



Call of the Wetland

CHYTRID FUNGUS AND ALBERTA AMPHIBIANS

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1910

WHAT IS CHYTRID FUNGUS?



Figure 1: *Batrachochytrium dendrobatidis*²

- Chytrid fungi are any fungi belonging to the phylum Chytridiomycota¹
- The parasitic fungus, *Batrachochytrium dendrobatidis* (*Bd*), is the only member of the phylum to affect vertebrates²

- This fungus causes chytridiomycosis² a disease associated with large declines in amphibian numbers³
- Chytridiomycosis exterminate entire infected populations²
- Some amphibians are carriers, meaning they do not develop the disease, but they can pass the fungus to other species⁴



Figure 2. Deceased frog with chytridiomycosis⁵

WHAT IS THE GLOBAL IMPACT?

- Almost a third of amphibian species are classified as threatened¹¹
 - 92.5% of this threat may be due to chytridiomycosis¹¹
 - *Bd* represents the largest current threat to amphibian biodiversity globally¹²
 - Acting as both predators and prey, amphibians are an important part of the food web in wetland ecosystems¹²
 - Amphibians are also important bio indicators of ecosystem health¹²
- Rapid infection rate means rare species or small populations could easily be exterminated¹²



Figure 5: Large scale amphibian die-off due to chytridiomycosis⁹

WHERE DID IT COME FROM?

- 1938: Earliest recorded finding of pathogenic *Bd* in a Sub-Saharan museum African Clawed frog (*Xenopus laevis*) specimen⁶
- 1961: First documented case of chytridiomycosis in North America⁶
- Trade: Amphibians have been traded globally as pets, food, and for use in laboratory experiments so it is difficult to identify the exact source of pathogenic *Bd*⁶
- *Bd* thrives in wet environments, spores can survive without a host for weeks in damp soil or water²
- *Bd* now found practically worldwide⁷

HOW DOES CHYTRIDIOMYCOSIS KILL AMPHIBIANS?

- Chytrid fungus burrows into amphibian skin⁸
- *Bd* also affects the amphibian's immune system, destroying leucocytes before they can attack the invader²
- High concentrations of *Bd* spores are associated with more severe disease, faster disease progress and increased death rate²

SYMPTOMS

- Red, peeling skin on abdomen, legs (desquamation)
- Loss of balance, unusual posture
- Sluggishness
- Decreased appetite
- Hyperkeratinization² of cells inhibiting electrolyte transfer, feeding, and growth



Figure 3. Frog with chytridiomycosis showing desquamation on legs²

ELECTROLYTE IMBALANCE

- Electrolytes are vital in maintaining electrical potential in cells, including electrical activity in the heart
- Amphibians exchange electrolytes through their skin
- Chytridiomycosis causes hyponatremia (low sodium) and hypokalemia (low potassium)⁹
- Some infected amphibians have electrolyte levels so low they are undetectable¹⁰
- Death results from cardiac arrest due to insufficient electrolytes⁹
- Herbicides, including Carbaryl and atrazine, are thought to disrupt the normal microorganisms on the skin and make the animal more susceptible to contracting chytridiomycosis²

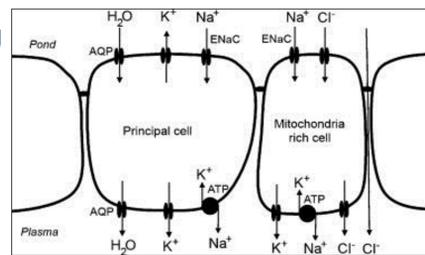


Figure 4: Electrolyte movement in cells²

TREATMENTS

- Probiotic supplements
- Daily antifungal baths for several weeks
- Treatment most easily offered to captive animals²
- Placing the animal in a warm environment, over 28°C
 - reduces reproduction rate of fungus enough for immune system to have effect²

References:

- ¹Rosenblum, E. B., Voyles, J., Poorten, T. J., & Stajich, J. E. The Deadly Chytrid Fungus: A Story of an Emerging Pathogen. *PLoS Pathog.* [Online] 2010. <http://www.plospathogens.org/article/citationList.action?articleURI=info%3Adoi%2F10.1371/journal.ppat.1000550> (accessed Jan 14, 2016).
- ²Mutschmann, F. Chytridiomycosis in amphibians. *Journal of Exotic Pet Medicine.* [Online] 2015. [http://www.exoticpetmedicine.com/article/S1557-5063\(2815\)290076-2/abstract](http://www.exoticpetmedicine.com/article/S1557-5063(2815)290076-2/abstract) (accessed Jan 16, 2016).
- ³Ouellet, M., Mikaelian, I., Pauli, B. D., Rodrigue, J., & Green, D. M. Historical Evidence of Widespread Chytrid Infection in North American Amphibian Populations. *Conservation Biology.* [Online] 2005. <http://www.jstor.org/stable/3591111> (accessed Jan 14, 2016).
- ⁴Kruger, K. Chytrid Fungus. <http://www.savethefrogs.com/threats/chytrid/> (accessed Jan 14, 2016).
- ⁵Figure 2: Brem, F. Chytridiomycosis [Photograph] 2008. from <https://commons.wikimedia.org/wiki/File:Chytridiomycosis.jpg?uselang=en-ca>
- ⁶Weldon, Che., du Preez, Louis H., Hyatt Alex D., Murrill, Reinhold and Speare, R. Origin of the amphibian chytrid fungus. [Online] 2014. http://www.wnc.cdc.gov/eid/article/10/12/03-0804_article (accessed Jan 16, 2016).
- ⁷Chytrid Fungus. Amphibian Ark. <http://www.amphibianark.org/the-crisis/chytrid-fungus/#> (accessed Jan 15, 2016).
- ⁸Chytrid Fungus. Save the Frogs. <http://www.savethefrogs.com/threats/chytrid/> (accessed Jan 14, 2016).
- ⁹Campbell, C.R., Voyles, J., Cook, D.L., & Dinudom, A. Frog skin epithelium: Electrolyte transport and chytridiomycosis. *International Journal of Biochemistry & Cell Biology.* [Online] 2012. <http://www.ncbi.nlm.nih.gov/pubmed/22182598> (accessed Jan 14, 2016).

