

# The Current Status of Ranavirus Die-Offs

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Material for this lecture predominantly comes from:

Duffus, A.L.J., Waltzek, T.B., Stöhr A.C., Allender, M.C., Gotesman, M., Whittington, R.J., Hick, P., Hines, M.K., and R.E. Marschang. 2015. Distribution and Host Range of Ranaviruses. In Gray, M.J. and V.G. Chinchir Eds, "Ranaviruses: Lethal Pathogens of Ectothermic Vertebrates"

[http://link.springer.com/chapter/10.1007/978-3-319-13755-1\\_2](http://link.springer.com/chapter/10.1007/978-3-319-13755-1_2)

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## Outline

- Distribution of Ranaviruses
- Ranaviruses in Amphibians
- Ranaviruses in Fishes
- Ranaviruses in Reptiles
- Global Ranavirus Reporting System

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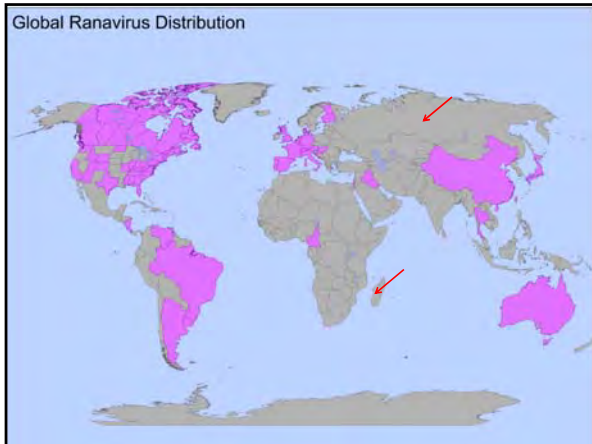
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### Ranaviruses

- Loose host specificity
  - Intertaxa transmission has been document
- ↑ in the number of RV – associated M&M events
- ↑ in the number of different RVs isolated

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### Ranaviruses in Amphibians

- Over 105 amphibian species (18 families) are currently known to be affected
- Numbers are increasing quickly!

Family	No. Species Affected
Alytidae	1
Ambystomatidae	8*
Bufoidea	8
Centrolenidae	1
Craugastoridae	3
Cryptobranchidae	2
Dendrobatidae	5
Hylidae	15
Hynobiidae	1
Leptodactylidae	2*
Megophryidae	1
Myobatrachidae	2
Pipidae	1
Plethodontidae	21
Ranidae	22*
Rhacophoridae	1
Salamandridae	8
Scaphiropodidae	1

Duffus et al. (2015)

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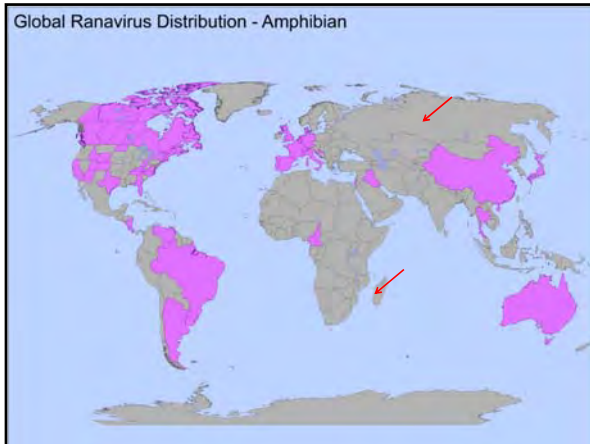
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### Ranaviruses in Amphibians

- First ranaviruses were isolated from *Rana pipiens* in the 1960s (Granoff et al. 1965 and Clark et al. 1968)
- *Frog virus 3 (FV3)* (Granoff et al. 1965)
  - Isolated from an *R. pipiens* with adenocarcinoma
  - Became the type species of the *Ranaviridae*

Bolete Iridovirus, Frog Virus 3, Ambystoma tigrinum virus

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### Ranaviruses in Amphibians

- Few reports of ranaviral disease in amphibians until the early 1990s
  - *Bohle Iridovirus (BIV)*
    - Australia - Spear and Smith 1992
  - *Ambystoma tigrinum virus (ATV)*
    - Southwestern USA – Jancovich et al. (1997)
  - *Frog virus 3 (FV3)* and FV3-like viruses
    - Ontario, Canada – Greer et al. (2005)
    - UK – Cunningham et al. (1996)

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### Ranaviruses in Amphibians

- Over 90% of RV reports in amphibians have occurred after 2010
  - Greater awareness and surveillance?




