

Ecol 483/583 – Herpetology
Lab 8: Reptile Diversity 2: Serpentes
Spring 2010

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Lab objectives

The objectives of today's lab are to:

1. Gain an appreciation for the extant diversity of the Serpentes.
2. Learn to identify species of snakes that live in Arizona.
3. Prepare for field trips that will take place during the next two weeks.

Today's lab is the second of three designed to introduce you to reptile diversity. You will get a chance to see many specimens of snakes, which will reinforce material presented in lecture.

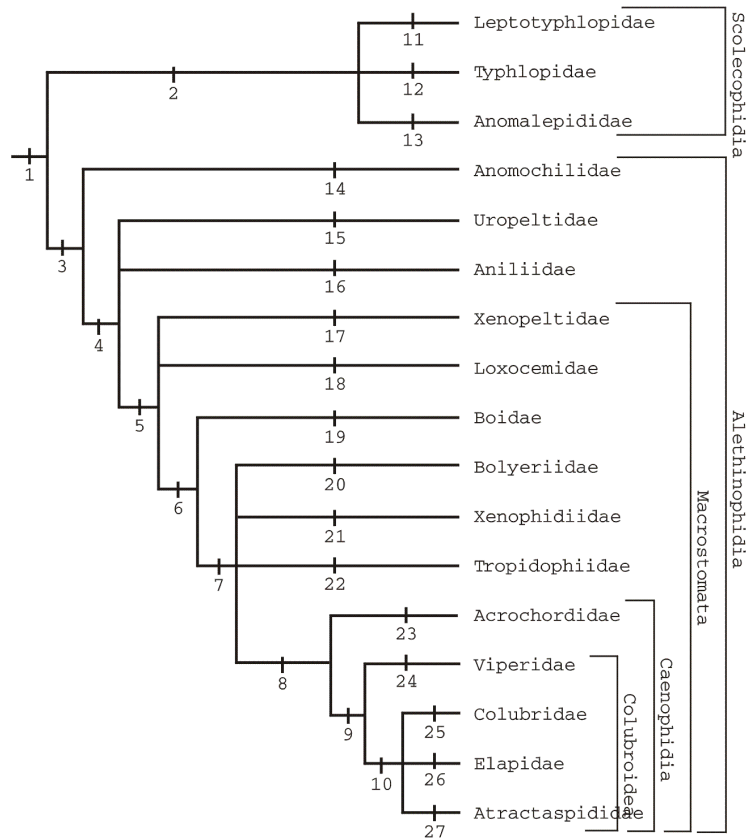
Tips for learning the material

Continue what you have been doing in previous weeks. Examine all of the specimens on display, taking notes, drawings and photos of what you see. Attempt to identify the local species to species and the others to their higher taxon. Quiz each other to see which taxa are easy for you and which ones give you troubles, and then revisit the difficult ones.

You will probably find that many of the snakes are harder to identify – they all have a relatively similar morphology. This means that you have to look at the details on these specimens to figure out how to identify them. The synopses for each group should help you. You will also continue to use a taxonomic key, building on your proficiency with that skill. This is an important tool for correctly identifying species, especially when they are very difficult to distinguish from other species.

Exercise 1: Diversity of Serpentes

(Modified from Bonine & Foldi 2008; Bonine, Smith & Stitt 2003; Edwards 2002; Prival 2000)



General information

Snakes, along with lizards and amphisbaenids, are members of the Squamata. The Serpentes (also called Ophidia) comprise a monophyletic group that is nested within the lizards, rendering lizards paraphyletic. Snakes have been around since at least the Cretaceous (~100 mya). Currently, we recognize 15 major clades, 420 genera and >2,900 species. With >2,100 of these species, the Colubroidea is by far the most diverse clade of snakes. The Scolecophidia is a group of fossorial, secretive snakes called the blind snakes, and suggestive of a fossorial origin to the entire clade. Snakes are found worldwide except at very high latitudes, and range in elevation from sea level to over 4,900 m. Five major clades are found in North America, north of Mexico, all of which are represented in Arizona.

Generalized morphology

Most snakes completely lack limbs, but some of the more basal groups, including the Boidae, have some hind limb and pelvic girdle remnants. Snakes are elongate in body form and the left lung is reduced or absent in most species. Almost all snakes shed their entire skin at once. They lack eyelids; instead a transparent scale called the **spectacle** covers the eye. Snakes also lack external ear openings and outer ear parts. They have 120 or more preloacal vertebrae, and have paired musk glands in the tail. The ventral scales on a snake correspond on a 1-to-1 basis to the preloacal vertebrae. Most snakes, especially the more derived groups, have very kinetic skulls that allow them to swallow relatively large prey.

