Amphibians

- Class Amphibia
- Approx 6000 recognized species
- 3 extant orders
  - Anura
  - Caudata ([Urodela])
  - Gymnophiona ([Apoda])

Order Anura

- Frogs and toads
- Approx 90% of known amphibian species
- Wide range of species and habitats
Order Caudata

- Salamanders and newts
  - Aquatic/semiaquatic
  - Regeneration of tissues
  - Larval forms: external gills
  - Several families with incomplete metamorphosis
    - Neoteny

Order Gymnophiona

- Caecilians
  - No metamorphosis
  - Annuli create ribbed appearance
  - Rare
    - Often underground/aquatic

Special considerations

- Husbandry/environment
- Anatomy/physiology
  - Metamorphosis
- Disease processes
Husbandry/environment

• Complex and varied, with some general themes
• When in doubt, turn to natural history of species
• Temperature
  • Generally lower than most reptiles
  • POTZ
• Humidity
• Water quality
  • Extremely important

Anatomy/Physiology

• Skin
• Respiratory system
• GI
• Renal
• Musculoskeletal system

Skin

• Semi-permeable
  • Generalized
  • Localized (tree frogs, toads)
• Glands for secretions
  • Cardiac glycosides in Toads (Bufonidae/Anaxys)
  • Neuromuscular blockers (dart frogs)
• Shed usually ingested
• No fat within SC space
Respiratory system

- General respiratory strategies
  - Branchial, buccopharyngeal, cutaneous, pulmonary
- Larval form
  - Gills
- Adults
  - Lungs
  - Gills present in some species (neotony)
  - Cutaneous respiration

GI

- Larval form
  - Aquatic
  - Omnivores, herbivores, carnivores
  - Keratinized mouth parts
  - Filter feeders
- Adults
  - Carnivorous with simple GI
  - Aquatic and terrestrial
  - Changes with metamorphosis
  - Teeth

Renal

- Paired coelomic kidneys
  - Pronephric to mesonephric depending on species
- Urinary bladder present
- Excretions
  - Urea - most species
  - Ammonia
  - Uric acid
Musculoskeletal

- Anurans
  - 4 limbs, well developed for jumping/climbing
- Caudates
  - 4 limbs, reduced size, swimming and walking
- Gymnophiona
  - Limbless

Amphibian examination

- Largely visual depending on species
- Starts well before seeing the animal!
  - History
    - Signalment
    - Medical history
  - Husbandry
    - Housing
      - Size
    - Water quality
    - Diet
    - Temp/humidity

Amphibian examination

- Moistened powder free gloves
  - Reduces disease transmission
  - Delicate skin
Amphibian therapeutics

- Medication routes
  - Depends on the type of medication/disease condition/current health state

- PO
- IM
- SC/IL
- IV
- Topical
- Environmental

Oral medications

- Generally compounded liquids
- Challenges
  - Species/size
  - Volume to be administered
  - Temperament
  - Ability to handle safely

Oral medications

- Administering meds
  - Measuring the amount
    - Insulin syringes without needles
    - Micropipettes
  - Expensive for uncommon species
- Opening the mouth
  - Small guitar picks
  - Rigid paper (business cards)
Intramuscular injections

- More direct application
- Warning with selected medications
  - Enrofloxacin - pH concerns
- Injection sites
  - Forelimb mm.
  - Hindlimb mm.

Subcutaneous/intralymphatic injections

- Lack of fat in SC, decreased space
- Over urostyle
  - Intralymphatic injections
- Limited medications
- Direct route
- Great route for fluid therapy

Intravenous administration

- Lack of great options for sites and meds
- Sedation needed
  - Selected cases
### Blood collection sites

**Anurans**
- Ventral abdominal vein
- Lingual plexus
- Femoral vein
- Heart
- Facial vein/musculocutaneous vein

**Salamanders/newts**
- Ventral tail vein
- Heart
- Femoral vein

### Topical medication

- Different than topical meds for mammals
- Skin permeability
  - High level of absorption
  - Administration of injectable meds topically
- Limited medications
  - Watch for pH issues
  - Watch for carriers in medications
  - Avoid oily meds

### Environmental applications

- Temperature
  - Cooler temperatures are better for amphibians
  - Heat stress possible
- Fluids
  - Intralymphatic fluids
  - Soaking
  - Intracoelomic?
Current updates

• Exotic Animal Formulary 5th ed, 2017
• Literature review from 2008-2016
• Updates on amphibian therapeutics
  • Analgesia
  • Sedation/Anesthesia
  • Antibiotics
  • Antifungals
  • Nutritional supplementation

General supportive care

• Fluid therapy
  • Fluid choice
    • Amphibian rings solution
    • Plasmalyte with dextrose
    • Balanced electrolyte solutions
  • Does it matter?
    • Osmolality vs volume replenishment

Analgesia

• What do we know?
  • Dosing for opioids may be radically different than mammals
    • Buprenorphine 38-50mg/kg in some species (red spotted newts, leopard frogs)
  • NSAIId
    • Meloxicam reduces circulating prostaglandin E2 levels 24hr post 0.1mg/kg dosing in American bullfrogs
    • Flunixin meglumine appears to be the NSAID of choice in Xenopus
Analgesia

• Don’t we know?
  • Pretty much everything else
    • How effective is meloxicam as an NSAID?
    • What are the appropriate opioid pain medications?

