Ranaviruses

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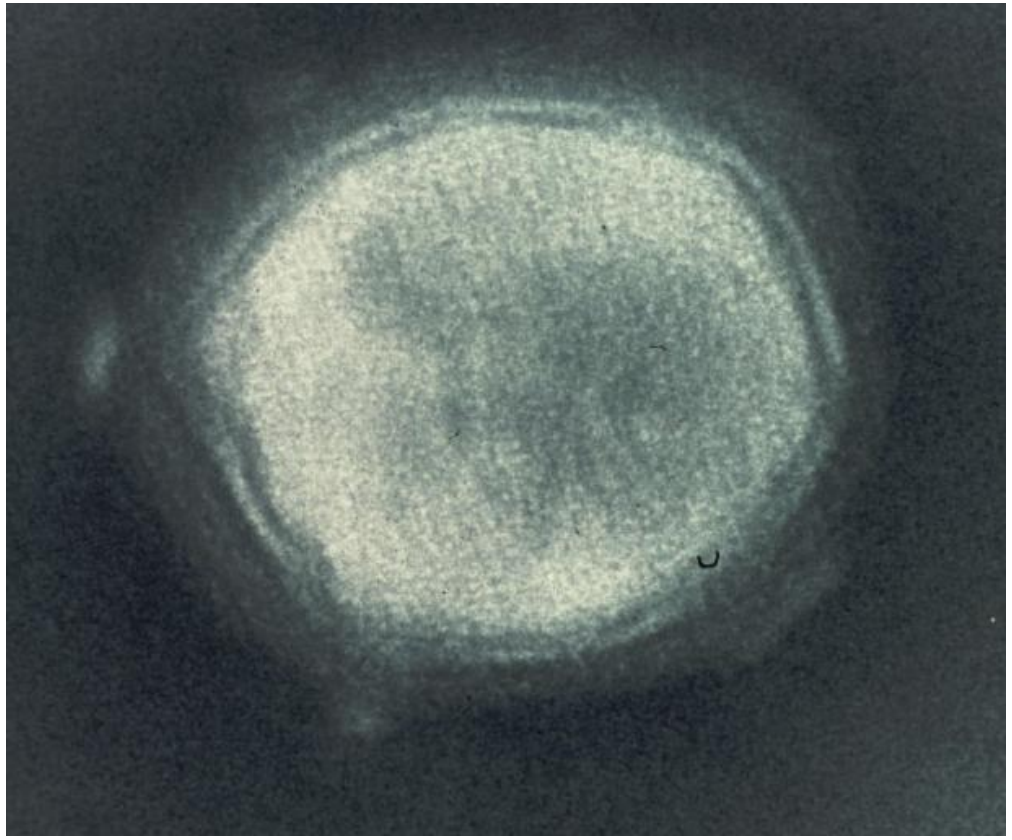
Ranaviruses

- *Iridoviridae*
  - Large
  - dsDNA
  - Icosehedral symmetry
  - Contain a lipid membrane



Family *Iridoviridae*

- Genera:
  - *Ranavirus*
  - *Megalocytivirus*
  - *Lymphocystivirus*
  - *Iridovirus*
  - *Chloriridovirus*

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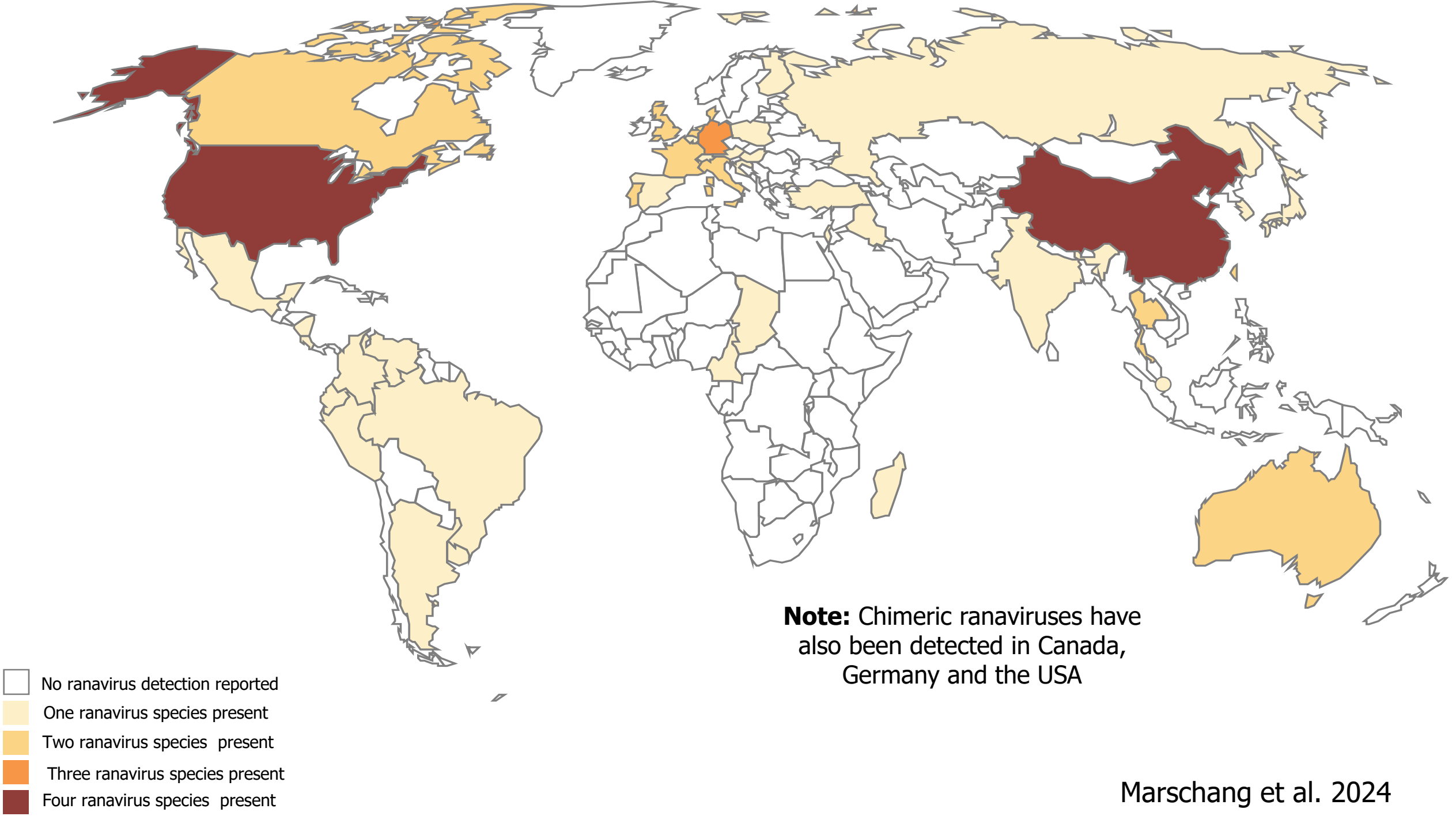
Ranavirus species: New taxonomy

