

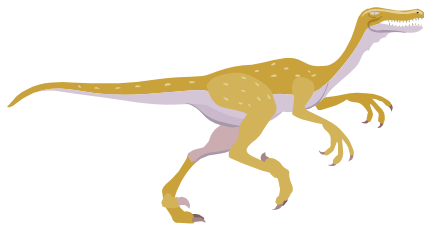


# The Origin of Higher Taxa



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employment somewhere)



- Why don't we see new phyla, *etc.* evolving today? (We do see new species and genera.)
- Why does the number of new categories at higher levels peak earlier than at lower levels (*e.g.*, most phyla present by end of Cambrian)?
- Does this pattern pose a problem for conventional evolutionary models?
- (Related questions about the rapidity of the Cambrian radiation are outside the present scope. See Campbell and Miller in Perspectives on an Evolving Creation.)

# Review of Linnaean categories (“taxa”)

- Urkingdom: Eukaryota, Archaea, Eubacteria
- Kingdom: Animalia, Plantae, Fungi, *etc.*
- Phylum Chordata, Porifera, Mollusca, Arthropoda, *etc.* (Division in plants)
- Class Mammalia, Gastropoda, Crustacea, *etc.*
- Order Primates, Veneroida, Lepidoptera, *etc.*
- Family Hominidae, Unionidae, Cidariidae, *etc.*
- Genus *Homo*, *Amblema*, *Ittybittium*, *Agra*
- species *Homo sapiens*, *Amblema plicata*, *Agra vation*, *Extra extra*
- Can modify with super-, sub-, infra-, *etc.*
- Most higher categories include multiple lower categories.
- Mnemonics such as King Phillip Came Over For Greasy Spaghetti

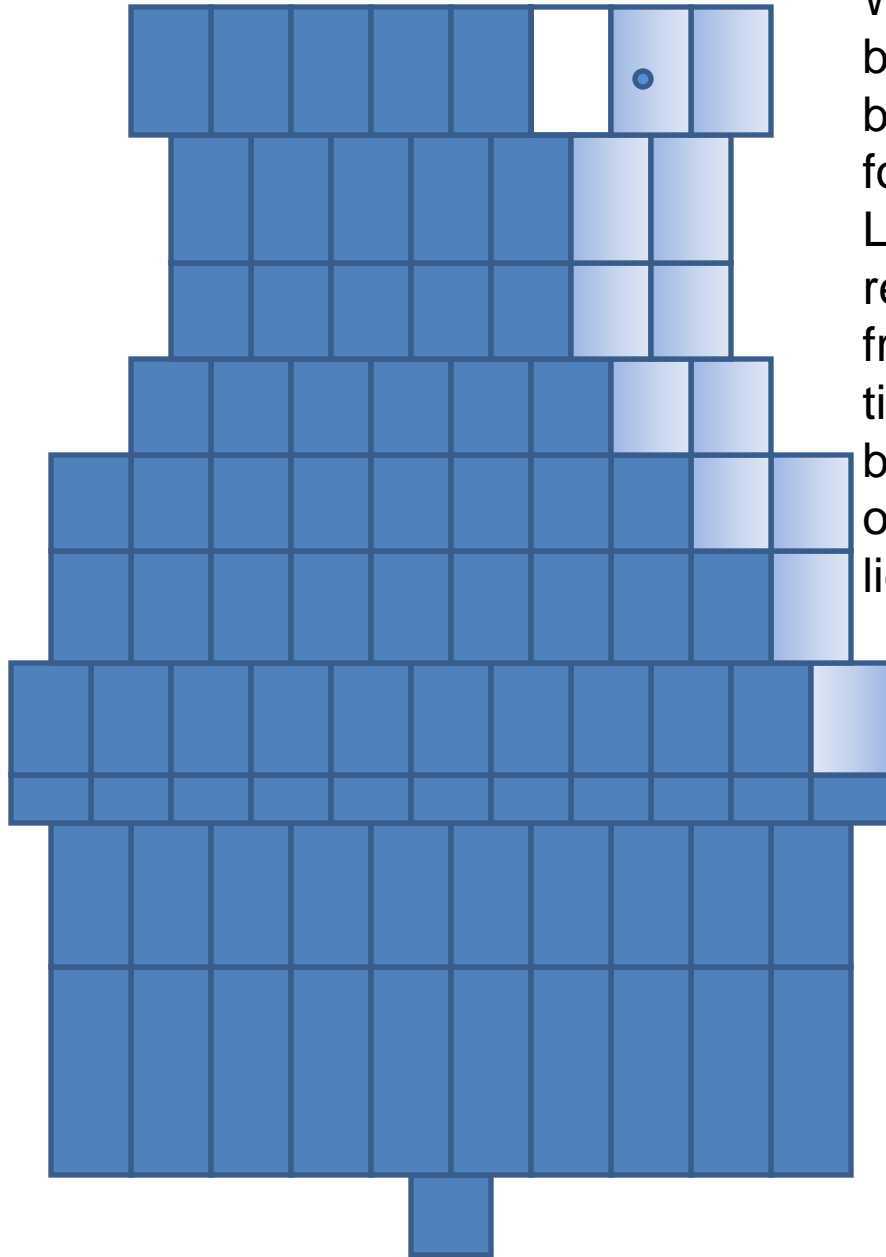
# What is the observed pattern of origination?

