

Pathogen Pollution:
A Deadly Global Threat to Amphibians

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Dwarf Green Tree Frog by Adam Rose


Overview

- I. Deadliest Threats to Amphibians
- II. Define Pathogen Pollution
- III. Spread of Pathogens
- IV. Impact of Pathogen Pollutions

Deadliest Threats to Amphibians

Initial Threats


- Overexploitation
- Direct Killing
- Habitat Loss
- Chemical Pollution
- Competition/Predation
- Introduction of Nonnative Species



A. Volozna

Recent Threats

- Climate Change
- **PATHOGEN POLLUTION**



A. Crawford

A.A. Cunningham et al. (2003)

What is Pathogen Pollution?

- “Pathogen pollution is the introduction of a pathogenic (or potentially pathogenic) parasite to a new (or naïve) host species or population.”
—A.A. Cunningham *et al.* (2003)
- “Pathogen pollution...refers to the process whereby pathogens are moved to new areas of the globe and then wreak havoc on unsuspecting hosts.”
—V.J. McKenzie *et al.* (2012)

What Makes Pathogens Deadly?

Global Spread

- Unintentionally or accidentally from:
 - Food Trade
 - Pet Trade
 - Scientific Research

A.A. Cunningham *et al.* (2003)



Other Reasons:

- Unpredictable
- Far-reaching
- Hybridization
- Stay in soil/water for years
- Many unnoticed/unrecorded

V.J. McKenzie *et al.* (2012)



Emerging Infectious Pathogens

Ranavirus

- Affects amphibians through indirect and direct contact and ingestion
- **Signs:**
 - Edema
 - Hemorrhage
 - Ulcerations
- Death probably by respiratory failure
- Ranavirus epidemic within common frog populations in Britain

A.A. Cunningham *et al.* (2003)

Chytridiomycosis

- Death by impaired function of the skin and muscle failure, leading to cardiac arrest
- **Signs:**
 - Thick skin
 - Lethargy
 - Abnormal posture with extension of hind legs
- Multiple die-offs in North America, Australia, Europe, Central America, South America, Asia, Africa, Caribbean, and New Zealand

D.B. Wake *et al.* (2008)

Global Presence of Ranavirus



Importation of American bullfrogs and goldfish have led to the introduction of ranavirus in the U.K., leading to common frog die-offs.

A. Duffus

A.A. Cunningham *et al.* (2003)

connected these strains.

Global Presence of Chytridiomycosis



Mass die-offs of the critically endangered yellow-legged frogs in California are due to chytrid fungus, introduced from nonnative frogs released in the area.

D.B. Wake *et al.* (2008)

North America, and Australia, and the pathogen is still spreading.

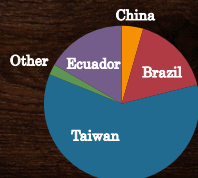
Global Spread Through Trade

- Global trade is primary driver of emergent pathogens, especially ranavirus.

- Hong Kong Pet Trade
 - 56.8% of live amphibians are positive for ranavirus
 - 11.7% tested positive for chytrid fungus

J.E. Kolby *et al.* (2014)

Country of Origin - Live Ranids (2000-2005)



L.M. Schloegel *et al.* (2009)

Impact of Pathogen Pollutions

**Add pathogen pollutions
into the diagram at any
point....**

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A.R. Blaustein et al. (2007)



References

- Blaustein, A.R. and B.A. Bancroft. 2007. Amphibian population declines: evolutionary considerations. *Bioscience* 57:437-444.
- Cunningham, A.A., P. Daszak, and J.P. Rodriguez. 2003. Pathogen pollution: defining a parasitological threat to biodiversity conservation. *Journal of Parasitology* 89:S78-S83.
- Fisher, M.P. and T.W. Garner. 2007. The relationship between the introduction of *Batrachochytrium dendrobatidis*, the international trade in amphibians and introduced amphibian species. *Fungal Biology Review* 21:2-9
- Kolby, J.E., K.M. Smith, L. Berger, W.B. Karesh, A. Preston, A.P. Pessier, and L.E. Skerratt. 2014. First evidence of amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) and ranavirus in Hong Kong amphibian trade. *PLOS ONE*.
- McKenzie, V.J. and A.C. Peterson. 2012. Pathogen pollution and the emergence of a deadly amphibian pathogen. *Molecular Ecology* 21:5151-5154.
- Schloegel, L.A., A.M. Pico, A.M. Kilpatrick, A.J. Davies, A.D. Hyatt, and P. Daszak. 2009. Magnitude of the U.S. trade in amphibians and presence of *Batrachochytrium dendrobatidis* and ranavirus infection in imported North American bullfrogs (*Rana catesbeiana*). *Biological Conservation* 142:1420-1426.
- Wake, D.B. and V.T. Vredenburg. 2008. Are we in the midst of the sixth mass extinction? A view from the world of amphibians. *Proceedings of the National Academy of Sciences of the United States of America* 105:11466-11473.