Species Name	Old Designation
Ranavirus alytes1	*Common midwife toad virus* (CMTV)
Ranavirus ambystoma1	*Ambystoma tigrinum virus* (ATV)
Ranavirus epinephelus1	*Singapore grouper iridovirus* (SGIV)
Ranavirus gadus1	*European North Atlantic ranavirus* (ENARV)
Ranavirus micropterus1	*Santee-Cooper ranavirus* (SCRV)
Ranavirus perca1	*Epizootic haematopoietic necrosis virus* (EHNV)
Ranavirus rana1	*Frog virus 3* (FV3)

Adapted from the ICTV proposal by Agah et al. 2023

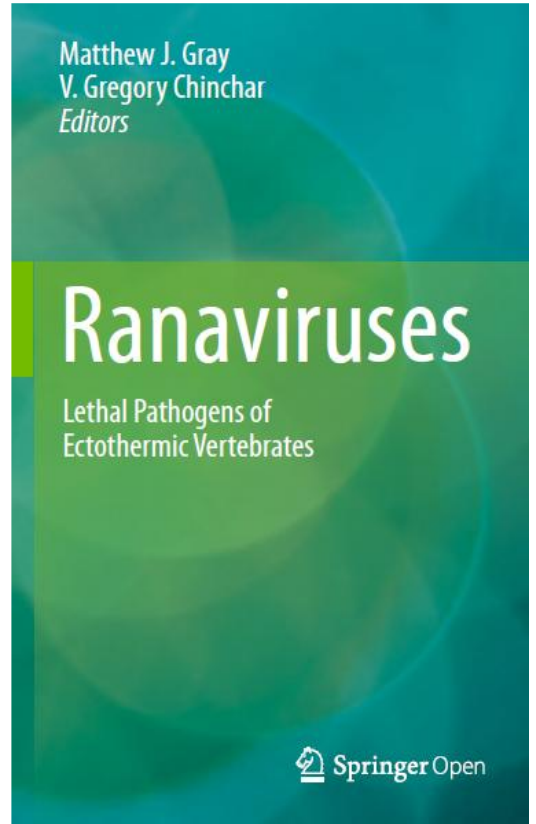
Global ranavirus distribution

Marschang et al. 2024


No ranavirus detection reported
One ranavirus species present
Two ranavirus species present
Three ranavirus species present
Four ranavirus species present
Note: Chimeric ranaviruses have also been detected in Canada, Germany and the USA
Marschang et al. 2024

Ranaviruses

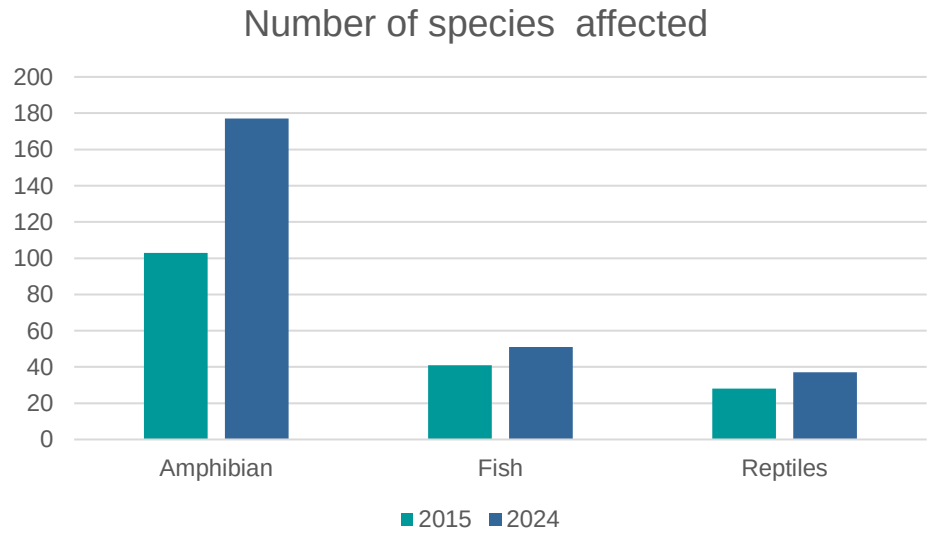
- These have been increasingly shown to be important pathogens of ectothermic vertebrates
  - –Amphibians
  - –Fish
  - –Reptiles



