Pseudogymnoascus destructans as the agent of white-nose syndrome (WNS) in bat populations

Andreia Garcês[1,2], Isabel Pires[3]

[1]Exotic and wildlife Service (CRAS) from Unvicersity of Tras-os-Montes and Alto Douro
[2]CITAB, University of Trás-os-Montes and Alto Douro, Vila Real, Portugal
[3]CECAV, University of Trás-os-Montes and Alto Douro, Vila Real, Portugal
*andreiamvg@gmail.com

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microorganisms MDPI

Introduction

Pseudogymnoascus destructans (formerly known as *Geomyces destructans*) is a psychrophilic fungus that is the etiologic agent of white-nose syndrome (WNS) in bats. A fatal fungal disease that has devastated bat populations in North Hemisphere, particularly in North America.

The first report of *P. destructans* (WNS) was in North America in a photograph of a hibernating bat taken in the winter of 2005-2006 in a hibernaculum near Albany, New York (USA). In New York, the specie affected was little brown bats (*Myotis lucifugus)* were the first to be infected and had the higher mortality, resulting in population declines of 90-100% in caves.

Distribution and dispersion

Figure 1. Distribution of *P. destructans.* (Yellow – Invasive, Green – Native).

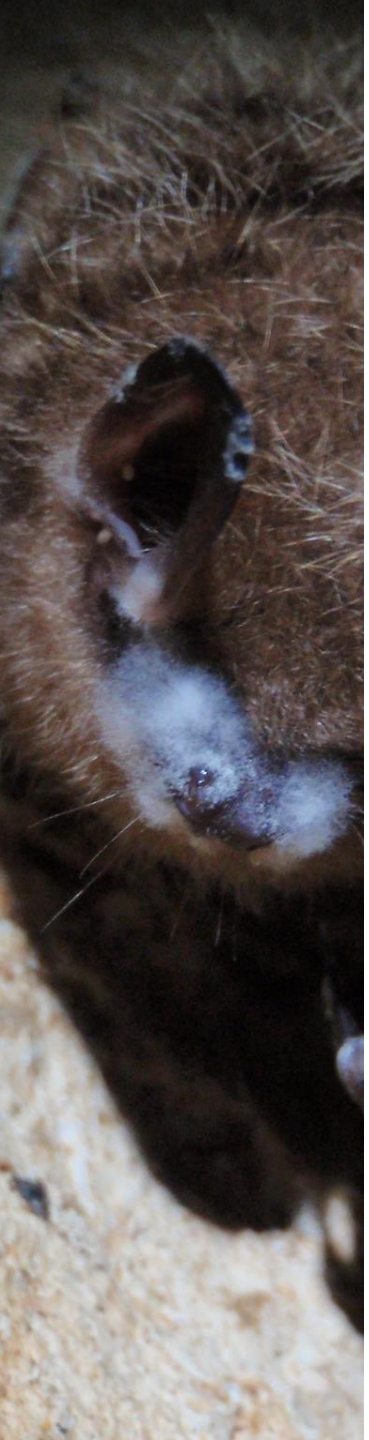
It is hypothesized that these fungi have been introduced to North America from Europe or Asia where are native. The route of introduction is still unknown, but the subsequent spread throughout North America probably occurred due to the natural movement of bats, contact with contaminated substrates and human clothing/equipment (particularly cave equipment) and host and vector organisms (pathway vector).

Affected species

North America: *Myotis sodalist, Myotis grisescens, Myotis lucifugus, Myotis septentrionalis, Eptesicus fuscus, Perimyotis subflavus, Myotis leibii, Corynorhinus townsendii virginianus, Myotis velifer, Lasionycteris noctivagans, Myotis austroriparius*.

Europe: *Myotis bechsteinii, Myotis blythii oxygnathus, Myotis dasycneme, Myotis daubentoniid, Myotis myotis, Myotis mystacinus, Myotis emarginatu, Eptesicus nilssonii, Rhinolophus hipposideros, Barbastella barbastellus, Plecotus auratus.*

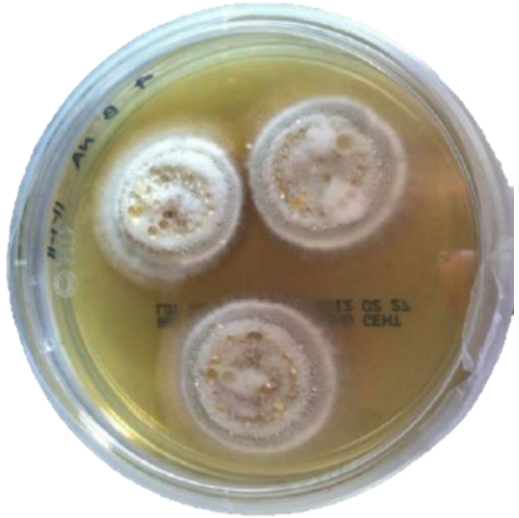
Asia: *Rhinolophus ferrumequinum, (Rhinolophus pusillus, Myotis adversus, Myotis macrodactylus, Myotis pilosus, Myotis chinensis, Murina usseriensis, Murina leucogaster, Myotis petax*.

