

## Amphibian Evolution and Characteristics



**Matthew J. Gray, Ph.D.**  
College of Agricultural Sciences and  
Natural Resources  
University of Tennessee-Knoxville



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## Goal of the Lecture

To familiarize students with the origin and evolution of amphibians and the characteristics of the Class and extant Orders of Amphibia.

### Reading Assignments:

Wells: pp. 1-15

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## Lecture Structure

- I. Class Amphibia Characteristics
- II. Amphibian Fossil Record
- III. Extant Amphibian Orders

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## What are Amphibians?

Ectothermic tetrapods that have a biphasic life cycle consisting of anamniotic eggs (often aquatic) and a terrestrial adult stage.

Kingdom: Animalia  
 Phylum: Chordata  
 Subphylum: Vertebrata  
 Class: Amphibia (amphibios: "double life")  
 Subclass: Lissamphibia  
 Orders:  
 • Anura (frogs)  
 • Caudata (salamanders)  
 • Gymnophiona (caecilians)




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## Amphibia Characteristics

- Cutaneous Respiration**
  - Oxygen and CO<sub>2</sub> Transfer (moist)
  - Family Plethodontidae (lungless salamanders)
  - Gills (larvae, few adult salamanders), 2 Lungs (adults)
- Two Types of Skin Glands**
  - Mucous Glands (cutaneous respiration)
  - Granular Glands (toxic secretions)
  - Paratoid Glands
- Sensory Papillae in Inner Ear and Doubled Transmission Channels in Middle Ear**
  - Columella – Papilla basilaris
  - Opercularis – Papilla amphibiorum (<1000 Hz)
- Green Rods in Retina (excluding caecilians)**
  - Function Unknown
  - Other Light Receptors: red rods, single and double cones
- Bicuspid Pedicellate Teeth**
  - Crown (above gum), Pedicel (connected to jawbone)
  - New Crown Emerges from Pedicel

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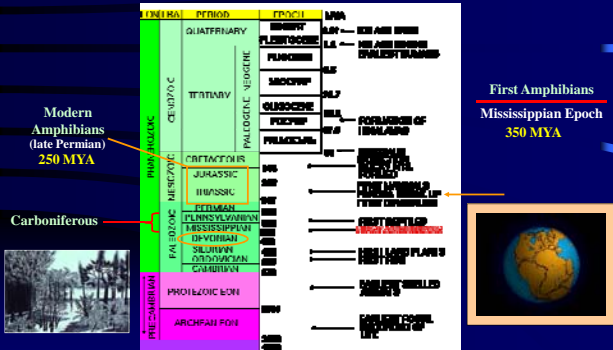
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## Fossil Record of Amphibians



Modern Amphibians (late Permian) 250 MYA

Carboniferous

First Amphibians Mississippian Epoch 350 MYA

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## Fish to Tetrapods

Greenland      Late Devonian Period      360 MYA



*Ichthyostega*  
1 m






*Acanthostega*  
0.6 m

What evolutionary forces encouraged transition to land?

- Piscivorous
- Limbs likely used for navigating
- Tail for balance
- Skeletal structure
  - > forelimbs
- Lungs



- Piscivorous
- Fish-like
- Limbs likely used for paddling
- Skeletal structure
  - > Elbow could not bend
- Gills and Lungs

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## Temnospondylous Amphibians


Late Carboniferous and Early Permian Periods



- 1.5-2 m long
- Bicuspid pedicellate teeth
- Tympanum likely
- Lungs & Cutaneous Respiration
- Shoulder disconnected from skull
- Likely piscivorous
- Engulfed prey
- Not a strong swimmer or fast tetrapod (likely hunted by stealth or opportunity)



*Eryopus megalcephalus*



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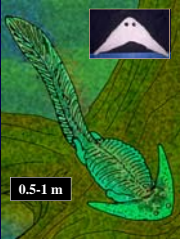
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## Nectrideans and Microsaurs

Carboniferous and Permian Periods


No Fossils:  
30 MY



*Diplocaulus magnicornus*  
0.5-1 m


### Nectridia

- Mostly Aquatic
- Resembled Newts (flat tails)
- Some with triangular heads
- Hydrofoils in slow moving streams
- Small fish and aquatic invertebrates



### Lepospondyli

6 groups with uncertain common ancestor



### Microsauria

“Small Lizard”

- Terrestrial (lizards), aquatic (newts), and fossorial

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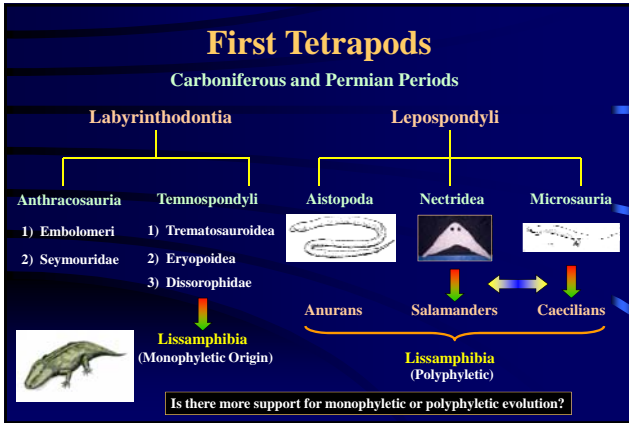
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## Fossil Record of Lissamphibia