Ranaviruses: Host Range

- Confirmed in at least:
  - 177 amphibian species (25 families)
  - 51 fish species (25 families)
  - 37 reptile species (17 families)

Marschang et al. 2024



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Ranavirus species in Amphibians

- *Ranavirus rana1* - Frog virus 3 (FV3)
  - Globally distributed
- *Ranavirus alytes1* - Common midwife toad virus (CMTV)
  - Europe, Asia, and North America (in chimeric viruses)
- *Ranavirus ambystoma1* - Ambystoma tigrinum virus (ATV)
  - North America

Table 1 Examples of field (clinical) signs and gross changes that can be observed in individuals with ranaviral disease

Class	Lesion
Amphibian larvae	Loss of buoyancy; erratic swimming; anorexia; swelling (edema) of the body, head, legs, and internal soft tissues; external hemorrhages (especially around the vent, periocular, gular region, legs); occasional internal hemorrhages (especially pronephros, liver, spleen)
Anuran adults	Lethargy; anorexia; loss of buoyancy and erratic swimming (aquatic species); swelling (edema) of legs, feet, body, and internal soft tissues; skin ulcers; dermal, oral, and internal hemorrhages (ecchymotic, petechial); friable (necrotic) organs
Caudate adults	Lethargy; anorexia; loss of buoyancy and erratic swimming (aquatic species); hemorrhages (especially on tail and plantar surfaces of feet); swelling (edema); skin ulcers; internal hemorrhages (ecchymotic, petechial); friable (necrotic) organs; necrosis of extremities (Chinese Giant Salamanders)

NOTE: Ranavirus infections in amphbians are notifiable to WOAH!

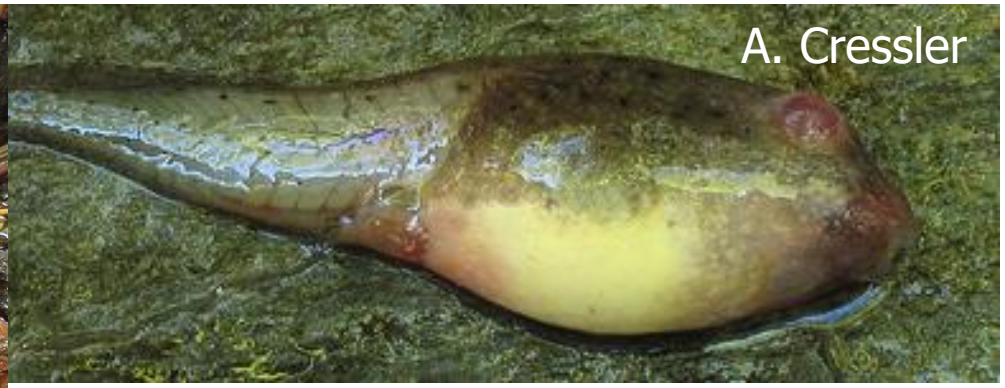
Miller et al. 2015, 2024

Iridovirus infection, *Rana dalmatina* (Croatia)

