The impact of the recognizing evolution on systematics

1. Genealogical relationships between species could serve as the basis for taxonomy
2. Two sources of similarity:
   (a) similarity from descent
   (b) similarity caused by convergence (driven by natural selection for the same function).

Phylogeny as the basis of Taxonomy

Before the acceptance of evolutionary theory, "related" and "naturalness" where used with a variety of meanings.
After Darwin "genealogically related" when we say "related" and we could *define* "naturalness" of taxa by whether or not they recognize clades.

clade – a branch of a phylogenetic tree including an ancestral species and *all* of its descendants.
monophyletic – the adjective form (from the Greek words "mono" for one and "phylon" for race, class or tribe). A clade is a monophyletic group.

Darwin’s largest contributions to systematics

1. provided a theoretical base for understanding the existence of the Linnean hierarchy and “relatedness” among organisms.
2. provided the expectation for a historical continuity among organisms – led to an emphasis on phylogeny reconstruction that underpins current systematics.

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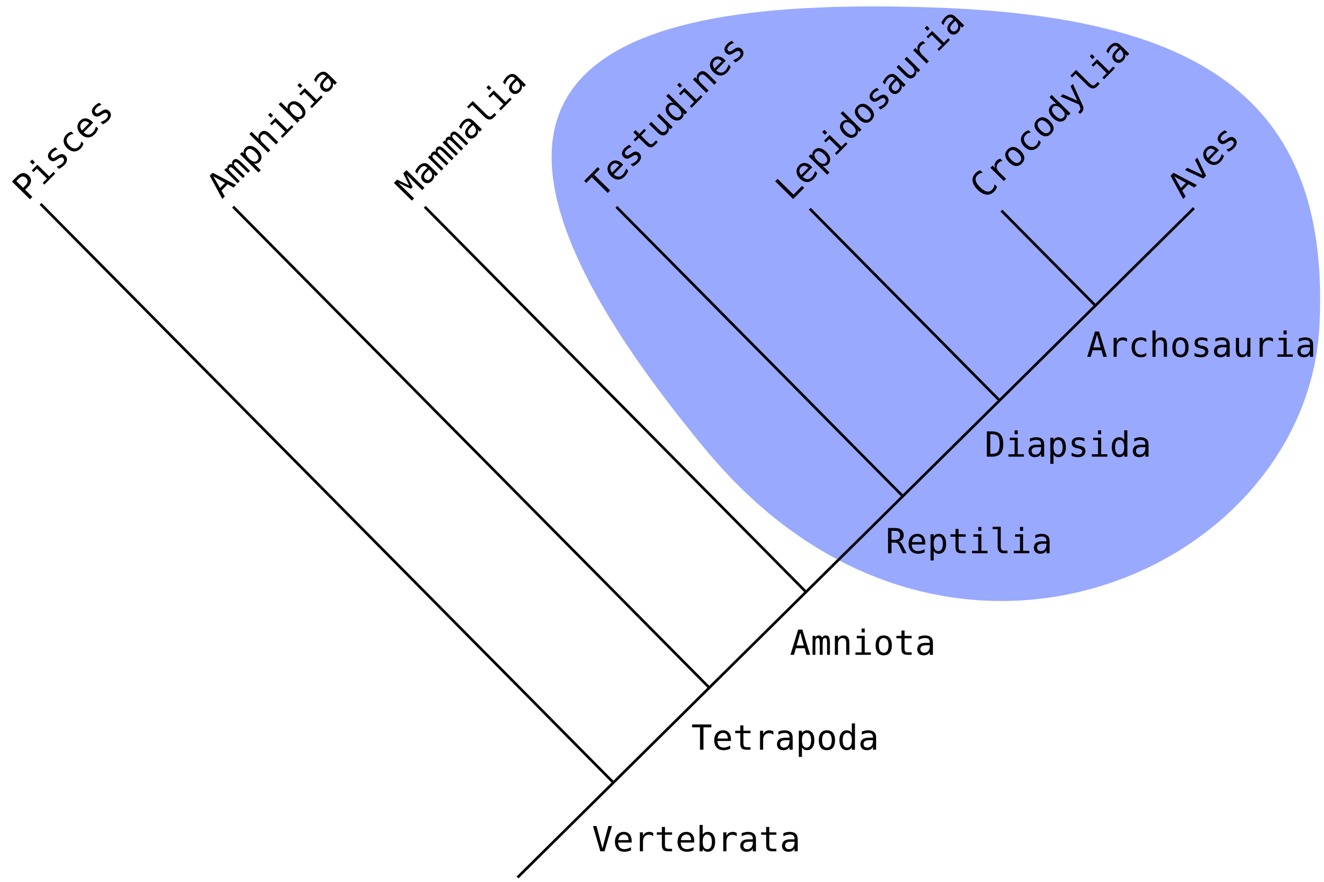

