LAB 1: DIVERSITY OF LIVING CRANIATES (VERTEBRATES)

Name: ____________________ SSN: _______________

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N.B. Preparation for next week's lab (Lampreys)

1) Walker & Homberger - Chapter 2

Preparation: Walker & Homberger - pp. xi-xii and Chapter 3

Background

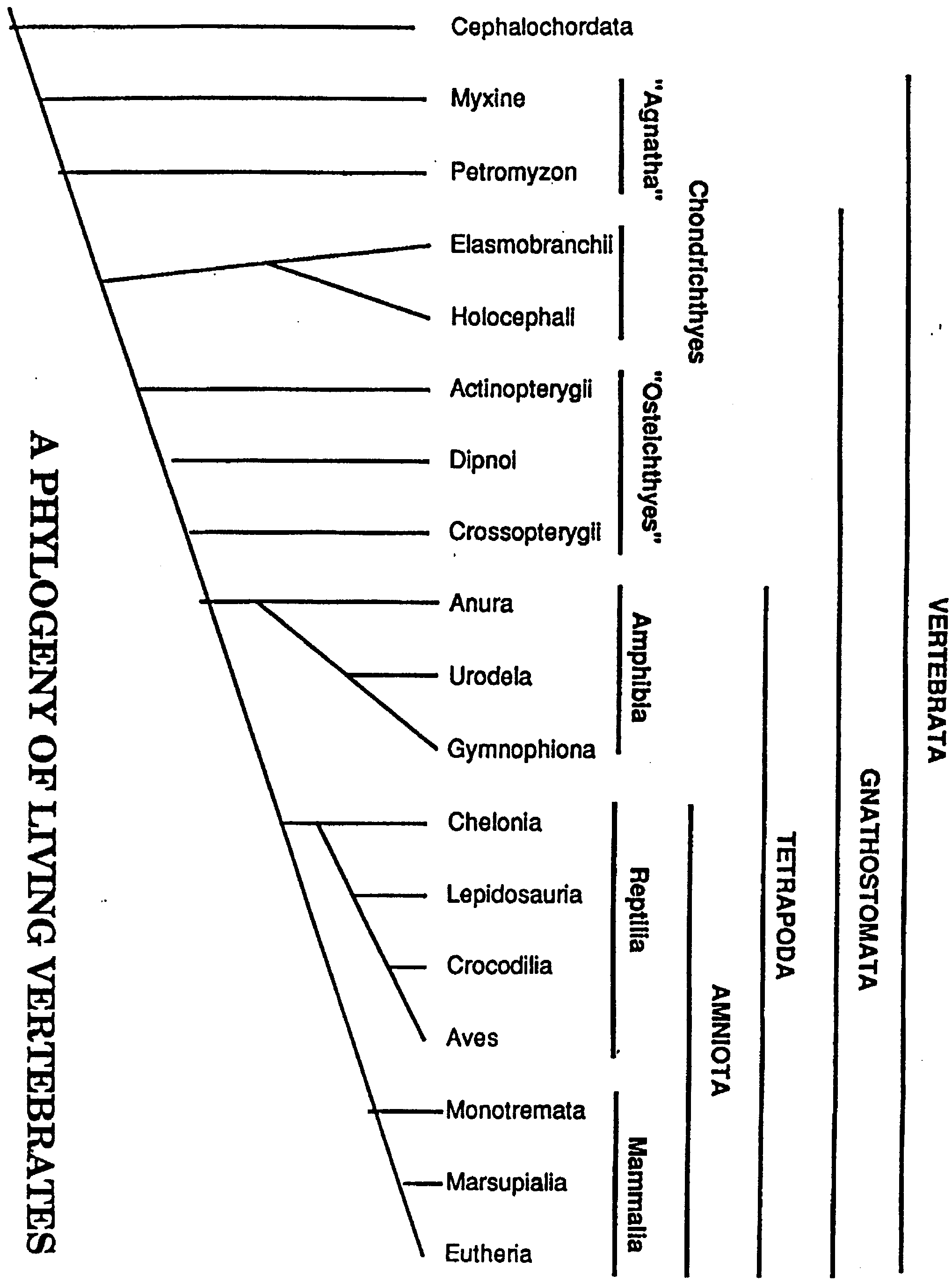
The evolutionary history of vertebrates is one that spans approximately 500 millions years. Although this may seem like an immense time span to us, vertebrates actually occupy a relatively brief period of geologic time when one considers the earth is ca. 4.6 billion years old. Time spans of this magnitude are difficult for us to comprehend so the history of life on earth is often translated into one calendar year. Using this scale, the earth came into existence on January 1 and the first evidence of life, fossil bacteria, appeared on April 4. It is not until November 20 (520 mybp) that we find fossil evidence of the first vertebrates. Jawed fish evolved on Nov. 30, the first amphibians invaded land on Dec. 3, and early reptiles appeared on Dec. 7. The first mammals evolved on Dec. 16 and the oldest known Homo sapiens only appeared around 11:45 p.m. on Dec. 31! Despite the recent origin of vertebrates, various lineages (both living and extinct) have diversified into a remarkable array of morphological forms.