Source: Dr. F. Mutschmann

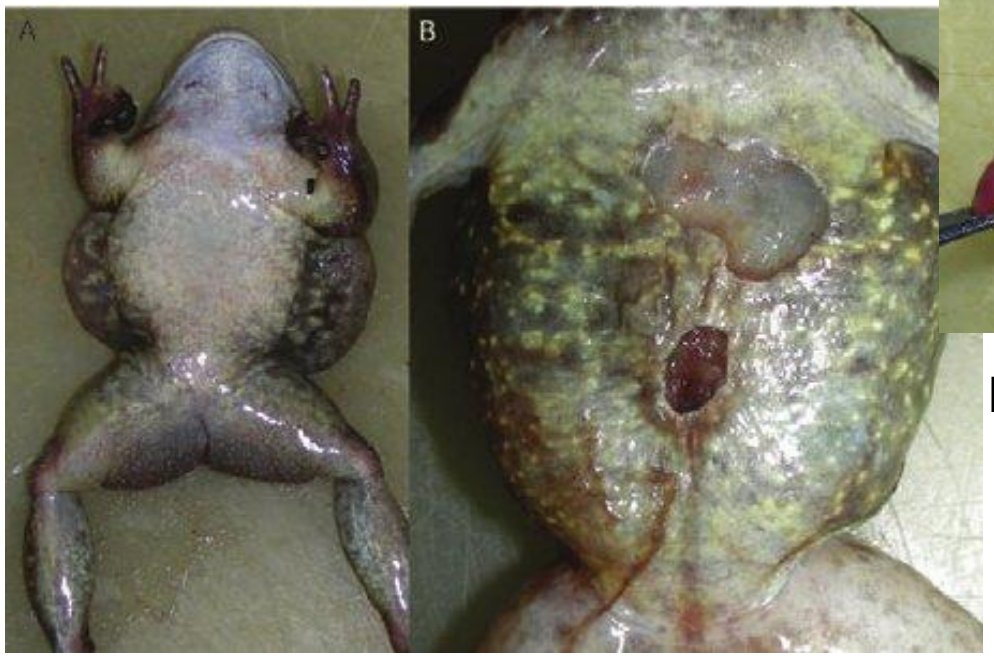
Lithobates sylvaticus – Ontario, Canada

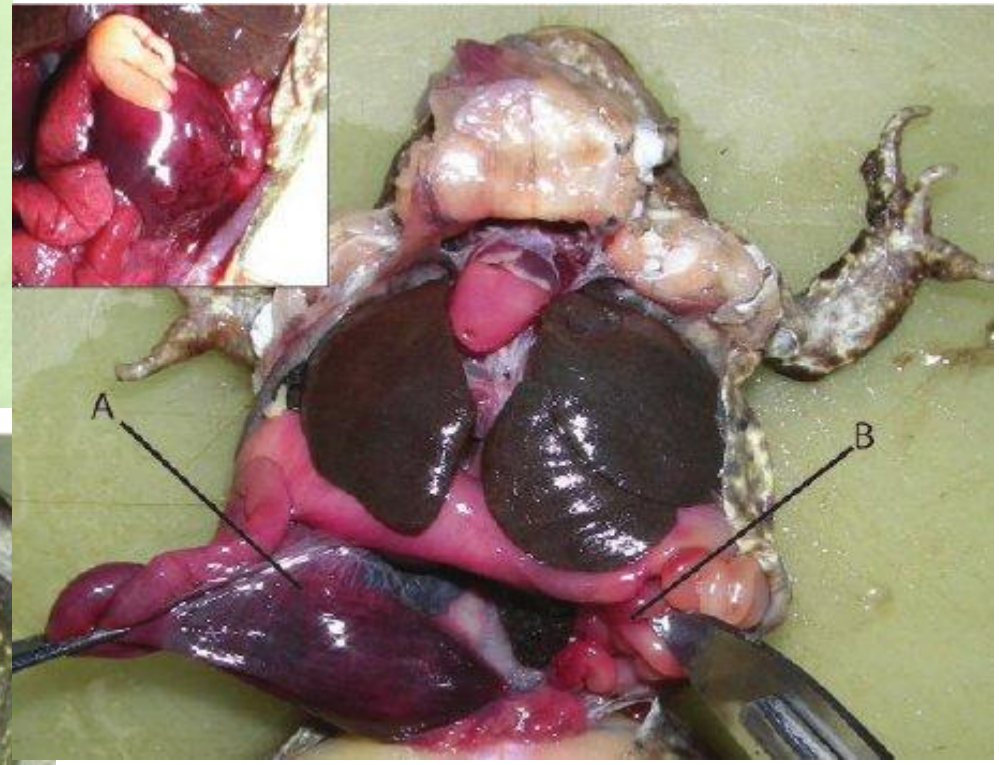
Ambystomatid larvae - USA



Lithobates catesbieanus - USA

Garden Wildlife Health, ZSL





Duffus and Cunningham 2010

Rana temporaria, UK

Distribution of amphibian ranaviruses

Marschang et al. 2024

Ranaviruses in Fish

- There are currently 4 species of ranaviruses that are recognized to occur only in fish:
  - *Ranavirus perca1* - EHNV – occurs in Australia and Europe
  - *Ranavirus micropterus1* - SCRV – Initially detected in NA fish, now emerging in Asia
  - *Ranavirus gadus1* - ENARV – occurs in European marine fish
  - *Ranavirus epinephelus1* - SGIV – Primarily occurs in Asian groupers

Ranaviruses in Reptiles

- Chelonians
- Squamates:
  - Lizards
  - Snakes

Ranaviruses in reptiles

- In the 1980‘s in Switzerland (Heldstab and Bestetti, 1982; Müller et al., 1988)
- In Hermann‘s tortoises (*Testudo hermanni*)
- In Switzerland (1 x imported from Yugoslavia)
- Associated with mass die-off with stomatitis, necrosis in the liver and spleen
- Virus detected by EM