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### Ranaviruses in Amphibians

- There are three recognized species of *Ranavirus* that affect amphibians
  - ATV
  - BIV
  - FV3
- However, there unclassified ranaviruses that also affect amphibians
  - CMTV, ADV, TFV, RGV...

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### Ranaviruses in Amphibians

#### FV3 and FV3-like Viruses

- Africa
  - Cameroon – Lake Oku - Docherty – Bone et al. (2013)
    - » Lake Oku clawed frog (*Xenopus longipes*) – Critically Endangered
  - Madagascar – Kolby et al (2015)
    - » E.g. *Mantidactylus mocquardi*
    - » Low sample sizes per site




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## Ranaviruses in Amphibians

### FV3 and FV3-like Viruses

- Asia
  - China
    - Heilongjian Province – Xu et al. (2010)
      - *Rana dybowskii*
      - 5.7% of adults and 42.5% of tadpoles surveyed were infected



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## Ranaviruses in Amphibians

### FV3 and FV3-like Viruses

- Asia
  - Japan
    - Mass mortalities in *Rana catesbiana* tadpoles and native species



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## Ranaviruses in Amphibians

### FV3 and FV3-like Viruses

- Europe
  - Denmark – Ariel et al. (2009)
    - *Pelophylax esculentus* – Edible Frog
    - ≈ 1200 dead adults
    - Many species of amphibians present, but only the edible frogs were affected



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## Ranaviruses in Amphibians

### FV3 and FV3-like Viruses

– Europe

• UK

- Began to emerge in the late 1980s in *Rana temporaria*
- Identified as a ranavirus in the early 1990s
- Quickly spread to *Bufo bufo*
- Emergence associated with an 80% decline in some *R. temporaria* populations
- Very interesting in *R. temporaria*
  - » 2 distinct disease syndromes that are not mutually exclusive

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## Ulcerative Form

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## Ulcerative – Hemorrhagic Form



From:  
Duffus and  
Cunningham  
(2010)

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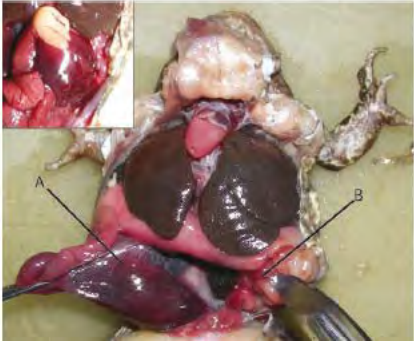
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### Hemorrhagic Form



From:  
Duffus and  
Cunningham  
(2010)

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### Ranaviruses in Amphibians

FV3 and FV3-like Viruses

- Europe
  - UK
    - Further mortalities - adult *Alytes obstetricans*



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### Ranaviruses in Amphibians

FV3 and FV3-like Viruses

- Europe
  - UK
    - Asymptomatic infections in *Lissotriton vulgaris*



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## Ranaviruses in Amphibians

### FV3 and FV3-like Viruses

#### – North America

- Canada
  - Ontario – Oliver Pond 1999
  - *Rana sylvatica*
  - Continuing tadpole infections until 2005



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## Ranaviruses in Amphibians

### FV3 and FV3-like Viruses

#### – North America

- USA
  - Found predominantly in the eastern states
  - Found in both captive and natural populations
  - Found in many different species of anurans and urodeles



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## Ranaviruses in Amphibians

### FV3 and FV3-like Viruses

#### – North America



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### Ranaviruses in Amphibians

#### FV3 and FV3-like Viruses

– South and Central America

- Brazil – Mazzone et al.
  - Mass mortalities in captive *Rana catesbeiana* tadpoles
- Chile – Fox et al. (2006)
  - Patagonian frogs – 1 infected individual
- Costa Rica – Whitfield et al. (2013)
  - 8 species infected
- Nicaragua – Stark et al. (2014)
  - 2 species infected




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### Ranaviruses in Amphibians

#### ATV

- Only known in the North America
- Found predominantly in the west
- First identified by Jancovich et al. (1997) in larval Sonoran tiger salamanders
  - Similar virus found near Regina Saskatchewan




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### Ranaviruses in Amphibians

#### BIV

– Australia

- Described in the early 1990s – Speare and Smith (1992)
- Captive recently metamorphosed *Limnodynastes ornatus* that experienced mortality




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## Ranaviruses in Amphibians

### BIV

- USA - Cheng et al. (2014)
  - Iowa Zoological Facility
  - Isolated from *Anaxyrus boreas boreas* that had experienced mass mortality
  - Toads were cohoused with wild caught specimens from Asia (these did not experience mortality)




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## Ranaviruses in Amphibians

### Other Amphibian Ranaviruses

#### CMTV

- Spanish Pyrenees
  - Emergence associated with declines in several species
- Found throughout continental Europe
- Evolutionarily distinct from other ranaviruses
  - Species designation?