Monophyly
image from http://en.wikipedia.org/wiki/Monophyly

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Similarities from common descent – "homologous characters"

- may exhibit anatomical correspondences coupled with functional difference – co-opting of existing structures.
- similarity in seemingly arbitrary features – "frozen accidents"

Convergent ("analogous") characters tend to:

- have similar function, and similar in form on a gross level – differ in details.
- present problems when we try to imagine a continuum of descent (final structure made by different parts, or significant devolopmental differences).
- have obvious fitness implications.

These "rules of thumb" too vague to provide an error-proof means of distinguishing from homology, but they capture a key insight of evolutionary thinking.

Taxonomy after Darwin

A burst of interest in phylogeny reconstruction, e.g., tree like constructions of Haeckel(1860 - 1890's).

But in the late 1800's and early 1900's there was a decline in systematics:

1. uncertainty about the reliability of phylogeny reconstruction and how to separate this from classification (conceptual problems)
2. disappointment in failure to resolve higher level phylogeny.
3. practical procedure for inferring phylogenies were lacking –
4. growing competition from other emerging branches of biology (embryology, cytology, Mendelian genetics, physiology, biochemistry, etc.)

5. Development of the codes of nomenclature became a focus of some researchers
6. Rise of population thinking became a focus of systematists. With the growth of the field of genetics and an understanding of the structure of populations, a new direction was forged for systematics.

International codes of nomenclature

Zoology (1901)
Botany (1930)
Bacteriology (1947)
The codes provided for:

1. rules for choosing among competing names
2. rules for how names must be proposed to be valid.

“The New Systematics”

book of that title by Huxley, J. (1940) gave its name to the movement – blended into the Modern Synthesis of evolutionary biology.

- a merger of “evolutionary taxonomy”, genetics, and theory of populations
- Concentrated on ‘microtaxonomy’ – species, subspecies and populations.

Phylogenetics before the 1960's

1. Many systematists conceded that phylogeny should be the basis of taxonomy but were very pessimistic about the prospects of inferring phylogenies.
2. Phylogeny estimates were the results of *ad hoc*, inscrutable analyses by experts rather than clear protocols.
3. There was debate on whether or not phylogenetic information should be the *only* information affecting taxonomy.