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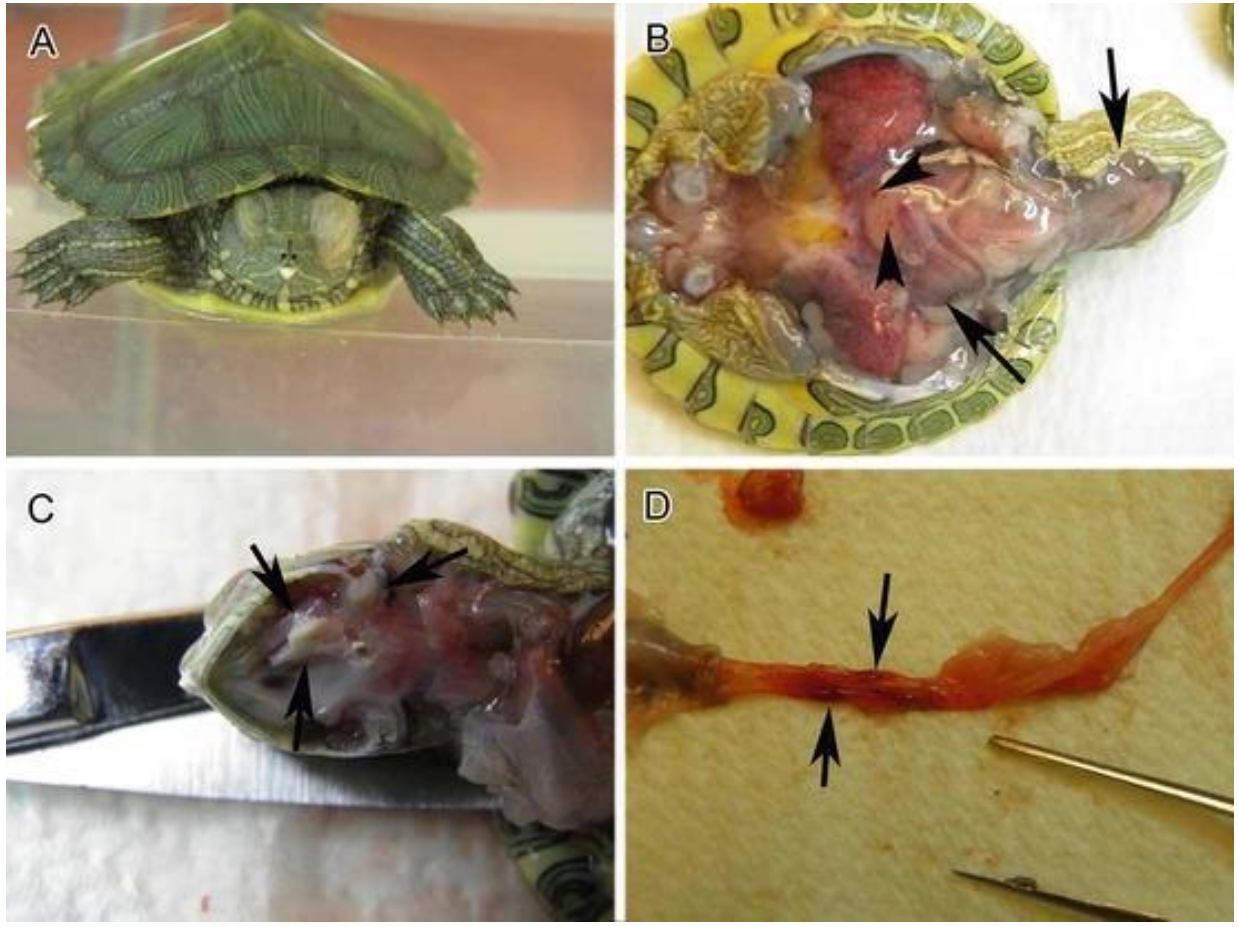
Ranaviruses in reptiles

- *Ranavirus rana1*, frog virus 3 (FV3)
  - Most often found in reptiles world-wide
  - Found in reptiles in Africa, Asia, Europe, North America, and Oceania



From: Miller et al., 2015. Comparative pathology of ranaviruses and diagnostic techniques. https://link.springer.com/chapter/10.1007/978-3-319-13755-1_7

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Ranaviruses in reptiles

- In North America:
  - Described in multiple chelonian species in the USA and Canada
    - Esp. box turtles (*Terrapene* spp.)
- In Asia:
  - „red neck disease“ in Chinese soft-shelled turtles (*Pelodiscus sinensis*) (Chen et al., 1999)

fishdb.sinica.edu.tw/chi/importpic.php?id=ZA79

Ranaviruses in reptiles

- In Europe:
  - Found in wild and/or captive reptiles in Austria, Germany, Portugal, the UK
  - Most often in chelonians
    - Mostly *Testudo* spp., but others as well
  - Also found in various squamate species
    - Lizards and snakes
    - mostly recent imports

Ranaviruses in reptiles

- In Australia:
  - Found in wild and/or captive squamates
  - First report from green tree pythons (*Morelia viridis*) imported from Papua New Guinea (Hyatt et al., 2002)
    - Ulceration of the nasal mucosa, necrotizing pharyngitis, hepatic necrosis
  - Serological evidence for prior infection also found in chelonians and crocodilians (Ariel et al., 2017)

Ranaviruses in reptiles

- *Ranavirus alytes1*, CMTV:
  - Found in chelonians and a snake in Europe
    - Poland, Spain, Switzerland
- *Ranavirus perca1*, EHNV:
  - Single report in a green iguana (*Iguana iguana*) in Germany
- Chimeric viruses (FV3/CMTV) found in chelonians and a lizard in Germany (Stöhr et al., 2013)

©Jakob Fahr, iNaturalist, *Natrix maura*

Ranaviruses in reptiles

- Clinical signs:
  - Koch‘s postulates have been fulfilled in several transmission studies in chelonians and squamate reptiles (Ariel, 1997; Johnson et al., 2007; Ariel et al., 2015; Maclaine et al., 2018, 2019)