Review and make sure that you are familiar with the different scales on the head and body of snakes, as illustrated in your field guide. This is important for being able to identify some species and will help you during the keying exercise. Also learn the correct way to count scale rows – another important skill you will use today – which is also shown at the beginning of the snake section of your field guide.

Generalized life history

In Arizona, snakes are most active during the warmer, wetter periods of the year (monsoon season). All snakes are carnivorous, but some are generalist feeders whereas others may specialize on skinks, snails, eggs, or some other prey. Most snakes are not territorial, and some den communally during the winter. Combat between males over mates occurs in some snakes. Most snakes are **oviparous**, but **ovoviviparity** has independently evolved at least 30 times. Typically, ovoviviparous species are more prevalent at higher latitudes and elevations. Parental care, usually in the form of egg guarding, has been documented in about 3% of snake species. Therefore, parental care seems to be more common in snakes than in lizards, but less common than in amphibians.

What is the difference between oviparity and ovoviviparity?

Why might ovoviviparous species be more prevalent at high altitudes?

Much can be inferred about the life history of a snake by examining its morphology. Typically, diurnal species have round pupils, nocturnal species have vertical pupils, and fossorial species have very reduced eyes. Sit and wait predators are usually heavy-bodied whereas active foragers are more slender. Arboreal species are very elongate and may have prehensile tails. Blotched and ringed snakes are more likely to rely on crypsis to avoid predators, whereas unicolored and striped snakes are likely to try to flee.

Name a species you might expect to be a sit-and-wait predator that is on display today. Would you say that it is nocturnal or diurnal? Why?

Name a species that you would expect to be an active forager that is on display today. Is it nocturnal or diurnal? Why?

Name one species that is on display today that is a dietary specialist. What kind of prey does it eat?

Conservation

The primary threats to snakes are habitat destruction (including road construction) and collection. In Arizona, vehicles kill hundreds of thousands of snakes every year. Collectors impact snake populations via both direct removal of individuals and associated habitat destruction. Some of Arizona's snakes have high market values including: the three montane rattlesnakes (Ridge-nosed Rattlesnakes, Rock Rattlesnakes, and Twin-spotted Rattlesnakes), Rosy Boas, Green Ratsnakes, and Sonoran Mountain Kingsnakes. Very little is known about the status of most snake species and no studies have shown an impact from collection on populations. However, many snakes have slow growth rates, small clutch and litter sizes, and high adult survivorship, suggesting that they may be particularly vulnerable to this type of threat. Another prevalent threat to snake populations outside the U.S. is harvest for consumption. Snakes are a common food source for humans in China and Southeast Asia.

North American Families

Leptotyphlopidae: Blindsnakes

Content and distribution: 2 genera, ~90 species. Distributed in SW U.S., Mexico, Central and South America, Africa, and SW Asia.

Morphology: This family includes some of the smallest snakes; species range in length from 10-46 cm. Unlike the other North American snake families, the mandibles attach anteriorly, so their skulls are not very **kinetic** compared to other snakes and quite robust. They have undifferentiated scales, which may help them bore through the substrate as they burrow. Eyes are very small or absent. Some have pelvic girdles and vestigial hind limbs.

Life history: All are fossorial. Most inhabit moist tropical forests and primarily eat ant and termite eggs and larvae. Most if not all are oviparous.

Miscellaneous facts: This is one of the basal snake families. Two species of *Leptotyphlops* occur in Arizona; you need a hand lens to differentiate between them.

Species in lab:

Leptotyphlops dissectus (dulcis) – New Mexico Threadsnake

Leptotyphlops humilis - Western Threadsnake

Examine a specimen of *Leptotyphlops*. What is meant by undifferentiated scales? How does this differ from other snakes?

What is a distinguishing feature between the two species on display?

Boidae: Boas, Pythons and Sand Boas

Content and distribution: 20 genera, 74 species. Worldwide, except eastern and central U.S., most of Canada, most of Europe, and East Asia.

Morphology: Boids include some of the world's largest snakes, reaching over 10 meters in length. The green anaconda (*Eunectes murinus*) is perhaps the heaviest bodied, while the reticulated python (*Python reticulatus*) is the longest. Boids have kinetic skulls, but they are less kinetic than those found in more derived families (colubroids). Boids are not venomous. They have remnants of hind limbs, vestigial pelvic girdles, and two lungs. Many boids have facial pits that can detect infrared radiation, usually located in the upper or lower labial scales.

Life history: Boids are constrictors. They are primarily ambush hunters. Habitats range from rain forest to mountain cloud forest to desert. All pythons are oviparous, whereas all boas and most sand boas are viviparous. Many pythons construct nests in which to lay their eggs and remain with their eggs until they hatch. Some female pythons coil around the eggs and shiver to generate heat for incubation. Some boids can eat very large prey.

Miscellaneous facts: Boids were much more widely distributed and diverse before the colubroids evolved during the Miocene (~20 mya). Today, boids are most diverse in places where there are no vipers, such as the Caribbean Islands and Australia.

