Origin of Amphibians and Reptiles.

Some of this is very confusing in your text due to the constant references to cladistic “nodes” or groups, which are not always defined.

0. Preliminary:

Geologic time table:

You ought to be somewhat familiar with the geological time scale.

Earth's geologic history is divided into big time periods called “era's”, which are in turn subdivided into “periods”.

Other divisions exist (e.g., epochs, eons, ages), but we won't need them.

We're interested in three eras:

Paleozoic 541 - 252 mya

Mesozoic 252 - 65 mya

Cenozoic 65 - 0 mya

Each of these is divided into periods [use diagram]

Your book makes frequent references to these geological eras or periods.

I. Amphibians.

Amphibians evolved from fish. That's the simple version.

Where, exactly, they came from is a bit controversial.

Fish classification (Osteichthyes):

Fish are generally (using traditional Linnaean taxonomy) classified into two sublcasses:

Subclass Actinopterygii (ray finned fish)

Your typical “fish”. Fins supported by thin bony rays.

Subclass Sarcopterygii

Fish with bony or fleshy fins.

There are two groups here:

Lungfish (Infraclass (?) Dipnoi)

Infraclass Crossopterygii

Includes the Coelacanth

Coelacanth's can be seen “walking” across the ocean floor using their “limbs”

These “limbs” are not strong enough to support the fish outside water.

There is some controversy as to exactly where Amphibians came from:

There is a lack of decent fossil specimens

In any case, it's clear that Amphibians developed from fish with lungs and/or bony fleshy fins.

(Which Infraclass they're most closely related to is a matter of debate, but is probably the Crossopterygii)

What about early amphibian fossils?

There are three to discuss (your text gives a few more you can read about on your own if you wish):

Tiktaalik - Briefly, a sarcopterygian fish from the late Devonian (375 mya). It shows numerous tetrapod characteristics including:

fins with wrist like characteristics - able to bear some weight

spiracles at the top of the head - probably connecting to primitive lungs

pectoral girdle separate from skull (thus gaining a neck)

may well represent a transitional fossil (which has been lacking until now)

Acanthostega - A bit more recent with fossils from 365mya.

Considered intermediate between sarcopterygii and tetrapods.

Interestingly, although limbs had 8 digits, they don't seem to have been able to support weight.

Generally thought to be aquatic, though possibly specialized for shallow water.

Ichthyostega - Again, a bit more recent than Acanthostega, though it may have

overlapped.

Probably the best adapted (so far) for terrestrial existence.

Lungs seem to be better developed.

Stronger rib cage.

Limbs strong enough to propel Ichtyostega on land, though just how well it could move on land is a matter of debate.

May have lived mostly in water, coming onto land to bask.

Or may have lived almost entirely on land as adults.

Subsequent amphibian evolution

We won't delve into all the dead ends and offshoots (with one important exception).

In general, amphibians, once they moved onto land, had the place to themselves. Reptiles hadn't evolved yet, so amphibians were near the top of the food chain.

Arthropods and fish presumably made up most of their food.

Some amphibians got to be fairly large (several meters).

Three major subclasses evolved:

Labyrinthodontia - extinct, though they gave rise to a group called Anthracosauria

- massive skulls, complex vertebra, strange “labyrinth” like teeth.

Lepospondylli - also extinct.

- not clear if they are a subclass.

- also not clear just how they are related to modern amphibians

- unique vertebrae (spool shaped, which gives the group it's name).

Lissamphibia - modern amphibians

There is some controversy about caecilians, but generally this group is considered to include all modern amphibians.

Some characteristics include:

reliance on skin for respiration

specialized visual cells in the retina (more on this later).

pedicellate teeth (dentine crown and base, separated by uncalcified dentine)

two types of skin glands

others.

Lissamphibia are divided into several superorders, but since the higher taxonomy is (as usual) controversial, we'll stick with the three traditional orders:

Gymnophiona (= Apoda) - caecilians

Caudata - salamanders

Anura - frogs

II. Reptiles

Reptiles and subsequent tetrapods are often referred to as Amniotes:

Amniotes refers to a membrane found in eggs that helps these organisms lay eggs on land.

Found in birds and mammals as well (in mammals, the “amnion” has been modified, but still surrounds the embryo and contains “amniotic” fluid).

So what about our friendly Anthracosauria?

They are sometimes called “reptile like amphibians”.

Flourished during Devonian - early Triassic

Exactly how they're related to modern reptiles is a matter of debate (most of the controversy is caused by cladistic analyses).

But they do have traits found in amniotes but not in amphibians:

atlas-axis arrangement is similar (first two vertebrae)

other vertebrae are also similar

First real reptiles include *Hylonomus*, *Paleothyris*, and possibly *Archeothyris*.

Archeothyris was actually a synapsid, which may indicate it was on the line to mammals.

[Skull characteristics]

Hylonomus was pretty much the first reptile which was undoubtedly a reptile. About 312 mya, with an anapsid skull.

Small, lizard like in appearance

Paleothyris was similar to *Hylonomus*, but is not as well known. About the same age as *Hylonomus* as well.

All modern reptiles are diapsids...

As it turns out, turtles are anapsids, but note:

Most classifications (including molecular) support the idea that the anapsid skull of turtles is a reversion (i.e., they branched off diapsids and lost the rear skull openings again).

What happened next?

Several groups of "reptiles" should be discussed briefly:

An early group of reptiles developed into Archosaurs.

Distinguished by various openings in the skull, ankle structures, various distinct femoral and humeral features (see text if you're really interested).

The interesting thing about Archosaurs is the groups that came off (see fig. 1.12, though it's mostly a cladistic representation):

Dinosaurs

Pterosaurs

Crocodiles

Birds

(several other groups that include animals like *Plesiosaurus* and *Icthyosaurus*)

Let's briefly discuss each of these:

Dinosaurs - originated about 230 mya in the early Triassic (some people will take it back to the late Permian)

Quickly radiated into most habitats on the planet, and were for millions of years the dominant terrestrial vertebrates.

Divided into two main groups based on hip structure:

Saurischian and Ornithschian

Gave rise to birds (strangely, birds evolved from the saurischian group).

Went extinct most likely due to meteor strike about 65 mya, though other factors may have been contributing.

Crater has been found on the Yucatan peninsula.

Had many advanced features:

feathers/four chambered heart/endothermy/parental care/herd behavior/active life style (compared to ectothermic reptiles).

Pterosaurs

Overlapped in time with dinosaurs, but were not directly related.

Generally agreed (some controversy) to have had powered flight.

Smithsonian actually built a scaled down flying model.

Went extinct at the same time as dinosaurs (“non-bird” dinosaurs!)

Crocodiles

We actually won't say much about them right now, since they're obviously still around.

Birds

Our best theories for the origins of birds place them as branching off therapod dinosaurs.

This includes bipedal carnivorous dinosaurs like *Tyrannosaurs*.

(Numerous therapod dinosaurs have been found with feathers).

Some people argue for Birds being “Dinosaurs”

Most cladistic (and some traditional) classifications support this.

Modern reptiles (see also Wikipedia for pictures):

Generally (although some cladistic classifications would differ) are divided into four orders:

Again, we won't bother with superorders or subclasses since this classification is controversial.

Crocodylia - Crocodiles

Sphenodontia - tuataras

Squamata - lizards, snakes, and amphisbaenids

Three suborders:

Lacertilia or Sauria - lizards

Amphisbaenia - Amphisbaenids (worm lizards)

Serpentes - snakes

Testudinae - turtles