Ranaviruses in reptiles

- Chelonians:
  - Nasal and ocular discharge
  - Oral lesions
  - Conjunctivitis and hyphemia
  - Blepharitis
  - Edema
  - Bleeding
  - Lethargy
  - Histology:
    - Vasculitis
    - Liver necrosis

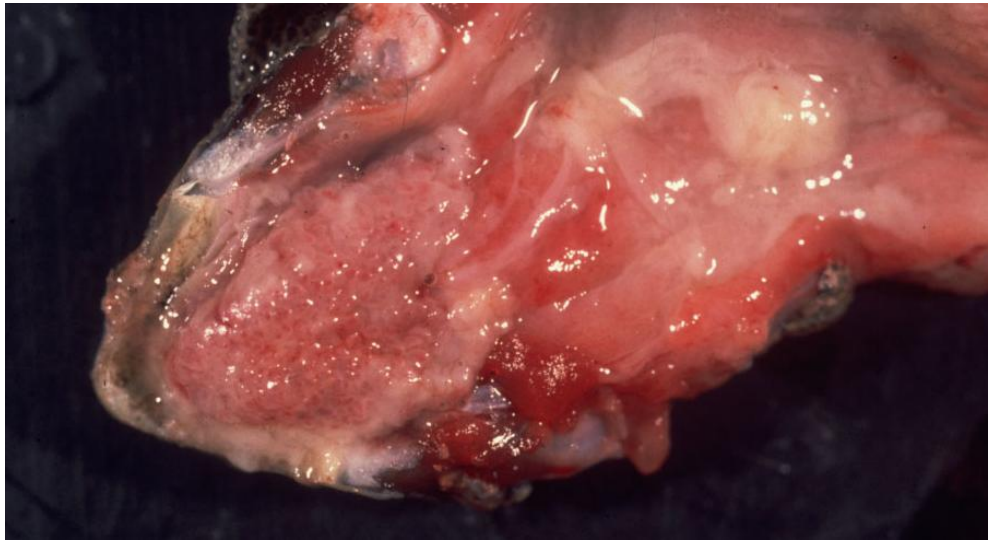
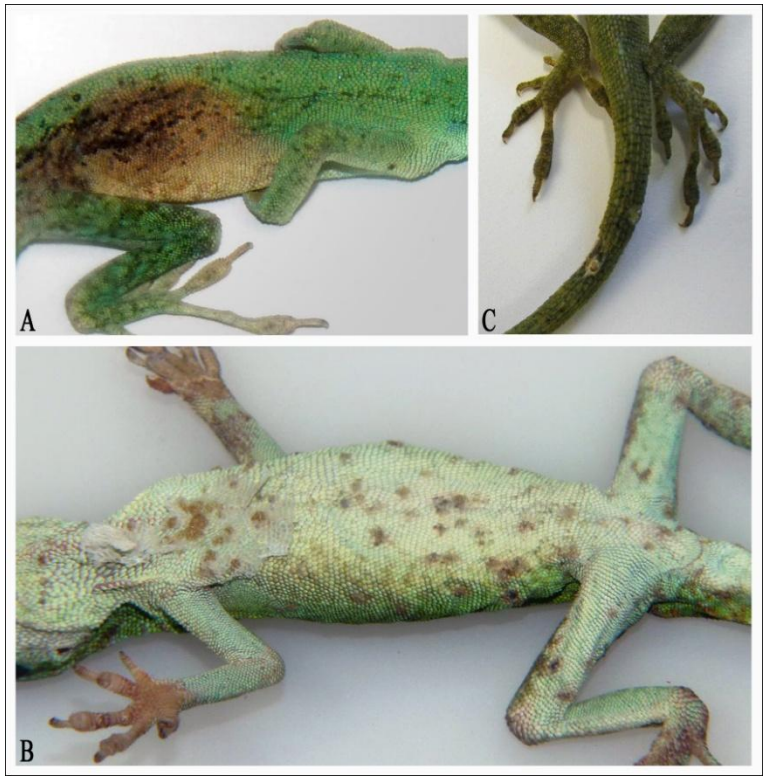


Photo courtesy of S. Blahak

Ranaviruses in lizards

- In squamates:
  - Skin lesions
  - Hepatic degeneration and necrosis
  - Vasculitis
  - Systemic disease