Three schools of Systematics

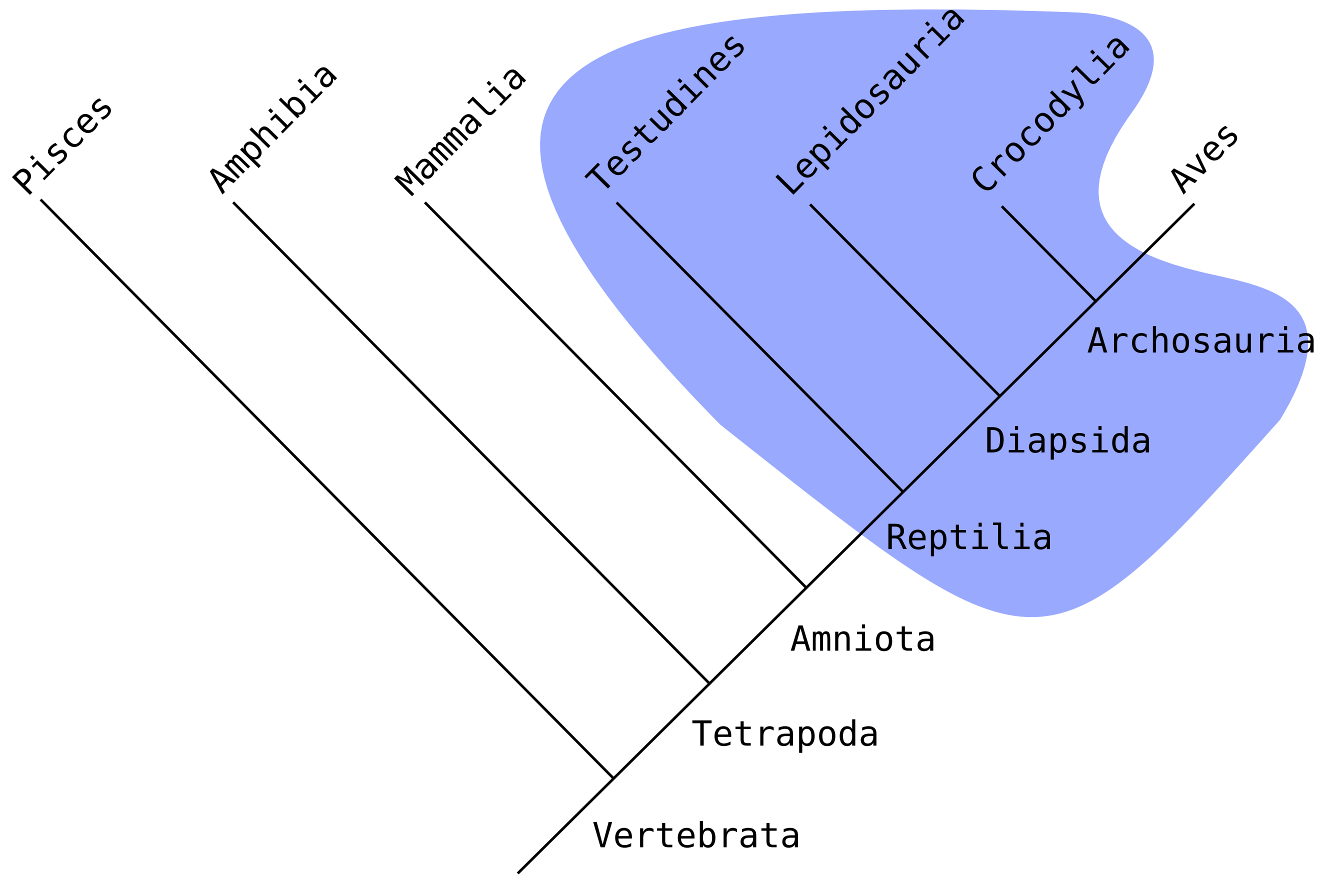
	Evolutionary Systematics	Phenetics	Phylogenetic Systematics
We can estimate phyologenies for most groups?	?	No	Yes
Taxonomic procedures must be standardized?	?	**Yes**	Yes
Taxonomy should reflect phylogeny only?	No	No	Yes