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## Ranaviruses in Amphibians

### Other Amphibian Ranaviruses

#### - *Andrias davidianus* Virus

- Isolated from captive *Andrias davidianus*
- High morbidity and mortality
- Closely related to CMTV (Chen et al. 2013)
- Conservation threat




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## Ranaviruses in Amphibians

### Other Amphibian Ranaviruses

- *Rana grylio* virus (RGV)
  - Isolated in the mid-1990s in China
  - Closely related to FV3
- Tiger frog virus (TFV)
  - Isolated from a morbidity and mortality event at an amphibian culture facility




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## Ranaviruses in Fish

- At least 43 species (22 Families) are currently known to be affected

Family	Number of Species
Acipenseridae	3
Anguillidae	1
Centrarchidae	10
Channidae	1
Cobitoidea	1
Cyprinidae	2
Eleotridae	1
Esocidae	2
Gadidae	1
Gasterosteidae	1
Actinuridae	3
Labridae	1
Labridae	1
Lutjanidae	1
Moronidae	3
Percidae	2
Poeciliidae	1
Salmonidae	1
Sciaenidae	1
Scophthalmidae	1
Serranidae	4
Siluridae	1

Duffus et al. (2015)

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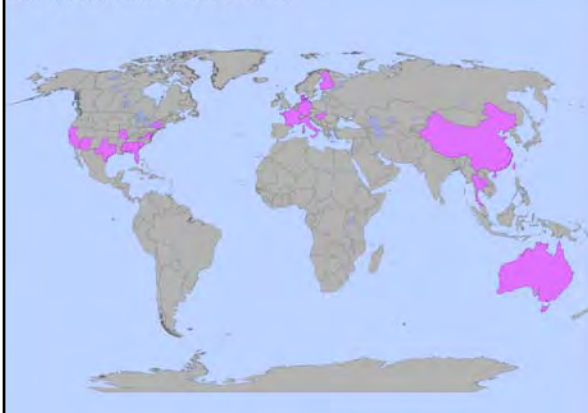
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Global Ranavirus Distribution - Fish




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### Ranaviruses in Fish

- There are several different ranaviruses that affect fish:
  - *Epizootic Haematopoietic Necrosis Virus (EHNV)*
  - *European Catfish Virus*
  - *Santee-Cooper Ranavirus*
  - FV3
  - BIV
  - Taxonomically Unassigned Ranaviruses

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### Ranaviruses in Fish

- ENHV
  - The first ranavirus ever to be associated with infection and mass mortality in any vertebrate
  - The causative agent of a mass mortality in redfin perch and rainbow trout in Australia in 1985
  - Affects animals in the wild and in aquaculture facilities in SE Australia
    - Thought to have spread from aquaculture to the wild



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### Ranaviruses in Fish

- *European Catfish Virus*
  - Most important *Ranavirus* in European fish
  - Found in farmed populations of sheatfish, brown bullheads and wild and farmed black bullheads
  - Has a significant effect on production of these animals
  - Host range and distribution is poorly known

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### Ranaviruses in Fish

- *Santee-Cooper Ranavirus*
  - Isolated from LMB from the Santee-Cooper Reservoir in South Carolina, USA
  - Has strains that are present in Asia
  - Many wild epizootics in North American LMB
    - Also affects other fish species that may be asymptomatic
  - Thought that the spread around the globe has been facilitated by the unrestricted trade in fish

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### Ranaviruses in Fish

- FV3
  - Only one wild case in fish in NA
  - But a few cases have been reported in cultured fish around the globe
  - Has impeded the restocking effects of the critically endangered pallid sturgeon by causing high mortality in farmed fish



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### Ranaviruses in Fish

- BIV
  - Very similar to EHVN
  - Only one M&M event in fish
    - Hatchery-reared tilapia fry in Australia



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### Ranaviruses in Fish

- Taxonomically Unassigned Ranaviruses
  - SGIV and GIV
    - Affect the production of grouper in SE Asia, but have also been isolated from non-grouper cultured species in Taiwan
    - Host range appears to be expanding (even into freshwater fish!)



