

Lecture roadmap

- General Characteristics of Caudates
- Caudate Evolution
- Caudate Ecology
- Major Caudate families

General Characteristics

- Very similar body plan
 Small head, elongate body, four limbs, and tail
- Do not hop; use lateral undulation
- Do not actively vocalize
- Attract mates via pheromones (mental gland)
- Elaborate mating rituals (tail straddling)



Salamander Evolution

- Important themes in salamander evolution....
 - Lunglessness
 - Small body size
 - Feeding strategies
- Convergent evolution; exploitation of different habitats
 - Tree-tops; prehensile tails (Bolitoglossines)
 - Longer bodies; reduced limb length

- Webbed feet





Salamander Evolution



- Body size variation (miniaturization)
 Terrestrial species (Plethodontids)
- Lunglessness
 - General characteristic of terrestrial species
- Feeding strategies
 - Hyoid structure evolution
 - Evolved numerous times independently

Caudate Distribution

- 10 families (9 depending on source)
- Low diversity throughout new-world tropics; absent entirely from old-world tropics
- Biology and ecology poorly understood
- Adaptive radiations



General Ecology

- Inhabit moist environments
 Facilitate oxygen exchange
- Four families fully aquatic
 Cryptobranchidae
 Amphiumidae
 Sirenidae
 Proteidae



- Six families terrestrial (not fully)
 Plethodontidae
- Hynobiidae
- Ambystomatidae
- Dicamptodontidae (Maybe)
- Rhyacotritonidae - Salamandridae



General Ecology

- Internal or external fertilization
 - Most families (7) exhibit internal fertilization (synapomorphic feature)
 - External fertilization (symplesiomorphic feature)
- Some families exhibit parental egg care
 - Increases egg hatching success
 - Decreases predation and disease
 - Greater demand on female



General Ecology

- Terrestrial salamanders important prey item
- Densities may range from 2,950 sal/ha 10,000 sal/ha -Equates to one salamander every 1m²
- Igher biomass than birds and small mammals combined



Questions to Consider

- What are some advantages to evolving internal fertilization?
- What are the advantages to evolving lunglessness, small body sizes, and different feeding strategies?
- What is the ecological importance of salamanders?

Family Ambystomatidae (Mole Salamanders)

- One genus; 31 total species
- New world distribution (US and Mexican plateau)
- Incomplete metamorphosis common (paedomorphosis / neoteny); A. talpodieum and A. tigrinum



Family Ambystomatidae

- Large, robust adults; relatively large compared to other caudates
- Eggs generally laid in clusters; some species lay eggs singly
- Fall, winter, and summer breeders (phenology depends on climate (i.e., soil temperature)
- Internal fertilization; via spermatophores



Family Amphiumidae

- Single genus (Amphiuma); three species
- Southeastern US (S. Miss. River and coastal plain)
- Inhabit slow-moving streams and ponds
 Low oxygen levels
- Heavy-bodied; four poorly developed sets of toes



Family Amphiumidae

- Important prey item for semi-aquatic snakes
- Internal fertilization; poorly known
 Male deposits spermatophore directly into female's cloaca



- Females coil around and guard eggs (under cover object)
- Display paedomorphic traits (internal gills and gill slits)

Family Cryptobranchidae

- Two genera; 3 species
- Andrias and Cryptobranchus



- Largest salamanders in the world (1.5 m length)
- Consume a wide variety of prey items (crayfish and stream crabs)





Family Cryptobranchidae

- Dorsoventrally flattened
- Large folds of loose skin (surface area for oxygen absorption)
- Lungs are present (vestigal and non-functional)
- External fertilization (females lack spermathecae); lack typical caudate courtship displays
- In Hellbenders eggs (250 to 400) are laid in two gelatinous strings
 Male fertilizes eggs
- Male will guard eggs

Photos by: Cyril Ruoso



Family Dicamptodontidae

- Single genus (*Dicamptodon*); four species
- Restricted to Pacific northwest and adjacent Canada
- Formerly placed in Ambystomatidae
- Relatively large terrestrial adults (> 200 mm)