In traditional systematics there are seven classes of living vertebrates. Their presumed relationships are shown on the accompanying cladogram (*vertclas.tif*). Note that some of the class names are shown with quotation marks and others are not. The quotation marks indicate that the group is not a natural group, that is, it is not monophyletic. A natural, or monophyletic group is one that includes an ancestor and all of its descendants. For example, consider the "Reptilia." Note that chelonians, lepidosaurs and crocodilians all share a common ancestor (they all stem from a common origin - a single line on the diagram). However, birds (Aves) also have the same common ancestor, yet the group "Reptilia" does not include them. Therefore, "Reptilia" is a name for a group that includes an ancestor and only some of its descendants.

Similarly, "Osteichthyes" (bony fish) represents a group of unrelated fish. If we go back far enough along the phylogeny we see that they do have a common ancestor eventually. However, that common ancestor is also the common ancestor of tetrapods (all limbed vertebrates), therefore "Osteichthyes" excludes some (in fact, most!) of the descendants of that ancestral species.

A group that contains an ancestor and only some of its descendants is called a paraphyletic group or unnatural group. Compare the paraphyletic groups discussed with some monophyletic groups (e.g. Mammalia and Chondrichthyes) and be sure you understand the difference.

Modern convention requires that names be given only to monophyletic groups. So why do we continue to use these old-fashioned paraphyletic group names? Mostly for convenience. We are in a transitional period in the science of systematics; textbooks and many scientists have not yet caught up. These paraphyletic group names have some utility, as well. The groups were *insert fig: vertclas.gif*



named because their members share many structural similarities. Unfortunately, these similarities are mostly primitive (i.e. they represent retention of an ancestral condition, they have failed to evolve) - hence do not accurately reflect the evolutionary history of the group (as we saw in the examples above). Only derived features of
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organisms clearly indicate monophyly. Nonetheless, the old names do tell us something about what the animals look like and how they live. Birds are excluded from the class "Reptilia," for example, because they are so different from the scaly, crawly crocodilians to which they are most closely related. In other words, crocodiles are more closely related to birds than they are to lizards in an evolutionary sense, but by not calling birds reptiles we emphasize the structural similarities of crocodiles and lizards on the one hand, and the extreme morphological difference of birds on the other. Thus many people think that this is a preferable system: names that reflect basic structural similarity, but not necessarily true evolutionary history. Which do you think is better?

<u>Today's Lab</u>
In today's lab you should familiarize yourself with representatives of the 7 living vertebrate classes. At each station is a representative taxon of each class. At some stations representative taxa of various subgroups within the class are also exhibited. At each station you will be asked to orient the specimen and observe specific characters and traits (see Lab Exercise below). You should also familiarize yourself with the class (and its relative abundance, i.e., number of species) and various subgroup names (**in bold typeface**) presented in the <u>traditional</u> classification below.

<u>Lab Exercise</u> (learning value only - no quiz)

At each station for the <u>representative taxon</u> provided:

1) Orient the specimen using the anatomical directions described on pages xi-xii of your lab manual)

2) Identify the characteristics of each group, where possible, using your lab manual (Chapter 3) as a guide).

3) Score the <u>representative taxon</u> for the following traits using the score sheet provided:

axial skeleton: absent (0), notochord (1), arcualia (2), vertebra (3)
jaws: absent (0), present (1)
mandible: absent (0), cartilaginous (1), multi-bone (2), single bone (3)
true (dentin) teeth: absent (0), present (1)
external gill openings: absent (0), present (1)
nostrils: absent (0), single (1), paired (2)
lateral line: absent (0), present (1)
paired fins/limbs: absent (0), fins (1), limbs (2)
skin: glandular (0), keratinized (1)
scales: absent (0), dermal (1), epidermal (2)
epidermal derivatives: absent (0), feather (1), hair (2)
openings of urogenital & digestive systems: single (cloaca; 0), separate (1)
metabolism: ectothermy (0), endothermy (1)

At the end of the class we will map out the above characters for the seven taxa on a simplified phylogeny (cladogram; *simpvert.ds4*) of the craniates, first by hand and then using a computer program (<u>MacClade</u>),. This will allow us to identify (1) which traits are primitive (symplesiomorphic) within a group, (2) which traits are derived (synapomorphic) within a group, (3) possible homoplasies (non-homologous similarities), and (4) autapomorphies (traits unique to a monophyletic group).

