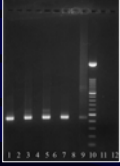

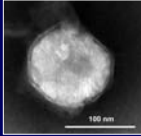




**Ranavirus:**  
What do we know about this emerging amphibian pathogen?

**Matthew J. Gray**  
Institute of Agriculture  
Center for Wildlife Health


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**Outline**

- I. EIDs and Amphibian Declines
- II. Ranavirus Characteristics & Possible Mechanisms for Emergence
- III. Tennessee Results
- IV. Possible Conservation Strategies

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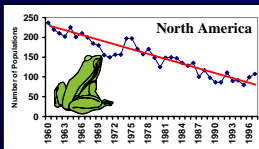
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**Amphibian Declines  
and Emerging Infectious Diseases**


Science  
306:1783-1786

EID 5:735-748




Nature  
404:752-755

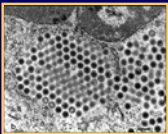
Biotropica  
37:163-165



Chytrid Fungus



Adults: >95%  
Larvae: 80-100% (Europe)



Ranaviruses

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## Ranavirus Characteristics


Docherty et al. (2003)



Granoff et al. (1965); Rafferty (1965)

- dsDNA, 150-280K bp
- 120-300 nm in diameter (3x smaller than bacteria)
- Icosahedral Shape (20)

Jancovich et al. (1997)



USA, UK, Canada, Australia

Family: Iridoviridae

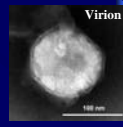
Genus: *Ranavirus* & Species: FV3

Europe, Central & South America

Phylogeny:

- Ambystoma tigrinum* virus (ATV)
- Leptodactylus* Venezuelan virus (Mat1)
- R. catesbeiana* virus Z (RCV-Z)
- Bohle iridovirus (BIV)
- Tadpole edema virus (TEV)
- Frog virus 3 (FV3)

Wang et al. (2003); Majji et al. (2006)



Virion

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## Ranavirus: Gross Signs

**Edema**



**Erythema and Dermal Ulcerations**





Signs can be Associated with Other Pathogens  
*Aeromonas hydrophila*

➡ Inanition, incoordination, emaciation

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## Ranavirus: Histopathological Signs

3 Primary Organs: Kidney, Liver and Spleen Chinchar (2002), Chinchar et al. (2003)

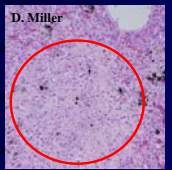
D. Miller (excreted)



50 μm

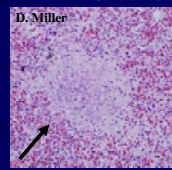
Kidney Degeneration

D. Miller



Liver Necrosis


D. Miller



Spleen Necrosis

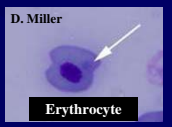
Viral Inclusions:

D. Miller



Liver

D. Miller



Erythrocyte

**Pathogenesis**

Target Organ Failure

Heart Failure

Toxicosis, Anemia

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## Routes of Transmission

Oral inoculation




Ingestion  
5 - 7 days






Necrophagy  
Cannibalism

Water Bath  
Contaminated  
Sediment



Time to signs: 1 - 2 weeks  
Time to mortality: 2 - 4 weeks

Gruha-Gray & Desser (1992)

**Invertebrates**  
(needs to be tested!)

Brunner et al. (2004), Pearman et al. (2004), Harp & Petranka (2006)

**Horizontal vs. Vertical:**

- Only Horizontal Transmission Demonstrated
- Duffus et al. (2008): Vertical Transmission Suspected

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## Reservoirs and Environmental Persistence

**Vertebrate Reservoirs:**

- (1) Amphibians
  - Intraspecific Reservoirs (Brunner et al. 2004)
  - Salamanders (Duffus et al. 2008)
  - Overwintering Tadpoles (Gray et al. 2007)
  - Xenopus laevis* (Robert et al. 2007)
- (2) Fish:
  - BIV & barramundi (Moody & Owens 1994)
  - SBV & TV2 viruses identical (Mao et al. 1999)
- (3) Turtles:
  - Eastern box turtle (Allender et al. 2006)

Jancovich et al. (2001)  
ATV did not infect tadpoles or fish

**Environmental Persistence:**

- ATV: 2 weeks @ 25 C water bath lost infectious capability.
- EHNV: •Distilled water = 97 days
- Dry surfaces = 113 - 200 days Langdon (1989)

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## Factors Contributing to Emergence

**Anthropogenic Stressors:** Forson & Storfer (2006); Gray et al. (2007)

1) Herbicide (Atrazine)  
Fertilizer (sodium nitrate)

Leukocytes

ATV Susceptibility ↑  
Inconclusive

2) Cattle Land Use: FV3 Prevalence → 150 head per ha per month

**Other Possible Stressors: Pesticides & Fertilizers, pH, UV-B, Thermal Pollution**

**Natural Stressors:**

- 1) Water Temperature
- 2) Development
- 3) Population Density

Other Possible: Predators, Pathogens

Genetic Diversity  
Pearman and Garner (2005)

No relationship detected

•Gray et al. (2007)  
•Harp & Petranka (2006)

Misnomer: *Ranavirus* only affects common species.  
No evidence that *Ranavirus* discriminates based on USFWS ESA protection status!

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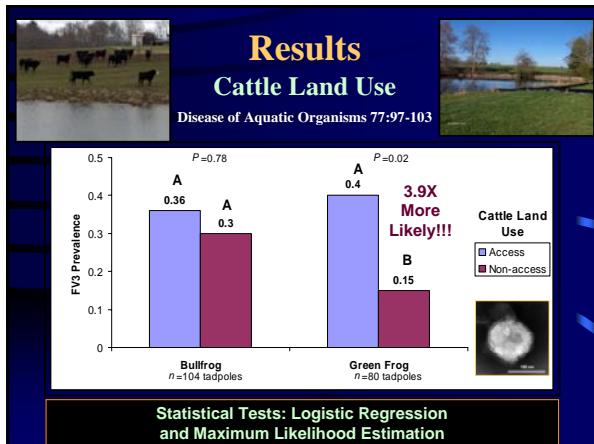
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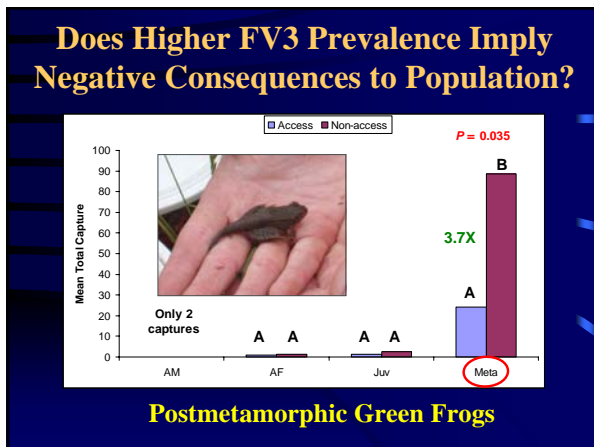
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