Evolutionary Systematics

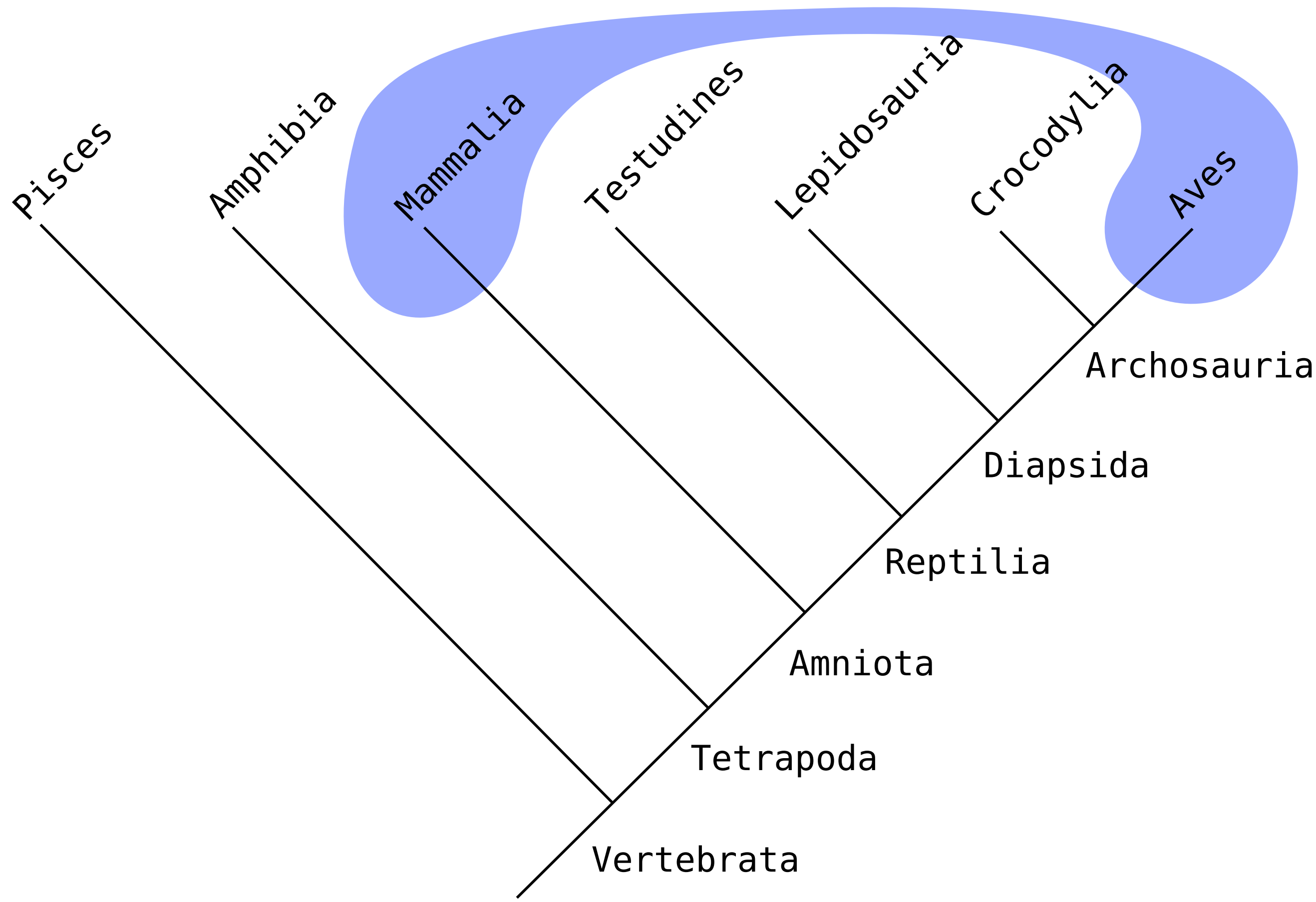
Different types of evolutionary change

1. **cladogenesis** - speciation, splitting of a lineage into 2 or more descendants
2. **anagenesis** - change within a lineage.

"Evolutionary" systematists felt that *both* types of changes must be reflected in classification – so that classification reflected both major components of evolution.



Paraphyly
image from http://en.wikipedia.org/wiki/Monophyly



Polyphyletic
image from http://en.wikipedia.org/wiki/Monophyly

Criteria for Delimitation and Ranking of a group

Quoted (or paraphrased) from page 267 Mayr and Ashlock (1991)

1. Distinctness (size of gap between groups)
2. Degree of difference (within a group - tight clusters argue for ranking).
3. Evolutionary role (uniqueness of adaptive zone)
4. Grade characteristics. grades are – “similar in general level of organization” (Simpson, 1961). E.g. prokaryotes.
5. Size of taxon
6. Equivalence of ranking in related taxa (balance)
7. Stability

Classic examples of the evolutionary systematics approach

1. Aves and Reptilia as classes – despite the fact that some "Reptiles" (e.g. crocodylomporhs) are more closely related to birds than they are to lizards.
2. Huxley (1940) suggested that humans should be in their own phylum – "Psychozoa" – because reasoning and rational thought were particularly important innovations.

