
### Emerging Fungal Pathogens in Wildlife: a systematic review of Veterinary Implications and One Health Challenges

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## Emerging Fungal Pathogens in Wildlife: a systematic review of Veterinary Implications and One Health Challenges

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**Abstract:** Emerging fungal pathogens represent an increasing threat to global biodiversity, animal health, and public health, particularly in wildlife populations, where outbreaks may result in ecological, veterinary, and zoonotic consequences. This systematic review aims to identify the main emerging fungal pathogens affecting wildlife and to evaluate the available evidence regarding their veterinary, environmental, and human health implications within a One Health framework. A comprehensive literature search was conducted across PubMed, Scopus, Web of Science, and CAB Abstracts for studies published between 2000 and 2025, using predefined keywords related to emerging fungal pathogens, wildlife mycoses, zoonotic fungi, and One Health. A total of 147 records were identified. After duplicate removal and relevance screening, 72 articles underwent full-text evaluation, and 48 studies met the eligibility criteria and were included in the qualitative synthesis. The most frequently reported pathogens included *Batrachochytrium dendrobatidis* and *Batrachochytrium salamandrivorans* in amphibians, *Pseudogymnoascus destructans* in bats, and *Paranannizziopsis* spp. in reptiles. Reports originated from North America, Europe, South America, Asia, and Oceania, affecting amphibians, bats, reptiles, birds, and small mammals. Diagnostic confirmation was commonly based on molecular assays and histopathology, given nonspecific clinical signs. From a One Health perspective, several wildlife-associated fungi show documented or potential relevance to human health, particularly among immunocompromised individuals and professionals with occupational exposure. Human cases, when reported, were diagnosed using culture, molecular methods, and histopathology. Environmental drivers such as climate change, habitat disturbance, and anthropogenic dissemination were consistently associated with pathogen emergence and spillover risk.

**Keywords:** emerging mycoses, wildlife health, One Health, veterinary diagnostics, fungal pathogens.

### 1. Introduction

Fungal pathogens have historically received less attention than bacterial or viral agents in both veterinary and public health contexts. However, in recent decades, the emergence and re-emergence of fungal diseases in wildlife populations have gained increasing recognition as significant threats to biodiversity, ecosystem stability, and animal health worldwide (FISHER *et al.*, 2020; FISHER *et al.*, 2022). These pathogens often cause high-mortality events, contribute to severe population declines, and, in some cases, drive species toward extinction. Unlike many bacterial or viral diseases, fungal pathogens frequently persist in the environment for extended periods, complicating eradication efforts and facilitating recurrent outbreaks (FISHER *et al.*, 2022).

Several high-impact fungal diseases illustrate the scale and complexity of this problem. The chytrid fungi *Batrachochytrium dendrobatidis* (Bd) and *B. salamandrivorans* have devastated amphibian populations globally, contributing to the decline of more than 500 species and the extinction of at least 90 since the 1970s (SCHEELE *et al.*, 2019; MARTEL *et al.*, 2013). Similarly, *Pseudogymnoascus destructans*, the causative agent of white-nose syndrome in bats, has killed millions of hibernating bats across North America, with cascading ecological consequences due to their role in insect population control (FRICK *et al.*, 2017). In reptiles, *Ophidiomyces ophiodiicola*, *Nannizziopsis* spp., and *Paranannizziopsis* spp. have emerged as significant causes of mycotic dermatitis, threatening both free-ranging and captive populations and raising concerns about cross-species transmission (SIGLER; HAMBLETON; PARE, 2013; LORCH *et al.*, 2016).

A complex interplay of ecological, climatic, and anthropogenic factors drives the emergence of fungal pathogens in wildlife. Climate change alters temperature and humidity patterns, creating new niches conducive to fungal proliferation (Garcia-Solache and Casadevall, 2010). Human activities, including global trade in wildlife and exotic pets, habitat fragmentation, and translocation of animals, further facilitate the spread of pathogenic fungi beyond their original geographic ranges (Fisher *et al.*, 2020). Moreover, shifts in host-pathogen dynamics caused by environmental stressors can compromise wildlife immune responses, increasing susceptibility to infections (Voyles *et al.*, 2018).

From a veterinary perspective, emerging fungal pathogens pose unique diagnostic and management challenges. Clinical manifestations in wildlife are often nonspecific or subclinical, complicating early detection and surveillance (UGOCHUKWU *et al.*, 2022). Accurate diagnosis typically requires histopathology, culture, and molecular tools such as PCR and sequencing, which may not be readily available in field settings (LORCH *et al.*, 2016). Furthermore, therapeutic options for free-ranging wildlife are limited, and antifungal resistance in some emerging pathogens poses significant challenges for effective disease control (FISHER *et al.*, 2022; WIEDERHOLD, 2023).

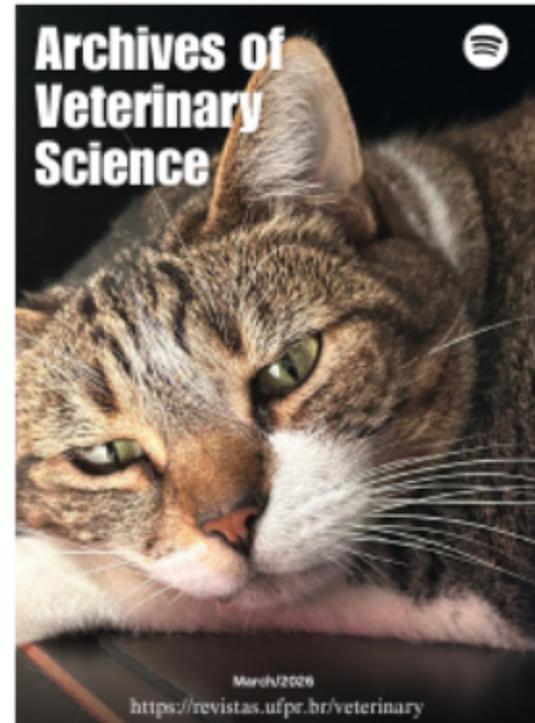
The One Health framework emphasizes the interconnectedness of human, animal, and environmental health. Many wildlife-associated fungi have zoonotic potential or can indirectly affect human health through ecological disruption. For example, declines in insectivorous bats caused by *P. destructans* can increase agricultural pest burdens, thereby impacting food security (Frick *et al.*, 2017). Similarly, disruptions in amphibian communities can alter aquatic ecosystems, with cascading consequences for biodiversity and ecosystem services (Scheele *et al.*, 2019).

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