- Many sources (such as some conventional biology textbooks) exaggerate the magnitude of the Cambrian radiation; focus on animals can also mislead.

Actual pattern:

- Animals show a rapid increase in phylum diversity in the late Precambrian and Cambrian, with a slight to pronounced lag in the peak number of new taxa at successively lower levels
- Occasional later peaks at various taxonomic levels
- Protists, fungi, plants-more gradual increase but similar lags and peaks
- Many things only known from Recent.

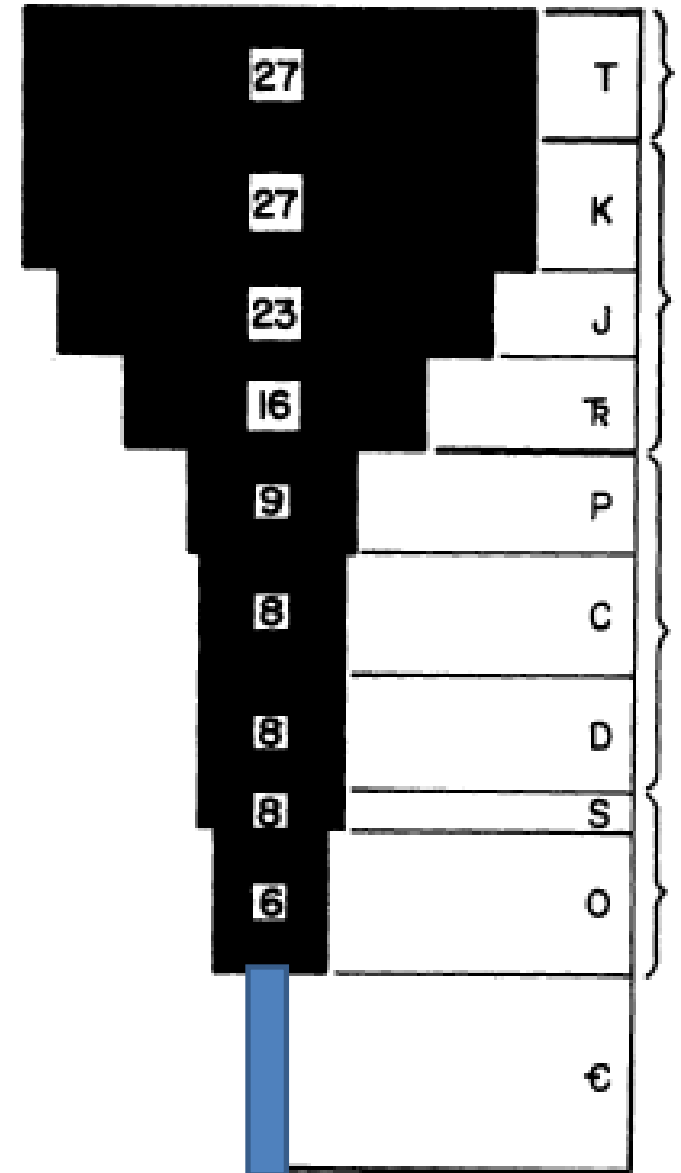
## Classes of Mollusks



White  
box=soft  
bodied, no  
fossil record  
Light blue=  
recorded  
from older  
time interval  
but not in the  
one with the  
light blue