ARE ALBERTA'S AMPHIBIANS AT RISK?

- *Bd* fungi has been documented in 44% of wetland sites tested in Alberta¹³
- No confirmed cases of chytridiomycosis or large-scale amphibian die-offs have been reported in Alberta – yet⁸
- However, *Bd* spores could spread by hikers, campers, hunters travelling between wetland areas
- We have time to act and stop the spread of *Bd* in Alberta's wetlands



Figure 6. An Alberta researcher samples a Canadian toad for chytrid fungus¹⁵

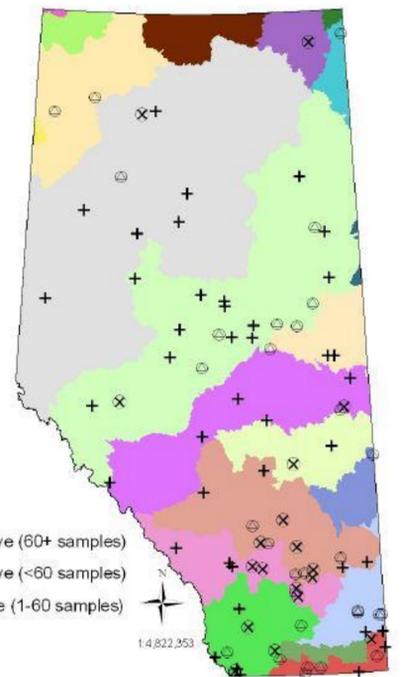


Figure 7. Map of *Bd* PCR test results in Alberta 2006-2010¹⁶

WHAT CAN WE DO?

Do	Don't
Wash boots with 10% bleach solution ² after visiting wetlands	Travel between wetlands without washing boots and equipment
Carefully dispose of waste water from pet amphibian aquariums	Dump water or pet amphibians (dead or alive) wetlands
Be careful about herbicide use, especially around wetlands	Trek unnecessarily through wetlands
Donate to amphibian habitat protection and chytridiomycosis research	Handle amphibians 
Get involved! Volunteer to monitor Calgary's amphibians with Call of the Wetland	

Call of the Wetland

- Volunteer to record amphibian calls you hear in Calgary parks and green spaces
- Documenting which species of amphibians live in Calgary, and where, is an important first step towards protecting these creatures from the risk of chytridiomycosis
- Download the free Call of the Wetland App

- ¹⁰Voyles, J., Vredenburg, V.T., Tunstall, T.S., Parker, J.M., Briggs, C.J., & Rosenblum, E.B. Pathophysiology in mountain yellow-legged frogs (*Rana muscosa*) during a chytridiomycosis outbreak. *PLoS ONE.* [Online] 2012. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0035374> (accessed Jan 16, 2016).
- ¹¹Kipatrik, A. M., Briggs C.J., Daszak P. The ecology and impact of chytridiomycosis: an emerging disease of amphibians. *Trends Ecol Evol.* [Online] 2010. <http://www.ncbi.nlm.nih.gov/pubmed/19836101>
- ¹²Why Frogs? Save the Frogs. <http://www.savethefrogs.com/why-frogs/> (accessed Feb 19, 2016).
- ¹³Stevens, S., Prescott, D., & Whiteside, D. Occurrence and Prevalence of Chytrid Fungus (*Batrachochytrium dendrobatidis*) in Amphibian Species of Alberta. Alberta Sustainable Resource Development. Fish and Wildlife Division, Alberta Species at Risk Report No. 143; Edmonton, AB, 2012.
- ¹⁴Pilliod, D. S., Muths, E., Scherer, R. D., Bartelt, P. E., Corn, P. S., Hossack, B. R., ... Gaughan, C. Effects of amphibian chytrid fungus on individual survival probability in wild boreal toads. *Conservation Biology: The Journal of the Society for Conservation Biology.* [Online] 2010. <http://www.ncbi.nlm.nih.gov/pubmed/20412086> (accessed Jan 14, 2016).
- ¹⁵Kendall, K. (n.d.). A researcher collects tissue samples from a Canadian toad (*Bufo hemiophys*) to test for chytrid fungus (*Batrachochytrium dendrobatidis*) (*Bd*) [Photograph]. Alberta Conservation Association.
- ¹⁶Stevens, S., Prescott, D., & Whiteside, D. Occurrence and Prevalence of Chytrid Fungus (*Batrachochytrium dendrobatidis*) in Amphibian Species of Alberta. Alberta Sustainable Resource Development. Fish and Wildlife Division, Alberta Species at Risk Report No. 143; Edmonton, AB, 2012.