

AMPHIBIANS PART I: SALAMANDER AND CAECILIAN DIVERSITY

GENERAL INFORMATION

The class Amphibia comprises three orders: Caudata (salamanders), Gymnophiona (caecilians) and Anura (frogs and toads). Currently (as of Jan. 17, 2017) there are 7,615 described species. In this first lab we will cover the major lineages within the salamanders and the caecilians. Lab two will cover the major lineages of frogs.



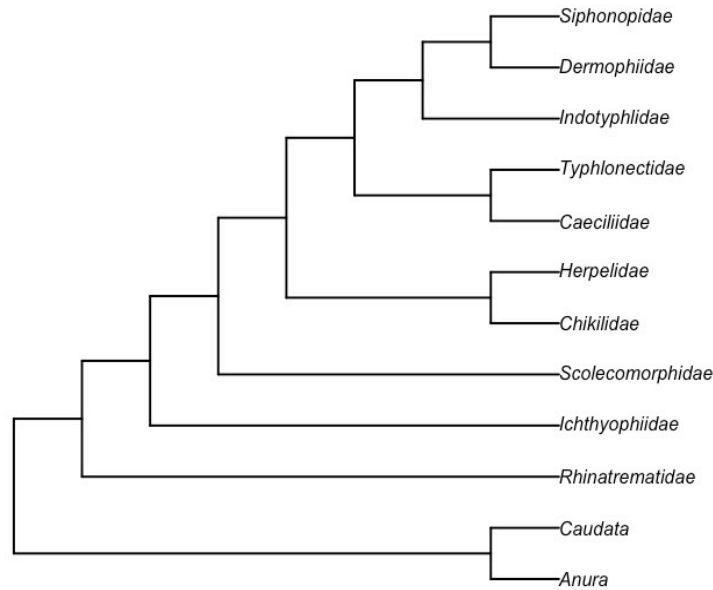
Salamanders are fairly diverse, comprising 10 families and ~695 species but can be easily covered in this class. Caecilian are much harder to identify, poorly understood, in general, and underrepresented in our collection, so you are not expected to be able to identify caecilian families but I have provided information on them for your amusement.

LAB 1 OBJECTIVES

1. Be able to identify species in the order Gymnophiona to order
2. Be able to identify species in the order Caudata to order and family
3. Learn and understand geographic distribution of orders and families (for Caudata)
4. Learn and understand relative diversity of major lineages

GYMNOPHIONA (CAECILLIANS)

Gymnophiona translates from Greek as naked snake. Caecilians are basal, distant relatives of frogs and salamanders. The group is generally recognizable by a limbless, elongate body form, reduced eyes, and dermal scales (in some species). Caecilians are characterized by the following combination of morphological features: 1) complete absence of limbs and limb girdles (note: reduction or loss of limbs occurs in some salamander groups, so pay attention); 2) the presence of *annuli*—distinct grooves ringing the body (reduced in some species), 3) greatly reduced or absent tail; 4) a chemosensory organ (tentacle) located between eye and nostril (note: can be difficult to see). Many other diagnostic characteristics of caecilians are based on skeletal morphology and skull ossification patterns.



Cladogram of the caecilians adapted from AmphibiaWeb and Pyron & Wiens 2011. This phylogeny is a hypothesis based on the limited information and sampling we have for this group and is likely to change as new data becomes available.

Gymnophiona

Diversity: 10 families, 33 genera, 205 species

Distribution: Pantropical—Central and South America, Africa, India and SE Asia

US Diversity: None

NM Diversity: None

Traits: see above

Specimens on display:

Note: Because Caecilians are hard to identify, poorly known, and underrepresented in our collection, I provide condensed information for all 10 Caecilian families as a supplement.