Triassic, Jurassic and Cretaceous Periods

**1) Anurans**

*Palaeobatrachus*



*Triadobatrachus massinoti*

- Origin: Madagascar
- Early Triassic (230 mya)



**2) Salamanders**



*Karaurus sharovi*

- Origin: Kazakstan
- Late Jurassic (170 mya)



**3) Caecilians**

Video



*Apodops pricei*

- Origin: Gondwanaland (SA)
- Late Cretaceous (100 mya)



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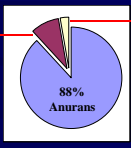
## Modern Orders of Amphibia

**Gymnophiona (caecilians)**

- 167 species




*Ichthyophis kohtaoensis*



280 Species in U.S.  
(86 Species in TN)

**Anura (frogs)**


- 5,420 species



*Dendrobates tinctorius*

**Caudata (salamanders)**

- 559 species



*Plethodon shermani*

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**Gymnophiona**

Caecus = blind

**Characteristics:**

- Earthworm like (7 cm – 1.5 m)
- Limbless (pectoral & pelvic girdles absent)
- Degenerate Eyes (most are fossorial)
- Internal Fertilization (phallosome)
- 20% Viviparous; 80% Oviparous

**Tropical Distribution**



**6 Families**




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**Caudata (Urodela)**

Smokeys Diversity (31)


**Characteristics:**

- Tailed Amphibians
- Lizard like (30 mm – 1.5 m)
- Well-developed limbs (except aquatic)
- Internal Fertilization (most)
- Larval Development External (most)
- Lack Tympanum & Middle Ear (opercular)

**Mostly Temperate Distribution**



**10 Families**




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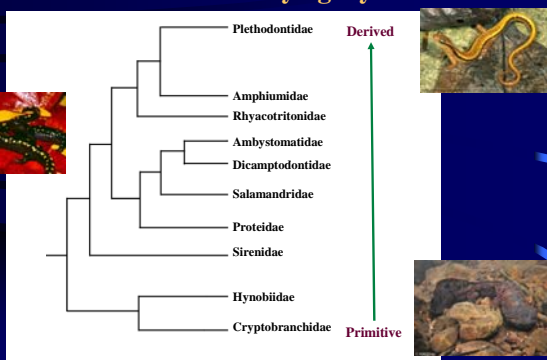
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**Salamander Phylogeny**



Primitive

Derived

Cryptobranchidae

Hynobiidae

Sirenidae

Proteidae

Salamandridae

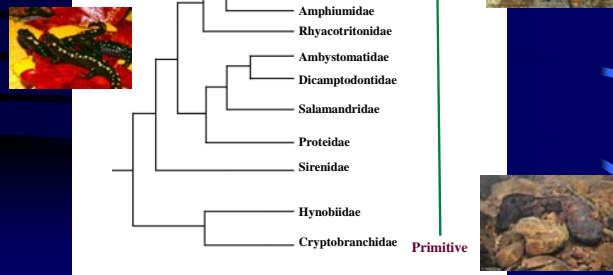
Dicamptodontidae

Ambystomatidae

Rhyacotritonidae

Amphiumidae

Plethodontidae




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## Anura

**Characteristics:**

- Shortened Presacral Vertebrate (usually 8)
- Ribs are reduced or absent (2<sup>nd</sup> or 4<sup>th</sup>)
- Presacral Vertebrae Firmly Articulated
- Large Hind Limbs, No tail (except 1 family)
- External Fertilization (usually)
- Flat heads and Large Mouths (usually)
- Vocal Sacs in Males (usually)

**Saltatorial**  
2-10X BL

**Video**

**Global Distribution**



**+36 (50) Families**  
Frost et al. (2006)



*Agalychnis callidryas*      *Dendrobates azureus*      *Lithobates clamitans*      *Phrynomantis bifasciatus*

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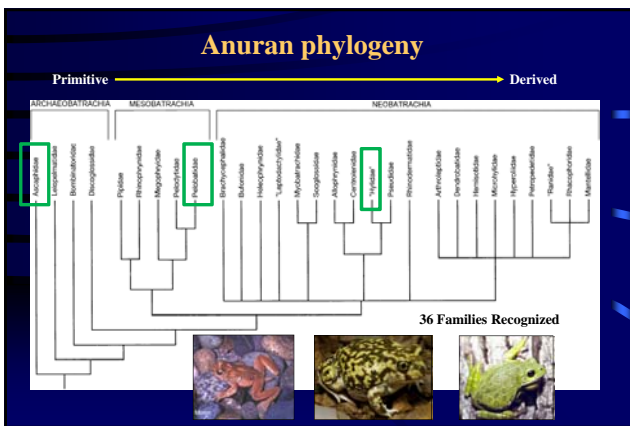
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