## Bivalvia

## SUPERFAMILIES



S. Stanley, 1968, J Paleo 42(1)



Hello my name is

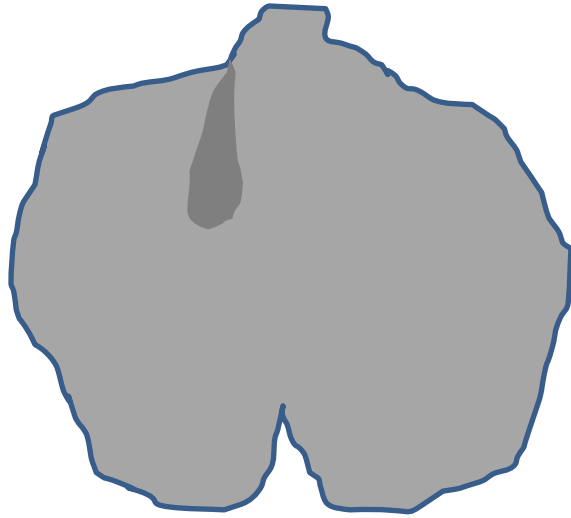
# Nomenclatural factors

- Because the system is hierarchical, appearance of any subgroup automatically entails the appearance of all the higher groups.
- The time of appearance of a higher taxon will equal the oldest time of any contained taxon; most higher taxa contain multiple lower taxa.
  - For example, discovery of a fossil snail, clam, or squid would establish the presence of mollusks.

- The time of appearance of a higher taxon will equal the oldest time of appearance of any contained taxon.
  - Campbells have been around much longer than me (much to the regret of many neighboring clans in Scotland). Scottish people have been around much longer than Campbells



# Minor exception-*incertae sedis*



*Gluteus minimus*, about 1 cm long.  
They are abundant in one particular layer, but what sort of organism made them is unknown.

- Distinctive forms sometimes get names even if we don't know what they are at a higher level
- More commonly the case with older fossils
- Davis, R. A. and H. A. Semken. 1975. Fossils of Uncertain Affinity from the Upper Devonian of Iowa. *Science* 187(4173): 251-254 .



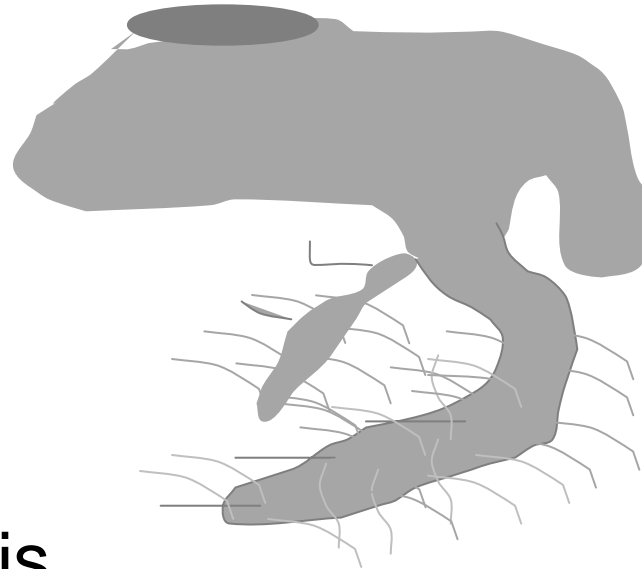
# Nomenclatural factors

- Definitions of higher taxa emphasize features perceived to be higher-level. They therefore will tend to be relatively generic
- Therefore, definitions of higher taxa apply to more things
- They may also be recognizable even when lower-level assignment is unclear.
- *Campeloma* but which species?



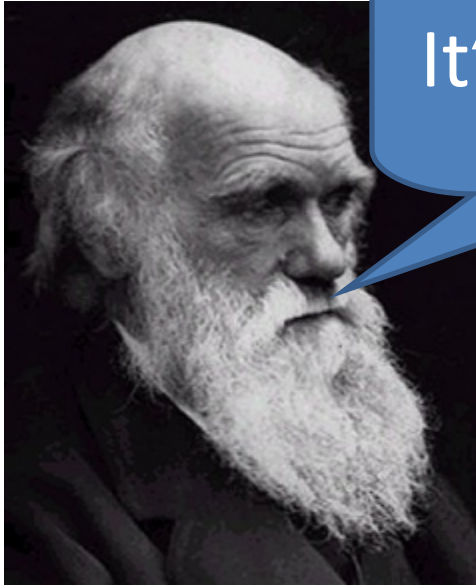
# Nomenclatural conservatism

- If a group of weird forms lacks standard features of a taxon but clearly belongs with it, taxonomists do not generally make new categories