Species in lab:

Corallus caninus – Emerald Tree Boa

***Lichanura trivirgata* – Rosy Boa**

Morelia viridis – Green Tree Python

Note the well-developed heat-sensing pit organs on the Emerald Tree Boa and the Green Tree Python.

Examine the three species on display. Can you find vestigial hind limbs on all of them?

“Colubridae”: Colubrids

Content and distribution: About 320 genera, with over 1800 species. A worldwide distribution.

Morphology: This is a very diverse group of snakes and there are no morphological synapomorphies that distinguish this family. About 1/3 of colubrids are venomous, rear-fanged snakes. Venom runs down the outside of slightly enlarged teeth near the rear of the mouth. Other morphological characteristics are highly variable.

Life history: Also highly variable. Most are oviparous. However, garter snakes (*Thamnophis*) are ovoviviparous. Many colubrid females only reproduce every two or three years. Most New World colubrids are active foragers.

Miscellaneous facts: Note that herpetologists use two words that look similar but mean different things - colubrid and colubroid. Colubrid refers only to the Colubridae. Colubroid refers to the clade Colubroidea, which includes four related modern clades: Atractaspididae, Colubridae, Elapidae and Viperidae. The Colubroidea + the Acrochordidae is called the Caenophidia. This is contrasted with the “Henophidia” and Scolecophidia. The Scolecophidia comprises the basal snakes. “Henophidia” is a paraphyletic taxon that could be described as “non-caenophidian macrostomatans”. Also notice that “Henophidia” is in quotation marks – this indicates that it is not a monophyletic group. Colubridae is a “trash can” taxon and is likely not monophyletic - it includes about 70% of all extant snake species.

**On the phylogeny provided above, identify the “Henophidia”.
Why do we call the Henophidia paraphyletic?**

Arizona species not in lab:

Chionactis paratrostris – Sonoran Shovel-nosed Snake
Gyalopion quadrangulare – Thornscrub Hook-nosed Snake
Thamnophis elegans – Terrestrial Gartersnake
Sonora semiannulata – Groundsnake

Species in lab:

***Arizona elegans* – Glossy Snake**
Bogertophis subocularis – Trans-Pecos Rat Snake
***Chilomeniscus stramineus (cinctus)* – Variable Sandsnake**
***Chionactis occipitalis* – Western Shovel-nosed Snake**
***Diadophis punctatus* – Ring-necked Snake**
Drymarchon corais – Indigo Snake
Drymobius margaritigerus – Speckled Racer
Elaphe guttata – Red Cornsnake
Elaphe alleghaniensis – Eastern Ratsnake
***Gyalopion canum* – Chihuahuan Hook-nosed Snake**
***Heterodon nasicus* – Western Hog-nosed Snake**
***Hypsiglena torquata* – Nightsnake**
***Lampropeltis getula* – Common Kingsnake**
***Lampropeltis pyromelana* – Sonoran Mountain Kingsnake**
***Lampropeltis triangulum* – Milksnake**
Lampropeltis zonata – California Mountain Kingsnake
***Masticophis bilineatus* – Sonoran Whipsnake**
***Masticophis flagellum* – Coachwhip**
***Masticophis taeniatus* – Striped Whipsnake**
Natrix cyclopion – Green Watersnake
Natrix sipedon – Northern Watersnake
Opheodrys vernalis – Smooth Green Snake
***Oxybelis aeneus* – Brown Vinesnake**
***Phyllorhynchus browni* – Saddled Leaf-nosed Snake**

Phyllorhynchus decurtatus – Spotted Leaf-nosed Snake
Pituophis catenifer – Gophersnake
Pituophis melanoleucus – Pinesnake
Regina grahamii – Graham’s Crayfish Snake
Rhinocheilus lecontei – Long-nosed Snake
Salvadora grahamiae – Eastern Patch-nosed Snake
Salvadora hexalepis – Western Patch-nosed Snake
Senticolis triaspis – Green Ratsnake
***Tantilla* spp.** – Black-headed Snake
Thamnophis cyrtopsis – Black-necked Gartersnake
Thamnophis eques – Mexican Gartersnake
Thamnophis marcianus – Checkered Gartersnake
Thamnophis ordinoides – Northwestern Gartersnake
Thamnophis radix – Plains Gartersnake
Thamnophis rufipunctatus – Narrow-headed Gartersnake
Thamnophis sauritus – Eastern Ribbonsnake
Thamnophis sirtalis – Common Gartersnake
Trimorphodon biscutatus – Western Lyresnake
Virginia striatula – Rough Earthsnake

For each genus that appears in BOLD above, list one synapomorphy. Then go up to the list above and come up with one autapomorphy for each species for genera where there are more than one species (in bold).