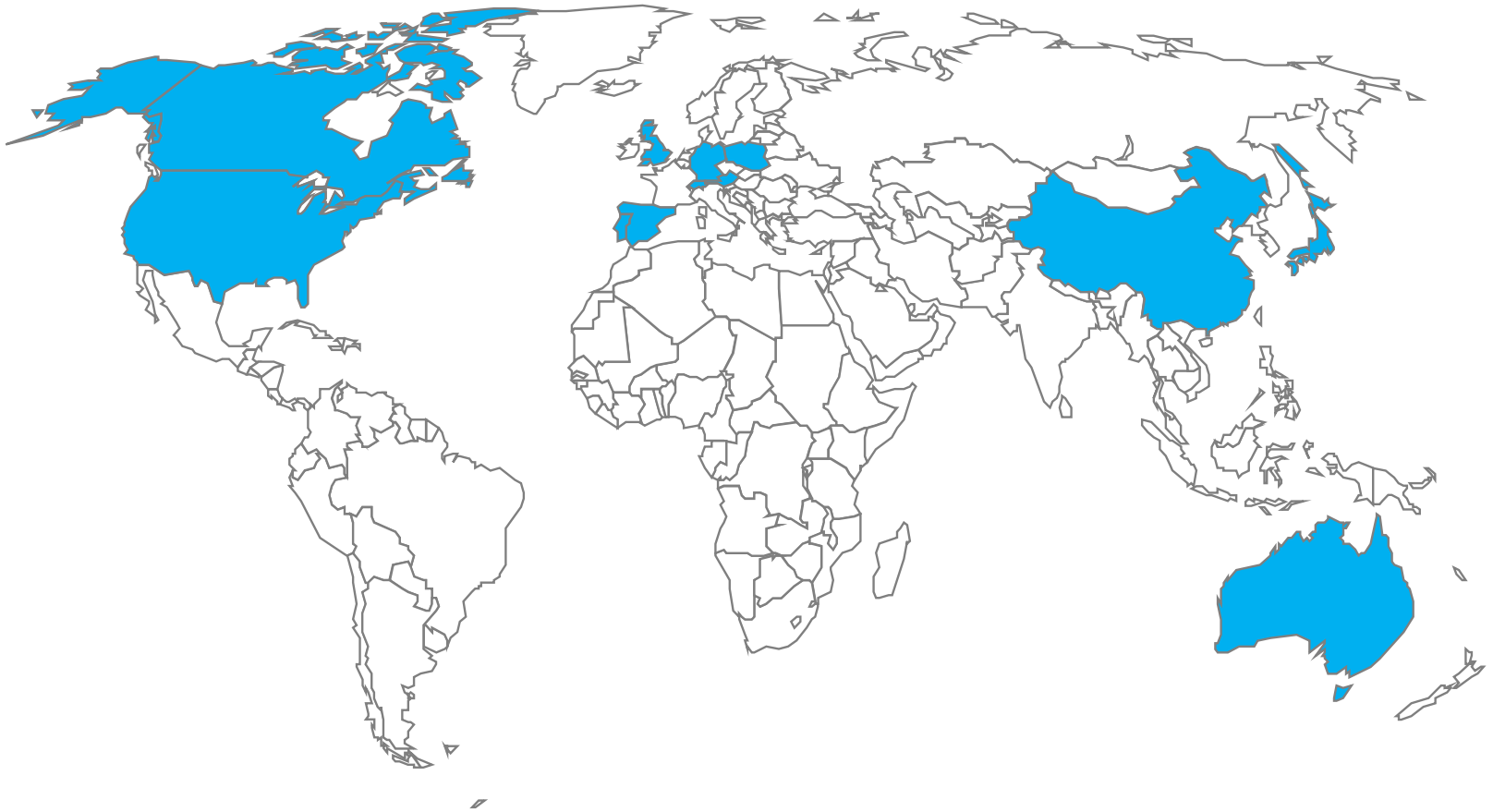
Japalura splendida



Anolis carolinensis

Pogona vitticeps

Distribution of reptile ranaviruses

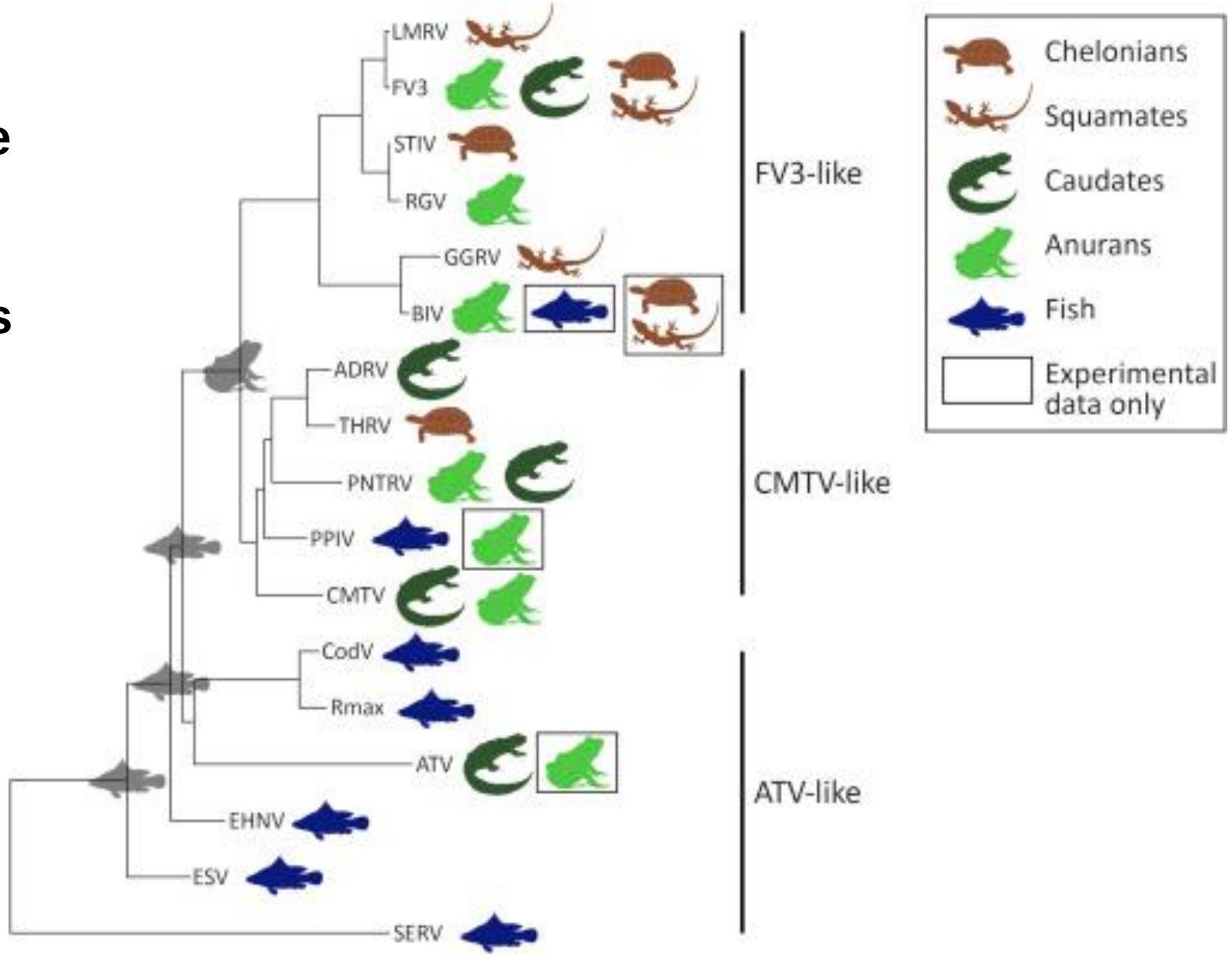


Marschang et al. 2024

Host Specificity

- Based on transmission studies
- Based on sequence data
- Based on genome organization

Pylogentic perspective on host range of ranaviruses



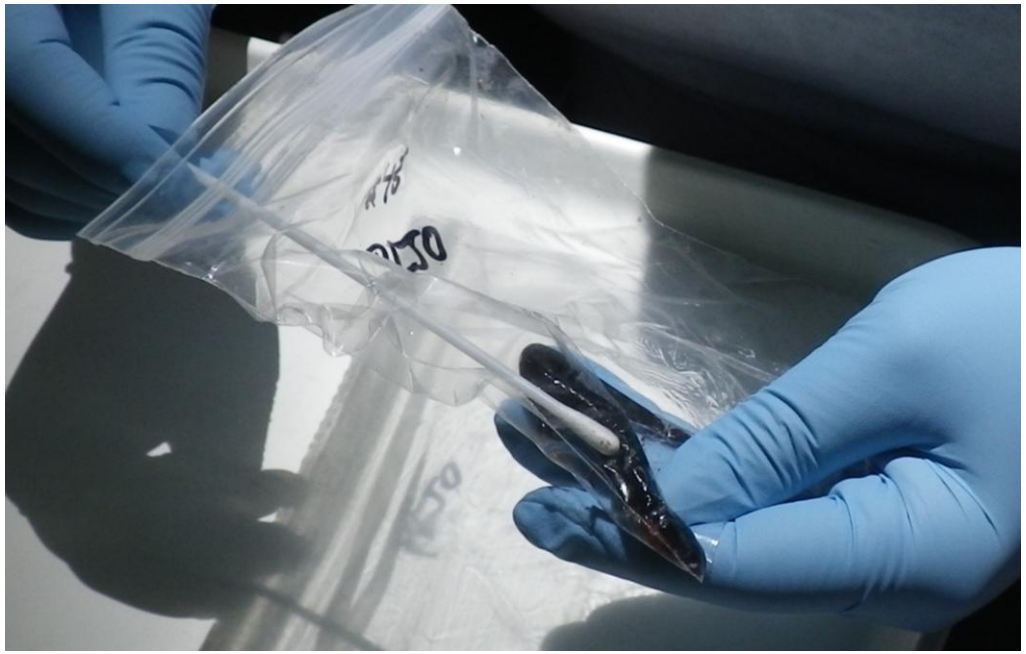
From: Price SJ, et al. 2017. From fish to frogs and beyond: Impact and host range of emergent ranaviruses. Virol 511:272-279.

Ranaviruses

- Some ranaviruses are able to switch hosts between different classes of animals
- They play a role in disease outbreaks in both wild and captive animals
- Anthropogenic spread appears to play a large role
  - Pet trade
- Virus, host, and environmental factors appear to influence pathogenicity

Ranaviruses

- Diagnosis:
  - Can be difficult
    - Virus detection: PCR, virus isolation in cell culture
    - Histology
  - Samples
    - Tissues
    - Oral swabs
    - Skin swabs
    - Cloacal swabs



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Ranaviruses

- Treatment
  - Temperature:
    - Ranaviruses cannot replicate at temperatures >32-34°C
  - Vaccination:
    - Work being done in fish and in amphibians (Chinese giant salamander, *Andrias davidianus*)
  - Persistent infections described

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Thank you for your attention

ecvm European College of Veterinary Microbiology

ARAV ASSOCIATION OF REPTILIAN AND AMPHIBIAN VETERINARIANS

ECZM EUROPEAN COLLEGE OF ZOOLOGICAL MEDICINE