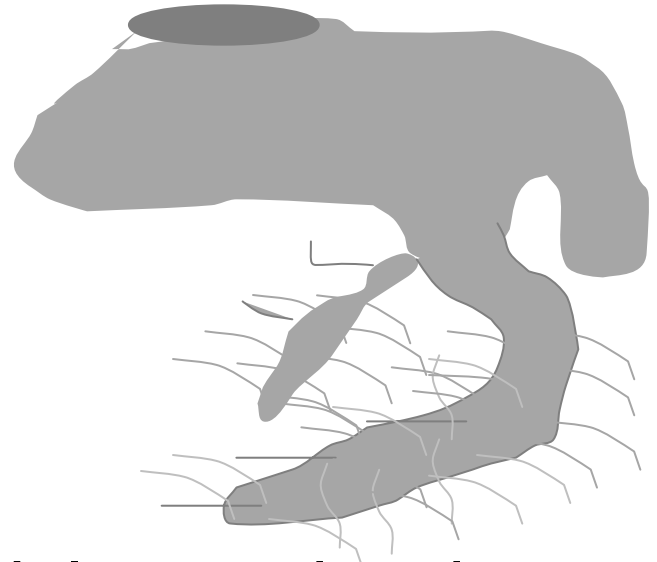
Guess what this organism is!

# Nomenclatural conservatism

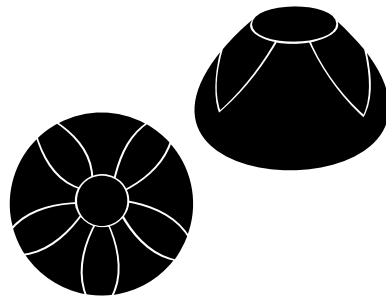


It's a barnacle!

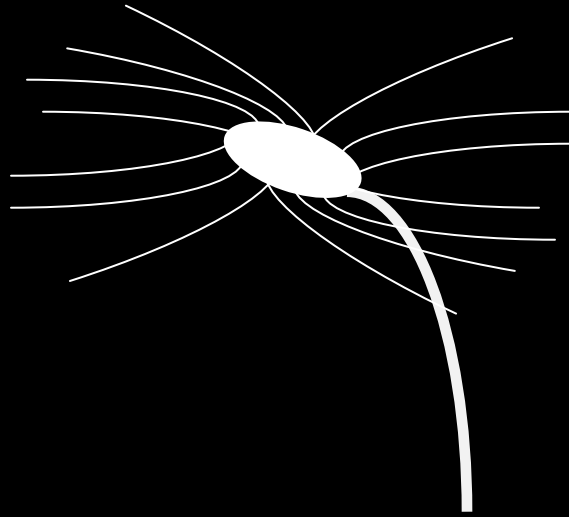
Famous barnacle expert (who also wrote about other organisms)



Although this adult parasite shows little sign of affinity, the larvae are standard baby barnacles.



# Poriferan without pores!



This deep-sea sponge has spicules and other features very similar to some fairly ordinary sponges. However, it entirely lacks the pores and water filtering feeding system that is characteristic of the phylum and instead traps small animals on its surface and digests them.



# Fossilization

- The fossil record is very patchy.
- The more inclusive the category, the better the chances of finding it.

# Fossilization

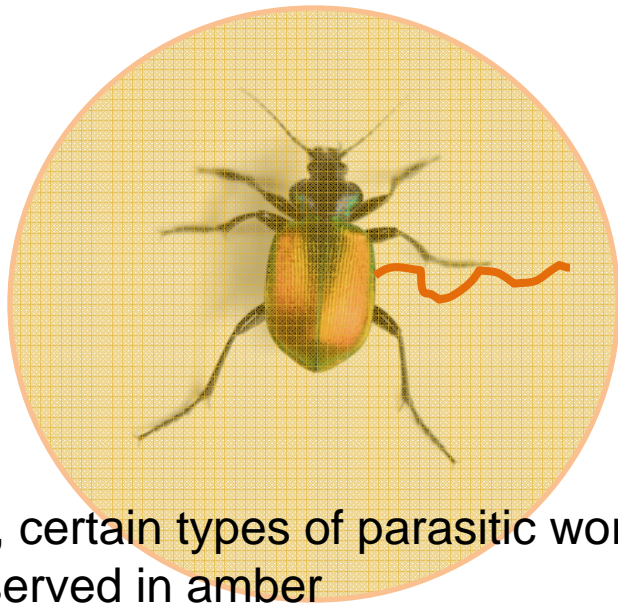
- Taphonomy-death, decay, destruction-many factors affect the preservation of fossil and what we can tell about the organism
- A poor fossil may still be identifiable to a higher category
  - A bit of exoskeleton with jointed leg is definitely from an arthropod, even if we can't tell what kind
  - Footprints from Alabama show that large pelycosaurs were present in the lower Pennsylvanian of Alabama, but we have no evidence about the rest of the body.