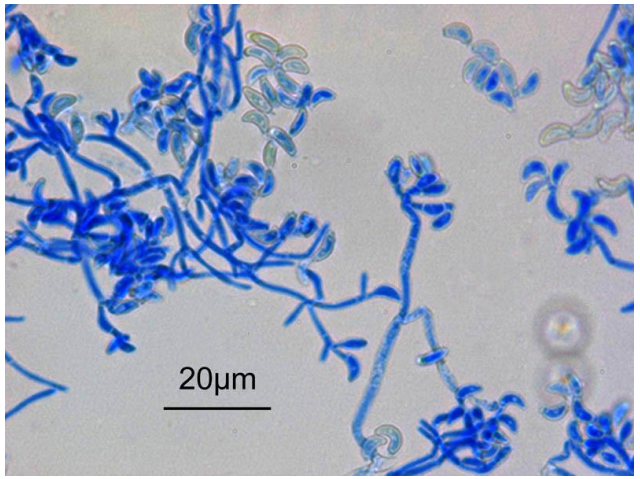


Pathogen Characteristics

It is psychrophilic fungi that grow at temperatures around 4 °C to 20 °C (*the* same temperatures that can be found *i*n winter bat hibernacula). It belongs to the genus *Pseudogymnoascus*, family *Pseudeurotiaceae*.

In laboratory is incubated at 5 to 15°C for 16 days. Colonies have a 1.0 mm diameter and are white marginally with grey to green powdery centres. The reverse side is uncoloured on cornmeal agar or brown in Sabouraud dextrose agar. Microscopically has moderately thick-walled, curved conidia and erect, hyaline, smooth, narrow and thin-walled conidiophores. Some virulence factors have also been identified in *P. destructans* that may contribute to skin invasion.





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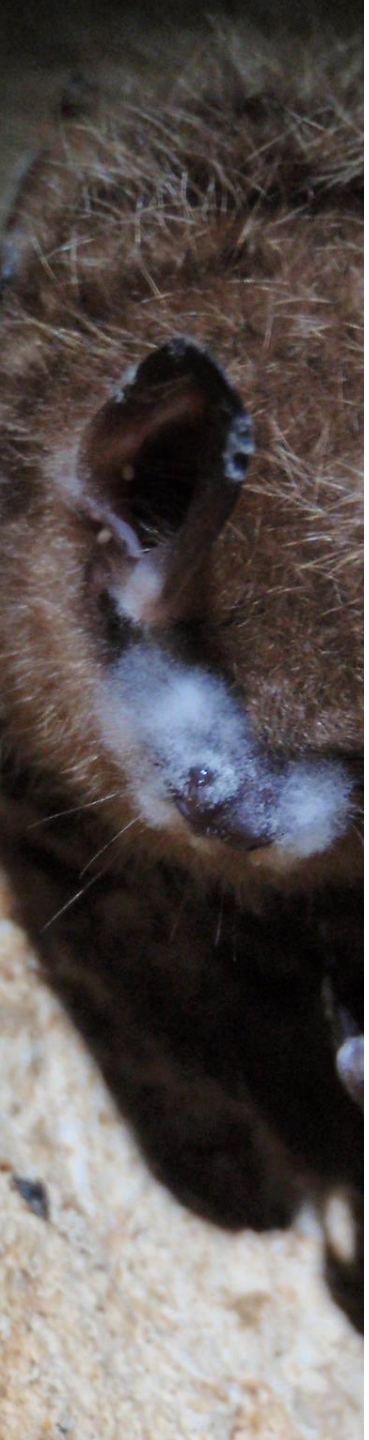

Clinical presentation

This fungi almost exclusively affects hibernating bats.

Gross clinical signals are fungal growth with 1 to 3 mm diameter, multifocal to coalescing white foci with a pinpoint black centre on the ears, ears, and wing membranes of hibernating bats. In the wings is also possible to observe areas of depigmentation, splitting, and dryness of the patagia. The animals infected also present behaviours alterations such as premature emergence from hibernation during the winter period.

Other systemic alterations that can be present are increasing evaporative water loss through the damaged skin, hypovolemia, hyperkalemia, acidosis, and hypotonic dehydration.

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Impacts of *Pseudogymnoascus destructans*

Social impacts

Some insectivorous bat species consume large quantities of mosquitoes each night, many carriers of many diseases that can affect humans. With the decline of bats there is a reduction in the elimination of these vectors and a higher risk for transmission of vector-borne diseases

Environmental impact

Populations that have been affected by *P. destructans* have a slow recovery due to already low annual fecundity (one juvenile a year) and other causes of mortality such as wind-turbine collisions. Some may never recover to the number before the infection. The alteration in bat populations can lead to alterations at the trophic level, damaged ecosystem services, negative impacts on agriculture, forestry, human and animal health and reduction of native biodiversity and threatened species.

Economic impacts

Insectivorous bats offer pest control services, by consuming insects that damage crops and forests, or vectors that carry diseases. Bat species also are important pollinators and dispersers of seeds in tropical and subtropical regions. These services save farmers millions of dollars every year. The mortality of bats due to these fungi is estimated to reduce these valuable and irreplaceable ecosystem services.

Conclusions

P. destructans has an enormous impact on the bat population, especially in North America, with so high levels of mortality that previously common bat species have become almost extinct.

There is limited understanding of both fungal pathogens and wildlife hosts, since fungal species, in general, are very poorly investigated compared to other taxa of pathogens. Antifungal medications existing are limited and those in use often have considerable side effects on the animals, and anti-fungal vaccines at still not available. There is also inadequate knowledge about the immunology, physiology, and ecology of *P. destructans* on the multiple species of bats infected. This has led to many challenges in the control and prevention of this disease.

Efforts to attend to this devastating disease have already been made, but in the future, more research and development of new drugs will be necessary to combat this disease.

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