

## Laboratory VI Arthropods

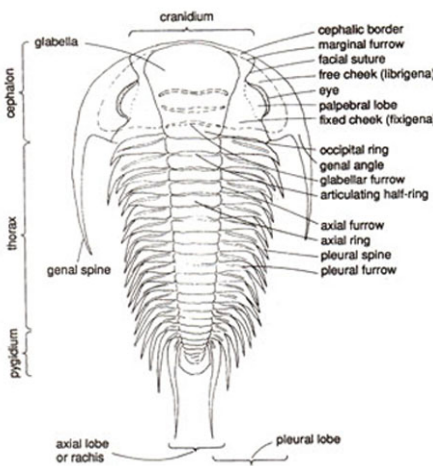
**Objective:** This is the second of three labs that will be introduced you to the main groups of fossil-forming marine invertebrates. You have two goals in this lab. (1) To understand the basic morphology of the group, and (2) to absorb the fundamentals of its classification. In lab, you will have a variety of specimens from most groups to examine. For each, you should observe the morphological features present in the fossils and link them to discussions of basic biology. You should also learn to identify the major groups.

**READ:** Chapters 14 in Prothero to accompany this handout. Bring your book to lab. The pictures will help!

**NOTE: The dichotomous key for trilobite orders will be due in lecture on Friday 1 March**

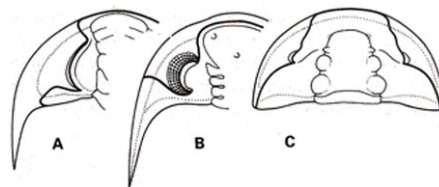
### Trilobites

Trilobites are among the most charismatic of marine invertebrate fossils. Next to ostracodes, they are also the most common arthropod fossils. They appeared in the Early Cambrian, were common until the end of the Ordovician, limped through that extinction, the Late Devonian extinction and finally became extinct at the end of the Permian.



The group takes its name from its three-part (tri-lobed) design. They have a head shield (**cephalon**) with a central bulb (**glabella**), the main body (**thorax**) that is composed of a variable number of segments, and a tail (**pygidium**). Each segment on the thorax includes a pair of branched legs. One branch contained gills, while the other was for walking or swimming. The cephalon is divided into several plates that broke apart during molting. Four patterns of plate sutures occur and these patterns are useful in distinguishing the major trilobite groups. In the **marginal** type of suture, only a narrow edge of the cephalon is separated from the main portion. In the **opisthoparian** type (A), the suture ends behind the corners of the cephalon (**genal angle**). In the **proparian** type (B), the suture ends above or in front of the

corner of the genal angle. In the **gonatoparian** type (C), the suture ends right at the corner of the cephalon.



Most trilobites have compound eyes, the first organisms to have them.

Order Agnostida (Cambrian – Ordovician) – button-shaped pygidium of equal size to the cephalon and only two or three thoracic segments.

Order Redlichiida (Cambrian) – marginal or opisthoparian cephalic sutures, may have long genal spines. Many thoracic segments. Small pygidium but may have a long tail spike. Large half-moon-shaped eyes.

Order Corynexochida (Early – Middle Cambrian) – opisthoparian sutures, large polygonal glabella. Thorax with 7 or 8 segments. Large pygidium that may be almost as large as the cephalon.

Order Ptychopariida (Middle Cambrian – Ordovician) – glabella tapers toward the front, with a large area of cephalon in front of it. Opisthoparian sutures, many thoracic segments and small, simple pygidium. This group is probably a taxonomic "waste basket" which means that it likely isn't a natural group, containing lineages that resemble each other because of convergence. The phylogeny bears this out. Note that the two genera representative of this group, *Ptychoparia* and *Olenus* are paraphyletic.

Order Asaphida (Middle Cambrian – Ordovician) – similar smooth cephalon and pygidium, opisthoparian sutures, 6 to 9 thoracic segments. Pleural lobes are rounded at the ends.

Order Illaenida (Cambrian – Devonian) – similar smooth cephalon and pygidium, or pygidium may be larger than the cephalon.

Order Trinucleida (Ordovician – Middle Silurian) – cephalon that may be over half the length of the body, short thorax and small pygidium. Marginal suture, glabella wider toward the front. No eyes.

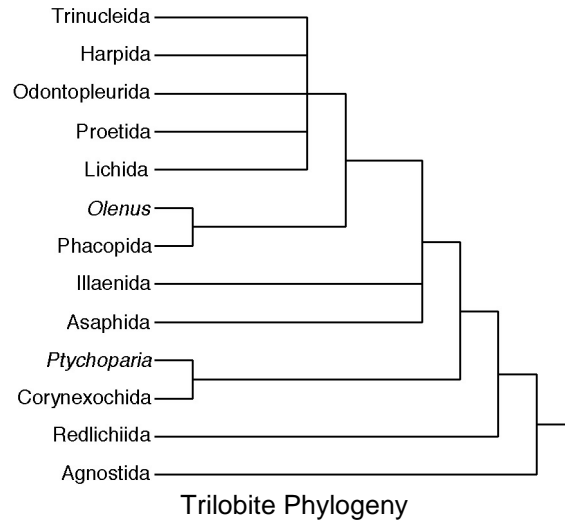
Order Harpida (Late Cambrian – Late Devonian) – large cephalon, short thorax and small pygidium. Glabella tapered toward the front. Eyes.