# Lagerstätten

- Deposits with exceptional preservation of fossils
- Not beer from Staten Island
- Most peaks in appearance of new higher taxa are associated with them, especially for soft-bodied forms.



Again, appearance in the fossil record of any lower taxon automatically is a record for the including higher taxa.

For example, certain types of parasitic worms are known as fossils only when their host got preserved in amber

# Fossilization

- The older the deposit, the more chances for geologic forces to destroy it. Thus, we generally have patchier sampling the older things get.
- Higher taxa, being more inclusive, are more likely to occur across a wide range geographically and ecologically and thus have a better chance of getting represented than any one included taxon.
  - Most orders of birds occur in North America and Australia, but only about ten species out of several hundred occur both places
  - Families of snails are generally either freshwater, terrestrial, or marine, but higher groups often include different major habitats.

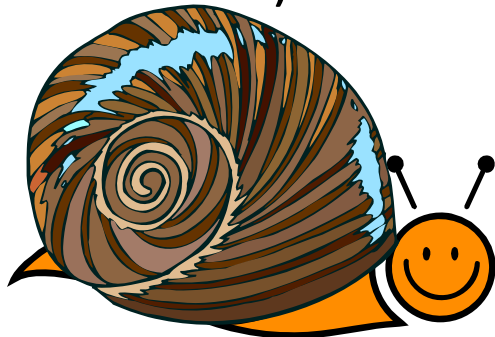




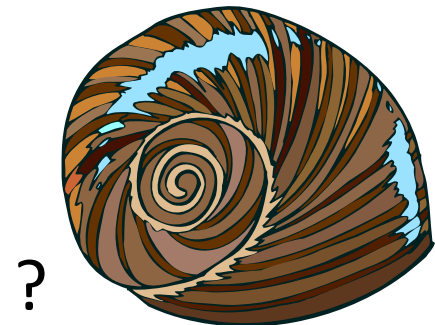
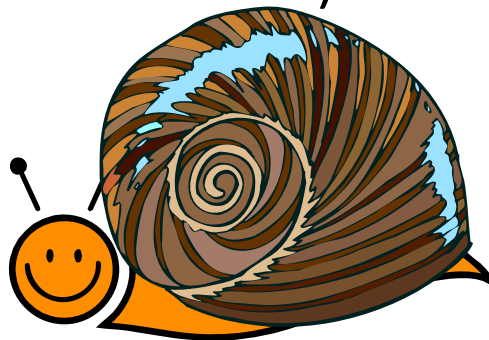
# Fossilization

- Some taxa are distinguished by poorly fossilized key features; however, they may be assigned to a higher taxon
- Ellis Yochelson once claimed that no one had found a definite fossil snail. The key feature to be a real snail is whether the body is twisted relative to the head-foot
- Although fossils similar to modern snails may be confidently regarded as snails, several older fossils not clearly related to modern snail groups are definitely mollusks but might not be true snails.

Snail (coil points backwards)



Non-snail (coil points forward)

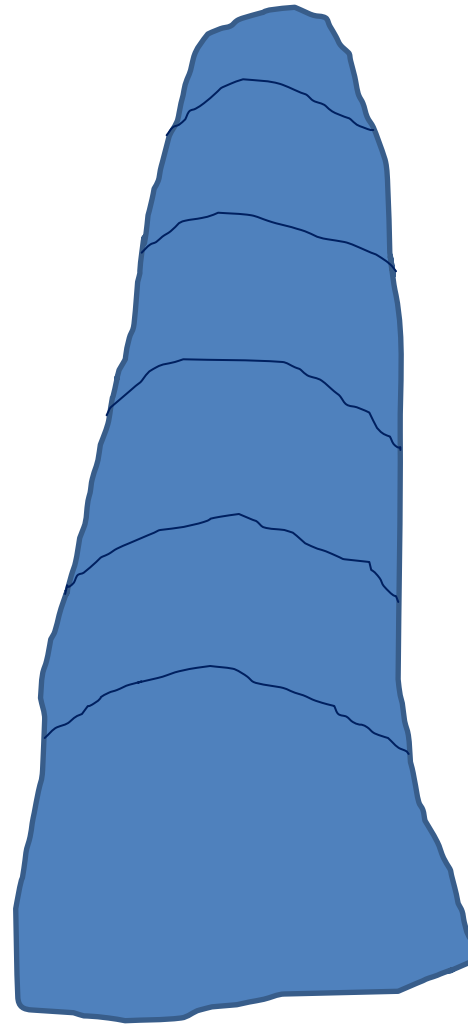


All of those apply to any scenario of origins.