Anesthesia/sedation

• Injectable meds
  • Alfaxalone
    • IM, IV, intracoelomic
  • Propofol
    • Intracoelomic
      • Deep anesthesia in tiger salamanders
      • Mild sedation in Sonoran desert toads
    • Intracoelomic
      • African clawed frogs

• Topical
  • Metomidate hydrochloride
    • Bath immersion
      • Great for sedation in Rana pipiens, but not surgical anesthesia
  • Sevoflurane
    • Topical gel mixture (distilled water, non-spermicidal jelly, sevoflurane)
    • American tree frogs
  • Isoflurane
    • Topical gel mixture (distilled water, non-spermicidal jelly, isoflurane)
    • American tree frogs
      • Noted skin irritation with application
Anesthesia/sedation

- Topical anesthesia
  - Tricaine methanesulfonate (MS-222)
    - Buffer to pH 7.0
    - Sodium bicarbonate
    - Varying ranges of effect
    - Much higher dosing than for fish
    - 0.5-2g/L
    - Bath to effect
    - Reverse with fresh water baths

Antibiotics

- Generalized bacterial infections
  - Common offenders
    - Aeromonas
    - Pseudomonas
    - Chlamydia/Chlamydophila spp.
    - Streptococcus
    - Staphylococcus
  - All antimicrobial choices should be made based on clinical signs and appropriate diagnostics
    - Culture and sensitivity
    - Gram stain

What’s new?

- Enrofloxacin
  - Several tissue concentration studies supporting 10mg/kg dosing
    - Xenopus laevis - IM or SC route
    - Coqui frogs - topical route
  - Increased concentration in the kidneys and liver
Antifungals

• Chytridiomycosis
  • Batrachochytrium dendrobatidis
  • Varying species of amphibians affected
  • Tadpoles and some species may be subclinical carriers
• Clinical signs
  • Death
  • Dehydration
  • Skin lesions
  • More likely from secondary infections

Antifungals

• Chytridiomycosis
  • Life cycle
    • Temperature dependent (23°C critical temp)
  • Various treatments have been evaluated
    • Always confirm treatment efficacy with PCR testing
    • Subclinical infections common

Antifungals

• Treatments
  • Temperature
    • 30°C ±10d for bullfrogs
    • Caution with sensitive species
  • Florfenicol
    • Reduces zoosporangia numbers, does not eliminate infection
    • GI and renal toxicity in tadpoles at 100μg/mL
  • Chloramphenicol
    • Continuous emerion with aggressive supportive care in debilitated Australian green tree frogs
Antifungals
• Treatments
  • Itraconazole
    • Topical treatments appear to be more effective for chytridiomycosis
  • Bath treatments x5min at varying concentrations
  • Terbinafine
    • Topical low dose therapy
      • Various species in study, cleared infections, confirmed by PCR

Antifungals
• Treatments
  • Voriconazole
    • Topical spray daily for 7 days
    • Worked in vivo for various species of poison-dart frogs
    • Poor results in vitro

Antifungals
• Batrachochytrium salamandrivorans
  • Salamanders and newts
  • Combination therapy for 10 days
    • Voriconazole, Polymyxin E, Elevated temperature
    • No effect at lower temperature (20 vs 15 oC)
Anti-virals?

- **Ranavirus**
  - Iridoviridae family
  - Large double stranded DNA viruses
  - Frog virus 3 (FV-3) and FV-3 like viruses
  - Worldwide distribution
- **Transmission**
  - Relatively stable in aquatic environments
  - Contaminated soil, direct contact, ingestion of infected tissues

Anti-virals?

- **Ranavirus**
  - No current treatments noted
  - Environmental disinfection
    - Nolvasan 0.75% for 1 min contact time
    - Sodium hypochlorite 3% for 1 min contact time
    - Virkon S 1.1% for 1 min contact time
    - Desiccation and exposure to heat (140°F) for 15-30 min

Nutritional therapies

- **Vitamin A**
  - **Products**
    - Aquasol A
    - Vitamin A gel caps
  - **Route**
    - Topical application of aquasol improved circulating vitamin A levels in foam nestling frogs compared to fortified vitamin A supplement over crickets
  - **Formulation**
    - Preformed vitamin A
    - Dietary carotenoids?
      - Increased plasma-retinol levels in false tomato frogs fed crickets injected with mixed carotenoids
    - Research deficient
Continuing amphibian education

- Professional groups
- Continuing education
- Books
- Journal articles

Professional Groups

- ARAV
- AAZV
- WAVMA

Recommended literature

- Journals
  - Journal of Herpetological Medicine and Surgery
  - Veterinary Clinics of North America: Exotic Animal Practice
  - Diseases of Aquatic Organisms
  - Journal of Zoo and Wildlife Medicine
Recommended literature

• Books
  • Amphibian Care and Captive Husbandry
  • Exotic Animal Formulary, currently in 5th ed.
  • Current Therapy in Reptile Medicine and Surgery
  • Manual of Exotic Pet Practice
  • Reptile Medicine and Surgery, 2nd ed. (New edition coming soon!)

Summary

• Amphibian medicine and therapeutics are constantly being updated
  • Mostly driven by concerns of global outbreaks of Chytridiomycosis, or by lab animal medicine
  • Large deficits are present in terms of analgesia and varying antibiotic options
  • Using evidence based medicine can drive us to identify and reduce these deficiencies through further research