



Amphibian commerce and the threat of pathogen pollution

Angela Picco, PhD
United States Fish and Wildlife Service



Commercial trade in wildlife

- **Wildlife trade-associated risks**
 - Spread of non-native species
 - Disease spread (pathogen pollution)
- **Possible implications of wildlife trade**
 - Declines and extinctions
 - Disruption of historical relationships
- **1.48 billion live animals imported by US since 2000**
 - 92% for commercial purposes, mostly for pet trade (Smith et al., 2009)




Amphibian trade

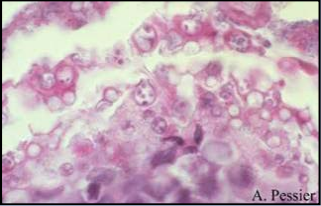


- Pet trade
- Food trade
- Research, biomedical, education
- Bait trade
- 5 million live amphibians per year imported into 3 main ports of entry in US from 2000 to 2005 (Schloegel et al., 2009)
>99% of these for commercial purposes

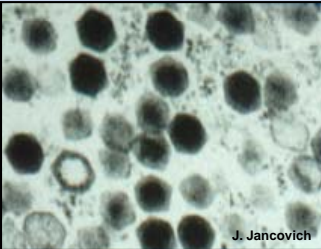


Amphibian pathogens

- **Bd (*Batrachochytrium dendrobatidis*)- amphibian chytrid fungus**
 - Only known to affect amphibians
 - Worldwide amphibian declines and extinctions
- **RV- Ranaviruses**
 - Affect amphibians, reptiles, and fish
 - Amphibian die-offs around the world in wild and commercial populations



A. Pessier



J. Jancovich

RV in amphibian pet trade

- Geng et al., 2010 (RV in farmed Chinese giant salamanders in China)
- More?



RV in amphibian food trade

- Geng et al., 2010 (RV in farmed Chinese giant salamanders in China)
- Schloegel et al., 2009 (RV in market bullfrogs from NY, LA, and SF)
- Mazzoni et al., 2009 (RV in bullfrog farms in Brazil)
- Miller et al., 2007 (RV in bullfrog farm in US)
- Galli et al., 2006 (RV in bullfrog farms in South America)
- Weng et al., 2002 (RV in cultured pig frogs in China)
- Zhang et al., 2001 (RV in cultured tiger frogs in China)
- Kanchanakhan, 1998 (RV in cultured tiger frogs in Thailand)



RV in amphibian research trade

- Miller et al., 2007 (RV in bullfrog farm in US)
- Jancovich et al., 2005 (RV in *Ambystoma mexicanum* from Ambystoma genetic stock center-formerly Indiana University Axolotl Colony)
- **More?**



RV in amphibian bait trade

- Picco and Collins, 2008 (RV in bait shop tiger salamanders in AZ, CO, NM)
- Jancovich et al., 2005 (RV in a tiger salamander from a bait shop in AZ)



RV in reptile trade

- RVs in soft-shelled turtle farms in China (Chen et al., 1999)
- RVs in python pet trade in Australia: Wamena virus (Hyatt et al., 2002)
- **More?**



What do we know?

- RV prevalent in all amphibian trade pathways.
- Multiple RV strains present in amphibian trade.
- Amphibians are released into the wild after being in trade.



What do we know?

- **Strains in trade may be more virulent than strains in wild.**



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- Hoverman et al., 2010 (hard to tell b/c diff time and passage history of isolates)
- Majji et al., 2006 (hard to tell b/c diff time and passage history of isolates)
- Storfer et al., 2007 (“putatively introduced” strain collected from wild, not trade)



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More research needed...



Discussion

OIE listing as internationally notifiable disease in 2008 (Schloegel et al., 2010)

Conservation actions?

- Recommendations in literature to prevent the spread of disease
- Some states are increasing regulation:
 - North Carolina**
 - No intro of Xenopus
 - No release of captives
 - No possession of >24 bullfrogs for import/possession unless permit
 - Missouri**
 - Tests for Bd
 - Bait amphibians illegal
 - California**
 - Bait amphibians illegal
 - Amphibian import permits halted, but then rescinded decision



Future research directions

- Are trade RVs more virulent than wild RVs?
- Are RV strains mixing in trade? Consequences?
- What is the likelihood that ranaviruses are transmitted from trade to amphibians in the wild?
- How is trade responsible for the spread of diseases into new areas?
- What effects do released pathogens have on native populations?
- How does pathogen pollution contribute to amphibian declines and extinctions around the world?
- What are the most effective approaches for curbing the spread of ranaviral disease into new areas?



Questions?

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USFWS Pacific Southwest Regional Office

L.M. Schloegel

J.P. Collins

Contact:

Angela_Picco@fws.gov

916.414.6490