Additional evolutionary considerations also make us expect a pattern similar to the observed one.

# Higher taxon= evolved earlier

- More inclusive category would have evolved earlier
- The oldest fossils may be generic (not yet evolved features of lower taxa) or transitional (starting to evolve the features).



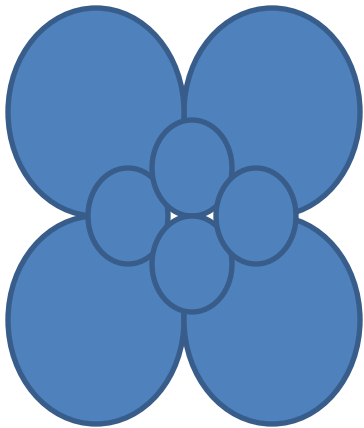
Cambrian almost cephalopod-the shell is chambered but there's no connecting tube. Definitely a mollusk, but what class to call it?

# “If it ain’t broke, don’t fix it”

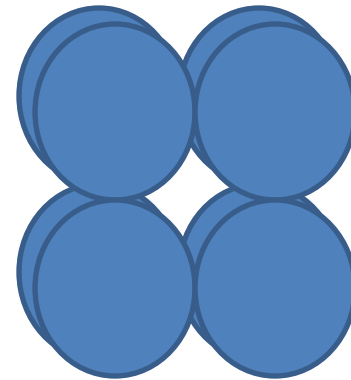
- The key distinguishing features of phyla and higher groups often have pervasive effects, beginning early in development.
- Altering such basic features, once they are established, often has a lower probability of success than tweaking more peripheral features or adding new things

For example, major groups of animals (deuterostomes and protostomes) start embryonic cell division differently

Early embryos, viewed from above



Spiral cleavage (most invertebrates)



Radial cleavage (vertebrates, echinoderms, etc.)

A photograph of a building at night with a prominent sign that reads "NO VACANCY". The sign is illuminated, with "NO" in red neon-style letters on a dark background and "VACANCY" in red letters on a white rectangular background. The building's facade is dark, and the sky is a deep blue.

# NO VACANCY

Less room for innovation as competition increased over time

E.g., why don't we see cats evolving into dogs? Because they would be competing with dogs which are already good at being dogs. If dogs went extinct, maybe cats would evolve into dogs.

A glowing white rectangular sign with the word 'VACANCY' in red, bold, sans-serif capital letters is mounted on a dark, possibly black, building facade. The background is dark, suggesting a night scene, with some architectural details of the building visible. The sign is slightly tilted to the right.

# VACANCY

More opportunities after mass extinctions

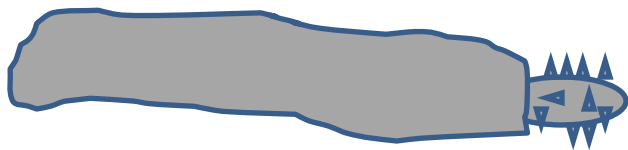
More opportunities in new habitats

More opportunities with key innovations

For example, the relatively late origin of several vertebrate classes reflects the new opportunities on land

# Cladistic classification

- Many taxonomists today are averse to having one taxon evolve into another one of the same rank (paraphyly)
- Acanthocephalans demoted from phylum to a class of rotifers; whales are a subgroup of artiodactyls rather than a separate order; birds as dinosaurs
- Some avoid using fixed ranks of taxa (phylum, class, etc.)



Acanthocephalan-parasite



Free living rotifer

# Hindsight

- In most cases, higher taxa are named because they form a distinct group. Wait a few million years to see what present-day taxa are at the root of future groups, and we can tell what new higher taxa are evolving today.





# Conclusions

- The hierarchical classification of organisms and the nature of the fossil record make us expect to see new higher taxa peak in number no later than, and usually sooner than, lower taxa.
- Evolutionary considerations give additional reasons to expect such a pattern.
- This only proves that evolutionary expectations match the diversification pattern at different taxonomic levels.
- Popular apologetics often needs more care in thinking out arguments. Let's help!