Family Dicamptodontidae

- Fertilization is internal by means of spermatophores
- Breed in cold mountain streams
- Larval period is prolonged (2-5 years)
- Adults may exhibit facultative paedomorphosis (e.g., external gills)
- One species (D. copei) is permanently paedomorphic

Family Hynobiidae

- Seven to nine genera; 49 species
 Two-thirds of species are in the *Hynobius* genus
- Asiatic distribution (C and E Asia; Siberia, China, Korea, and Japan)
- Most are terrestrial as adults
 One genus, Onychodactylus is semi-aquatic



Family Hynobiidae

- Lungs usually well developed
 Absent in Onychodactylus
- Adults lack gill slits, external gills, and nasolabial grooves
- Breed in streams or ponds; little courtship display
- Females lay eggs in long elliptical sacs (resemble Ambystoma egg masses)
- Males directly fertilize egg masses
- Ranodon deposits rudimentary spermatophore and female deposits eggs on spermatophore



Family Plethodontidae

• 27 total genera; > 375 species



- Largest and most diverse family of salamanders
- North, Central, and South America
 Karsenia koreana is from Korea
- A great deal of uncertainty with the evolution within the Plethodontidae
- New species discovered with regularity

Family Plethodontidae

- Lungless salamanders
 Rely solely on cutaneous respiration
- Nasolabial grooves
- Direct and larval development (extreme variation)
- Within some genera, large differences in larval pd., habitat partitioning, etc.
- Inhabit streams, caves, bogs, seeps, and forests



Family Plethodontidae



Family Plethodontidae



- Ensatina sp. complex
- "Ring" species
- Continual gradient of evolution in progress

Family Proteidae

- Two genera (Necturus and Proteus); five species
- Eastern half of N. America and eastern Europe
- Stream-dwelling throughout entire life period
- Facultatively paedomorphic (external gills, gill slits, and no eyelids)
- Requires silt-free, free-flowing streams



Family Proteidae

- Proteus anguinus; cave obligate species
- Resembles cave-dwelling species native to North America
- Internal fertilization via spermatophore
 Eggs are attached to the female's shelter





Family Rhyacotritonidae

- One genus; four species
- Torrent salamanders
- Pacific northwest in US
- Were once placed in the Dicamptodontidae
- Inhabit cold mountain streams
- Semi-aquatic adults

Family Rhyacotritonidae

- Courtship occurs on land or in stream splash zones
- Fertilization occurs via spermatophores; eggs attached to the underside of rocks
- Larvae need 3 to 5 years for metamorphosis
- Larvae and transformed sub-adults live in shallow, cold stream pools



Family Salamandridae

- 15-20 genera; 70 species
- Eastern and Western US, Europe, SE China, and Japan
- No one genus has more than 4 species
- Large-bodied with some species exceeding 200 mm



Family Salamandridae

- Typically have rough or granulose skin
- Some species have toxic skin secretions
- Elaborate courtship displays
- Complex life cycle in some species
 Larvae, terrestrial eft, aquatic adult

Family Sirenidae

- 2 genera (Siren and Pseudobranchus); 4 total species
- SE and central US and northeastern Mexico
- Elongate eel-like bodies that lack hind-limbs
- Front-limbs may be reduced in some species
- All species are facultatively paedomorphic (gills, gill slits, and no eyelids)
- Lungs are present, but small

Family Sirenidae

- Inhabit sloughs, ponds, ditches, and other low oxygenated aquatic environments
- Use gills, skin, and lungs for respiration
 Primarily lungs in oxygen-poor habitats
- Thought to have external fertilization due to lack of spermathecae
 Mating never been observed

Pseudobranchus striatus

- Eggs attached to submerged vegetation
- Forage on crayfish and other aquatic invertebrates

Points to Consider

- Be sure to know basic life history strategies of each family
- Know the general geographic distribution of each family
- Understand basic breeding biology for each family
- Required readings, Wells: pages 58-73 and Vitt and Caldwell 421-433.