Family: **Rhinatrematidae** — 2 genera, 11 species — northern South America

Traits: secondary and tertiary annuli, dermal scales, terminal mouth, tentacular opening adjacent to eye, true tail

Family: **Ichthyophiidae** — 2 genera, 57 species — southern and southeastern Asia

Traits: true tail, dual jaw closing mechanism, secondary and sometimes tertiary annuli

Family: **Scolecomorphidae** — 2 genera, 6 species — E and W equatorial Africa

Traits: counter-sunk lower jaw, tentacle-like openings at end of snout, orbits absent—eyes connected to base tentacle protruded with tentacle

Family: **Herpelidae** — 2 genera, 9 species — Africa

Traits: perforate stapes, multiple antotic foramina, no separate septomaxillae or separate prefrontals (all skeletal traits)

Family: **Chikilidae** — 1 genus, 4 species — India, Bangladesh

Family: Caeciliidae — 2 genera, 42 species — South and Central America

Traits: inner mandibular teeth, maxillopalatine covers eyes, monocuspid teeth

Family: Typhlonectidae — 5 genera, 14 species — northern South America

Traits: completely or semi-aquatic, tracheal lungs, narial plugs, lack dermal scales

Family: Dermophiidae — 4 genera, 14 species — Africa, Central and South America

Traits: secondary annuli and annular scales

Family: Indotyphlidae — 7 genera, 22 species — India, Africa, and the Seychelles

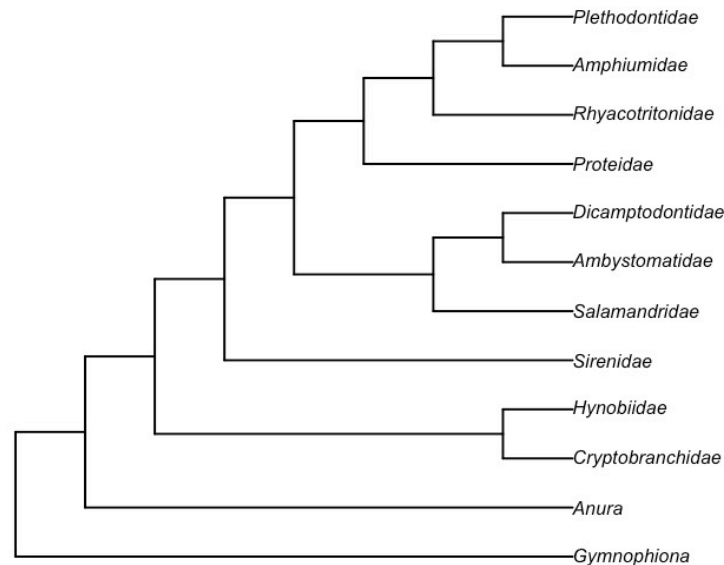
Traits: inner mandibular teeth, some bicuspid teeth, eye at border of squamosal and maxillopalatines, viviparity plus lack of scales and secondary annuli, or oviparity

Family: Siphonopidae — 6 genera, 26 species — South America

Traits: oviparity, imperforate stapes and lack of inner mandibular teeth

CAUDATA (SALAMANDERS)

Salamanders are primarily distributed in the Americas and Eurasia, they are absent from Africa (with one exception), Australasia and most oceanic islands. Most salamanders are generally recognizable by being ‘lizard-like’ in appearance and having smooth to rough, scale-less skin. The general salamander body plan is variable and several species exhibit reduction and/or loss of limbs and limb girdles. However, salamanders can easily be distinguished from other vertebrates by the presence of the following combination of characteristics: 1) one or two pairs of limbs present; 2) scale-less, granular skin; and 3) a well-developed, post anal tail. Many species are pedomorphic and retain juvenile characteristics, like external gills, through adulthood. Additionally, a number of internal skeletal and muscular characteristics are useful for diagnosis but not easily observed in preserved specimens.



Cladogram of the salamanders adapted from Pyron and Wiens 2011

Diversity: 10 families, 68 genera, ~695 species

Distribution: Americas, Europe, Asia, India, Korean peninsula, Japan, extreme N Africa

US Diversity: 9 families, 24 genera, ~130 species

NM Diversity: 2 families, 3 genera, 3 species

Expect practical questions regarding identification to family, diagnostic traits, relative diversity, and distribution of each family. Pay attention to New Mexico species, you will be asked to identify these to the species level (we will revisit them in three weeks).

Family: Cryptobranchidae

Diversity: 2 genera, 3 species

Distribution: China, Japan, Eastern US

NM Diversity: None

Traits: largest salamanders, eyes lidless, baggy skin for cutaneous respiration, flattened body shape, incomplete metamorphosis, gill slit (hidden), suction feeders, no tongue, 4 well developed limbs, external fertilization, nest guarding by males.

