Evolution of terrestriality in arthropods

Arthropod structures that enhance terrestrial living

- exoskeleton
- internal fertilization
- flexibility of respiratory structures

Examples of terrestrial radiations

**Crustaceans**
- maintain gills
- often close to water
- Hermit crabs, fiddler crabs, shrimp
- pill bugs (Isopoda)
  - probably from marine environments
  - 5000 species total, probably several hundred terrestrial ones

**Chelicerata**
- modifications to exoskeleton and internal physiology
- many similarities between marine and terrestrial forms

**Myriapods and insects**
- Both groups have
  - respiration through a tracheal system
  - blood does not need to circulate for oxygen transfer
  - openings to outside spiracles
  - excretion through malphigian tubules
- Myriopods depend on humid environments and have no waxy cuticle
- Hexapods do not depend on moisture

Mapping arthropod features onto phylogeny
- Difficult to resolve deep relationships (star phylogeny)
- Biramous appendages probably primitive
- Mandibles probably primitive
- Originally marine
- Terrestriality evolved multiple times
- The tracheal system and malphigian tubules are shared homologies between myriopoda and hexapoda
Fossil record

arthropods

Arthropods were present in the early Cambrian
Some forms clearly recognizable as belonging to existing groups,
others not
the trilobites went extinct

Evolution of hexapods

types of insect fossils
sedimentary deposits
insects in amber (65 MYA-recent)
between 400 and 350 million years ago
first hexapod found is 390 MYA- Devonian
belonged to a currently recognized insect order
freshwater deposits scarce, so it is difficult to find earliest
insect fossils
carboniferous period (285-360 MYA)
diversification of several groups that have since become extinct
evolution of wings
more than 300 MYA
Palaeodictyoptera- extinct at end of Permian
Related to cockroaches and earwigs
over seventy genera in 20 families
Had long wings- 56 cm!
appearance of some existing groups (dragonflies, mayflies, cockroaches)
gigantism in ancient insects
large forms found in several groups
may have been caused by higher oxygen levels in atmosphere
as levels declined, tracheal system could not support the large size
timeline for appearance of groups
appearance of beetles, bugs, dragonflies in the Permian period
butterflies and wasps appear in Triassic
by end of cretaceous, the insect fauna is modern

Morphological evolution in insects
Existing species often several million years old
Genera older than that
Morphological evolution in insects may be relatively slow
Insects and plants

earliest plant fossils show evidence of insect damage
some old fossils of flowering plants (e.g. sycamore, 97 MYA) show
damage by insects related to extant species
insect plant associations can be very old and diversification of
plants may have enhanced that of insects

cautions in interpreting the fossil record

the oldest fossil does not necessarily represent the earliest
member of a group
fossils do not necessarily represent ancestors of existing
species
features of fossil organisms are not necessarily more primitive
than those of extant ones