Order Phacopida (Ordovician – Devonian) – proparian sutures.

Order Licida (Ordovician – Devonian) – glabella extends to the edge of the cephalon and may be divided into a number of segments. Large pygidium that may be composed of three pairs of expanded and fused thoracic segments.

Order Odontopleurida (Ordovician – Devonian) – spines on the cephalon, thoracic segments and pygidium.

Order Proetida (Late Cambrian – Devonian) – opisthoparian suture, large glabella and large pygidium.



### Chelicerates

The chelicerates include the arachnids (spiders, scorpions, daddy–long–legs, mites, ticks and chiggers), horseshoe crabs, and the eurypterids (New York’s State Fossil!). The chelicerates have only two body segments (head and thorax combined). The front segment bears a pair of **chelicerae** that serve as mouth parts, **pedipalps** that can be mouthparts or pincers, and four pairs of walking legs. The back segment contains no appendages.

Spiders have a poor fossil record due in part to their terrestrial lifestyle and part to their lack of mineralized hard parts. However, a few are known from extraordinary fossil assemblages like amber. An extinct spider–like group, the trigonatarbids, are present in the Early Devonian Rhynie Chert plant assemblages. Here they appear to have been predators on other arthropods.

Horseshoe crabs (Silurian – Recent) have a long history in a variety of habitats. They are characterized by a large head shield, relatively long abdominal segment and long sword–like tail. Although the group has had more diversity in the past, its basic design and lifestyle appear to be little changed.

Eurypterids (Ordovician – Permian) were the top predators of the Paleozoic. They are morphologically variable. In some, pedipalps are modified into pincers. The tails of some are modified as paddles, while others have a long tail spine like the horseshoe crab. In some, walking legs are modified into paddles, while in others, legs may have allowed the eurypterid to walk on the bottom or perhaps in very shallow water. This variety of form suggests a variety of ecologies, from swimming to stalking the bottom of a variety of habitats.

### Crustaceans

Crustaceans (lobsters, crabs, shrimp, barnacles) have a basic body design that includes two pairs of antennae in front of their mouths, and three pairs (maxillae and two pairs of mandibles) behind the mouth. The major groups within the crustaceans are distinguished based on the number of walking legs. For example, decapods (crabs and lobsters), which appeared in the Devonian, have 10 pairs of walking legs.

This group also includes the barnacles, which resemble arthropods mainly during larval stages, and ostracods. Ostracods are small (< 2 mm) crustaceans that live in a two-valved shell. They are both planktonic and benthic. They are also numerous and fast-evolving, making them excellent biostratigraphic tools.

### Tracheata

This group includes the millipedes, centipedes and insects. All three groups have a long, but spotty fossil record. Millipedes, which really have 100–200 legs, are known from the Late Silurian; centipedes, with 50–80 legs, first appear in the Early Devonian. Insects are known from the Middle Devonian, again from the Rhynie Chert. Like spiders, the insect fossil record consists mostly of a few extraordinary *Lagerstätten*, particularly amber. Thus, we know a great deal about Eocene insects from the Baltic region and Cretaceous ones from Puerto Rico, but little in between. However, based on these data and a robust phylogeny of living insects, we can show that most of the major groups originated early. The relative late-comers were butterflies, ants, wasps and bees, which appear in the Jurassic and Cretaceous.

**In lab?** In lab you have three main tasks.

- (1) Using the characters discussed above, sort trilobites into major groups. Once sorted, make some drawings of representatives from each major group for which we have representatives.
- (2) Examine specimens of the other major arthropod groups discussed above. Sadly, we don't have representatives of each, but we do have examples of the most common. Make drawings in your notebook that will allow you to recognize these major groups again if you were to see them, say, on a quiz. Also make some written notes about how to distinguish major groups.
- (3) Add the ranges of all of these groups to our course time line.
- (4) Examine the lobster to observe his/her characteristic morphology.
- (5) Develop a dichotomous key for the orders of brachiopods discussed above. A dichotomous key is a series of questions arranged in a decision tree. If each of the questions is answered correctly, the user should arrive at the correct identification of the taxon. For example, here is a dichotomous key for the students in this class:

### Questions for Further Thought

1. Prothero discusses the idea that Coryneochid trilobites may be pedomorphic. Describe the evidence that supports this argument.
2. In your notes, outline the major phases of insect evolution. What do Labandiera and Sepkoski (1993, *Science* 261:310–315) say about the co–diversification of flowering plants and the insects that might have pollinated them (butterflies, bees etc.).
3. Look carefully at the phylogeny of trilobites. Now look at the ranges of each of the lineages. Do you see evidence of inconsistency between these two patterns? Ghost lineages? Later branched lineages appearing in the fossil record before earlier–branching taxa?