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Assignment (due next week):

A. Define the following terms:

synapomorphy

symplesiomorphy

autapomorphy

homoplasy

B. Using the traits scored in today's lab exercise, give an example of the following:

1) A synapomorphy defining (uniting) the Amniota:

2) A trait that is symplesiopmorphic for Craniata/Vertebrata:

3) A traits that is autapomorphic in Mammalia:

4) A homoplasy uniting Aves and "Agnatha":

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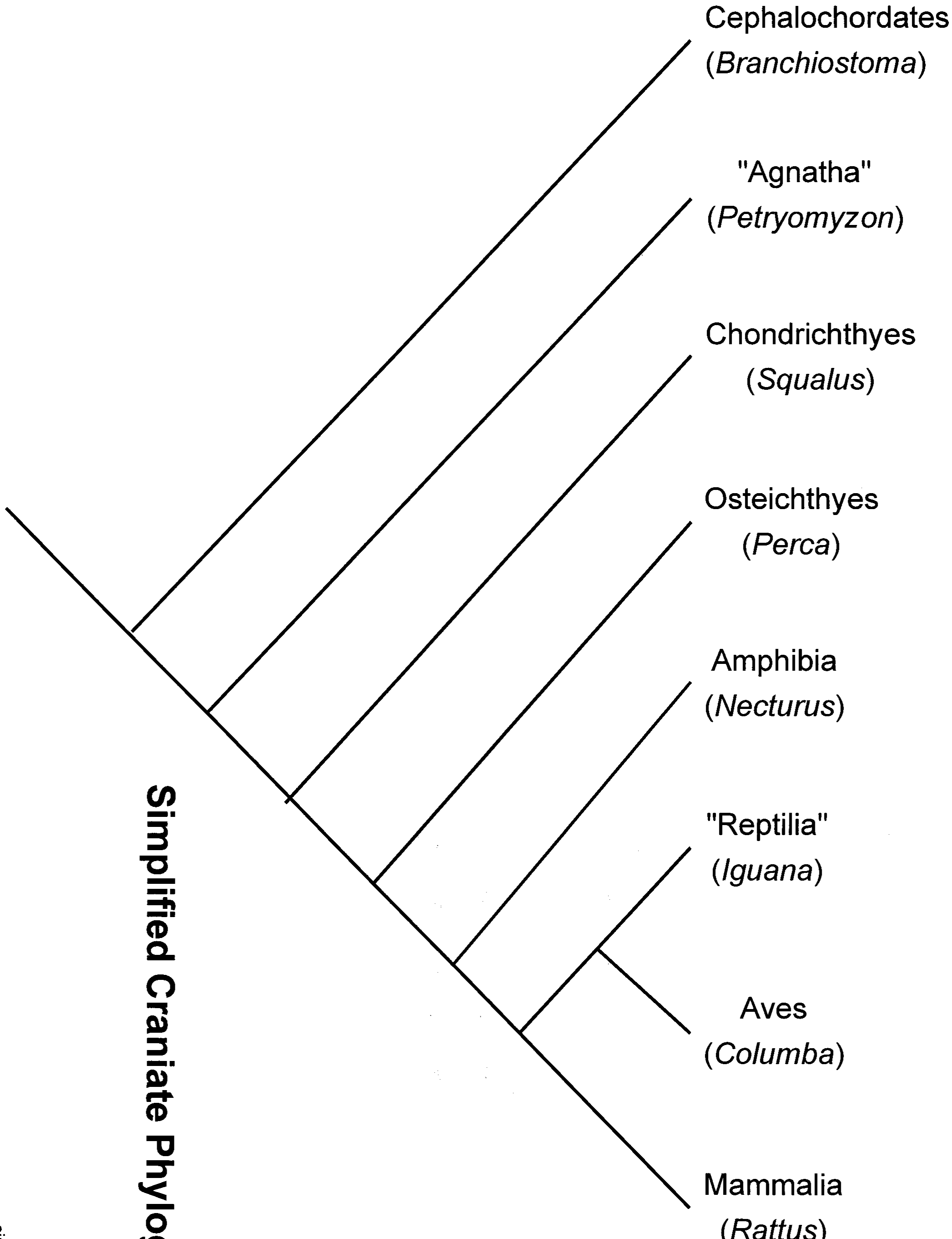

Simplified Craniate Phylogeny

simpvert.ds4