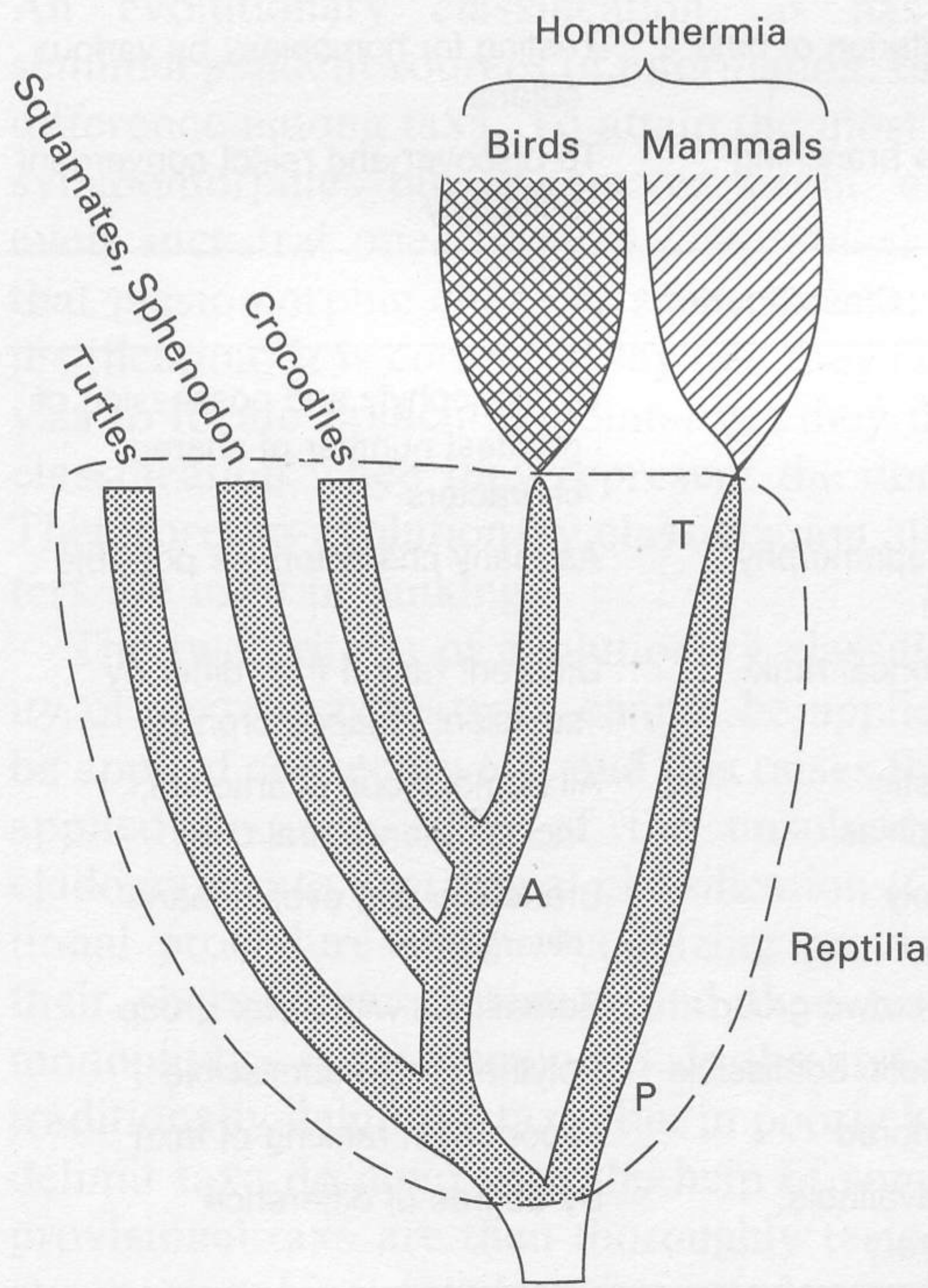


FIGURE 10-3
A phylogeny of the Recent classes of Amniota, with the monophyletic (though paraphyletic) Reptilia, the two holophyletic ex-groups Birds and Mammals, and the invalid convergently polyphyletic taxon Homothermia. A = Archosauria, P = Pelycosauria, T = Therapsida. (*After Carroll 1988.*)

From Mayr and Ashlock, 1991

Numerical taxonomy – phenetics

1. choose the specimens OTU's: operational taxonomic units
2. choose and measure characters (largest number possible).
3. treat characters equally
4. code the characters in a matrix
5. produces a similarity matrix.
6. use clustering methods to group OTU's

References

Mayr, E. and Ashlock, P. D. (1991). *Principles of Systematics Zoology*. McGraw-Hill, New York, 2nd edition.