Specimens on display:

Family: Hynobiidae

Diversity: 9 genera, 66 species

Distribution: Asia—from Ural Mountains to Pacific, South to Afghanistan and Iran

NM Diversity: None

Traits: Complete metamorphosis, typical terrestrial body plan, distinguished from other salamanders by osteology. Lungs reduced in some, absent in one genus.

Specimens on display:

Family: Sirenidae

Diversity: 2 genera, 4 species

Distribution: SE North America and extreme northeastern Mexico.

NM Diversity: None

Traits: Eel-like, incomplete metamorphosis (paedomorphic), external gills, 2 forelimbs, reduced number of digits, no hind limbs or pelvic girdle, external fertilization

Specimens on display:

Family: Proteidae

Diversity: 2 genera, 6 species

Distribution: Eastern NA to Gulf of Mexico, Italian Alps, E Europe

NM Diversity: None

Traits: Paedomorphic, large external gills, no eyelids, 4 good limbs, reduced number of digits, reduction/loss of skeletal structure of upper jaw.

Specimens on display:

Family: Salamandridae

Diversity: 21 genera, 115 species

Distribution: Europe, Asia, India, Japan, North America and extreme North Africa

NM Diversity: None

Traits: Variable in appearance, all have 4 good limbs, complete metamorphosis in most, many aquatic, smooth to rugose skin, toxic skin secretions, often brightly colored.

Specimens on display:

Family: Dicamptodontidae

Diversity: 1 genus, 4 species

Distribution: Pacific NW from CA to Canada and Rocky Mtns.

NM Diversity: None

Traits: Large, brown mottled with black, facultative metamorphosis

Specimens on display:

Family: Ambystomatidae

Diversity: 1 genus, 32 species

Distribution: North America, from Central Mexico north to Canada, West to East

NM Diversity: 1 species, *Ambystoma tigrinum*

Traits: Few distinctive characters, moderate size, smooth skin, robust body, short blunt head, metamorphosis either facultative, absent or obligate.

Specimens on display:

Family: Amphiumidae

Diversity: 1 genus, 3 species

Distribution: Southeastern North America

NM Diversity: None

Traits: Eel-like, incomplete metamorphosis, paedomorphic, gill slits, lacks eyelids and external gills, 4 tiny legs, reduced number of digits

Specimens on display:

Family: Rhyacotritonidae

Diversity: 1 genus, 4 species

Distribution: Pacific Northwest from California to Washington

NM Diversity: None

Traits: Small, semi-aquatic in/near fast-flowing streams, complete metamorphosis, reduced lungs, large eyes, square gland behind vent of males

Specimens on display:

Family: Plethodontidae

Diversity: 28 genera, ~460 species: very diverse, has been divided into 4 tribes

Distribution: disjunct distributions in E & W North America, Central Mexico, South America, Southern Europe, Korea

NM Diversity: 2 species, *Aneides hardii* and *Plethodon neomexicanus*

Traits: Highly diverse—worm-like to “normal”, fossorial to arboreal, some aquatic cave dwellers, many have direct development. But all lack lungs and have a nasolabial groove.

Specimens on display:

Subfamily: Hemidactyliinae

Diversity: 21 genera, ~360 species

Distribution: North, Central, and South America

Subfamily: Plethodontinae

Diversity: 7 genera, 96 species

Distribution: North America, Europe, Korea

Discussion Questions

Ambystomatid salamanders are quite diverse, rates of diversification for this group have been found to be nearly double that of plethodontids, which is commonly attributed to their tendency towards paedomorphism. Why would paedomorphism lead to an increase in speciation rates? (Hint: ambystomatids have a tendency to breed in ponds and lakes rather than rivers and streams...)

Plethodontidae contains about 2/3 of all salamander species, or about twice the number of species in the remaining 9 families combined. Why might this be?

Two continents (other than Antarctica) are essentially devoid of salamanders. Why?

Most salamander families are only found in a single nearly-contiguous region. Which salamander families can be found on multiple continents? What is the significance of the patterns of those families?

One of the most intriguing biogeographical patterns in herps is the presence of Indotyphlid caecilians in the Seychelles. Why is it strange that they are found there?