Elapidae: Cobras, Mambas, New World Coralsnakes, Sea Snakes, Kraits, Australasian Endemics (like the Taipan and Brown Snakes)

Content and distribution: 62 genera, ~300 species. Distributed throughout the Southern Hemisphere. Also found in southern U.S., northern Africa, Middle East, and South Asia.

Morphology: All are venomous. They have **proteroglyphous dentition**, or relatively short front fangs that are fixed (not moveable), on a long maxilla, and hollow or deeply grooved to administer venom. The venom is primarily **neurotoxic**. Cobras have expandable hoods. A few cobra species can spit venom upward to blind potential predators. Seasnakes have flattened tails and bodies, valvular nostrils, salt glands and a very long lung.

Life history: Most are oviparous. Some female cobras guard eggs. Most elapids feed on ectotherms - frogs, lizards, fish, and snakes. However, mambas primarily eat mammals and birds. Most New World coralsnakes feed on other snakes.

Miscellaneous facts: Elapids are most diverse in Australia, where there are no vipers and few colubrids. Australian elapids have evolved to occupy niches held by vipers and colubrids in other parts of the world.

Species in lab:

Micruroides euryxanthus – Sonoran Coralsnake

Micrurus tener – Texas Coralsnake

Naja spp. – Cobra

Pelamis platurus – Yellow-bellied Seasnake

Neurotoxic venom is often viewed as more potent and dangerous than hemotoxic venom (more widely found in the Viperidae). What tissues do these two types of venom target? What would neurotoxin be more dangerous than hemotoxin?

Viperidae: Adders, Old World Vipers, Pitvipers

Content and distribution: 20-27 genera, ~228 species. Worldwide, except Australia.

Morphology: All are venomous. These snakes have a **solenoglyphous dentition**, or long, hollow fangs on a reduced, moveable maxilla. When the mouth is closed, the fangs are folded back and down. When the mouth is opened to strike, the maxilla pivots and the fangs extend downward. Viperids administer a primarily hemotoxic and cytotoxic venom. However, some species (including our Mohave Rattlesnake) have developed neurotoxic venom as well. They have extremely kinetic skulls and some can ingest prey weighing 1.5 times as much as the snake. Most are heavy-bodied, but a few are arboreal and slender. Pitvipers have two highly-developed facial pits to detect infrared radiation. Most pitvipers have a tail spine that

produces a buzzing sound when vibrated against vegetation. In one group of pitvipers, the rattlesnakes, this has developed into an actual rattle.

How do the heat-sensing pit organs of rattlesnakes differ from those seen in boids?

Life history: Most viperids use a combination of ambush and active foraging. They often utilize cryptic coloration to avoid detection. Most are viviparous, including all of Arizona's viperids. Parental care is common in this family; females remain with their young until at least their first shed.

Miscellaneous facts: Pitvipers can detect temperature differences as small as 0.003°C! Four of Arizona's pitvipers are state-protected – the Massasauga, Ridge-nosed Rattlesnake, Rock Rattlesnake, and Twin-spotted Rattlesnake – because they have very limited distributions and are sought after by pet collectors.

Species in lab:

Agkistrodon contortrix – Copperhead

Agkistrodon piscivorus – Cottonmouth

***Crotalus atrox* – Western Diamond-backed Rattlesnake**

***Crotalus cerastes* – Sidewinder**

***Crotalus cerberus* – Arizona Black Rattlesnake**

Crotalus durissus – Neotropical Rattlesnake

Crotalus exsul – Red Diamond Rattlesnake

Crotalus horridus – Timber Rattlesnake

***Crotalus lepidus* – Rock Rattlesnake**

***Crotalus mitchellii* – Speckled Rattlesnake**

***Crotalus molossus* – Black-tailed Rattlesnake**

***Crotalus oreganus* – Western Rattlesnake**

***Crotalus pricei* – Twin-spotted Rattlesnake**

***Crotalus scutulatus* – Mohave Rattlesnake**

***Crotalus tigris* – Tiger Rattlesnake**

***Crotalus viridis* – Prairie Rattlesnake**

***Crotalus willardi* – Ridge-nosed Rattlesnake**

***Sistrurus catenatus* – Massasauga**

Sistrurus miliarius – Pygmy Rattlesnake

List an autapomorphy for each of the species listed above in bold.

Exercise 2: Keying Snakes

In going through the specimens on display today, you probably noticed that some snakes can be tricky to identify. As you know, a taxonomic key can help you with this. On display are six unidentified specimens that you should key out. Don't forget to write down the steps you took to arrive at each identification.

A. Steps: _____
Species: _____

B. Steps: _____
Species: _____

C. Steps: _____
Species: _____

D. Steps: _____
Species: _____

E. Steps: _____
Species: _____

F. Steps: _____
Species: _____

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