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### Ranaviruses in Fish

- Taxonomically Unassigned Ranaviruses
  - Cod Ranavirus
    - Isolated from wild Danish Atlantic Cod
  - Short-finned Eel Ranavirus
    - From NZ
  - Pike-perch Iridovirus
    - From Finnish Fingerlings
  - Ranavirus maxima
    - Isolated from turbot fry from Denmark

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### Ranaviruses in Reptiles

- At least 30 species (12 Families) are currently known to be affected

Family	Number of Species Affected
Agamidae	2
Anguillidae	1
Boiidae	1*
Dactyloidae	2
Emyridae	6
Gekkonidae	1
Iguanidae	1
Lacertidae	2
Pythonidae	4
Testudinidae	9
Trionychidae	1
Varanidae	1

Duffus et al. (2015)

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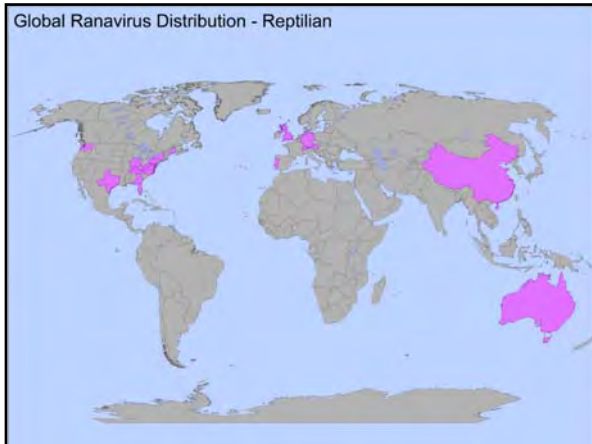
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### Ranaviruses in Reptiles

- FV3-like
- CMTV-like
- STIV

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### Ranaviruses in Reptiles

FV3-like

- Most RV infections that have been described in reptiles have been FV3-like
- Occur in both captive and wild animals
- The first case of a reptile infected with an RV were two chelonians from NA

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### Ranaviruses in Reptiles

#### FV3-like

- Adult chelonians have more commonly been reported to have FV3-like infections
  - However, in Eastern box turtles, juveniles are actually more likely to be RV positive
  - This suggests that similar to amphibians and fish, chelonians vary in their susceptibility to RV infections



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### Ranaviruses in Reptiles

#### FV3-like

- Squamates are also susceptible to FV3-like infections
  - The first reported RV infections in this group were juvenile green tree pythons
  - FV3-like viruses have also been reported in and isolated from these animals in European wild and captive populations

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### Ranaviruses in Reptiles

#### CMTV – like

- In Germany, 7 juvenile Hermann's tortoises that died had CMTV-like infections
- All showed similar signs of disease



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## Ranaviruses in Reptiles

- STIV
  - Soft-shelled turtle iridovirus
  - Taxonomically unassigned
  - From a mass mortality event of farmed Chinese soft-shelled turtles
  - Turtles were exhibiting 'red-neck' disease
  - Sequence is similar to FV3



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**GLOBAL RANAVIRUS**  
Reporting System

The Global Ranavirus Reporting System allows you to create and manage records for Ranavirus studies and reports, import and export data, view tables and maps of reports, and leave reviews and comments on reports.

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## Global Ranavirus Reporting System

<https://www.youtube.com/watch?v=nTRaWECVfMM&feature=youtu.be>

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## Global Ranavirus Reporting System

<https://mantle.io/grrs>

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## Resources

- Global Ranavirus Consortium  
[www.ranavirus.org](http://www.ranavirus.org)
- Southeastern Partners in Amphibian and Reptile Conservation (SEPARC)  
– Disease Task Team Information Sheets  
[www.separc.org](http://www.separc.org)
- OIE  
[www.oie.int](http://www.oie.int)

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## Special Thanks Go Out To:

Dr. Rachel Marschang	Dr. Matt Gray
Dr. Natalie Steckler	Dr. Greg Chinchar
Dr. Tom Waltzek	Dr. Jesse Brunner
Dr. Anke Stöhr	Dr. John George
Dr. Richard Whittington	Mr. Robbie George
Dr. Paul Hick	
Dr. Matt Allender	

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