

COLEOPTERA: Derived from the Greek word “koleos” meaning “sheath”; and “pteron” meaning “wing”, refers to the front wings which are hardened wings that cover the second pair of wings used for flight that are folded when not in use.

Common name: Beetles

Coleoptera is the largest order in the animal kingdom and has as many species as the entire plant kingdom including algae and fungi. An estimated over 350,000 species have been described worldwide with more added to the list each year (ca. 40% of the known species in Hexapoda). There is almost as much diversity within several of the larger families in the Coleoptera than in many orders. Identification of even family level can be challenging. Certain families are much more commonly collected than others. If these large families are recognized, then time spent using keys can be greatly reduced.

The 12 most common and species abundant families are (includes 70 % of Coleoptera and most of the economically important Coleopterans species):

- 1) Carabidae (ground beetles)
- 2) Staphylinidae (rove beetles)
- 3) Scarabaeidae (scarabs)
- 4) Buprestidae (metallic wood boring beetles)
- 5) Elateridae (click beetles)
- 6) Cantharidae (soldier beetles)
- 7) Cleridae (checkered beetles)
- 8) Coccinellidae (lady beetles)
- 9) Tenebrionidae (darkling beetles)
- 10) Cerambycidae (long horned beetles)
- 11) Chrysomelidae (leaf beetles)
- 12) Curculionidae (weevils)

Diagnostic characters of Coleoptera: Front wings (**elytra**; singular-- **elytron**) usually meet in a straight line down the middle of the back of each beetle and cover folded hind wings, biting/ chewing mouth parts with well-developed mandibles, and no cerci. Key characters used to make identifications to family are antennae, leg characters; thoracic sclerites, and to a lesser extent head, size, shape and color. Wing folding is usually uniform and specific from family to family.

Classification/ Phylogeny: Currently there is general agreement among many specialists on suborders but there is debate among Coleopterists at the super family and family levels. (Some of the debate stems from classification systems based on larval characters vs. adult characters). The modern consensus is that Coleoptera were derived from some Megaloptera

– like ancestor, probably in the Permian period. Lower Permian fossils exist that exhibit elytral venation intermediate between primitive existing Coleoptera and Megaloptera.

Some richness of extant Coleoptera is associated with extreme morphological, ecological and behavioral diversity. An ongoing debate by evolutionary biologists centers around: “what has contributed to this diversity over time”. To date, diversification of the most species-rich extant lineages has been associated with co-radiations with angiosperms in the Cretaceous (herbivory), and/or mammals, and /or geological and climate change. A recent study suggests that the pre-Cretaceous origin of more than 100 present-day lineages and sustained diversification in variety of niches.

COLEOPTERA SUBORDERS:

Archostemata--Considered the most primitive beetle group. The earliest beetle fossils are from the upper Permian and belong to this suborder; a few species survive to this day. Thirty-five known species occur worldwide, 5 of which are found in North America—rare. Immatures and adults are often associated with logs of oak, pine, chestnut. Some adults are pollen feeders; larvae often bore into fungus-infested or rotting wood. Two families: Cupedidae, Micromalthidae.



Myxophaga-- about 65 species occur worldwide, but only 4 in the United States. Beetles are very tiny (0.5-2.0 mm) and the biology of species in each family is poorly known. Adults of many species are found at stream margins, sometimes in the splash zone. Adults and their aquatic larvae feed on algae growing on rock surface. Several species have been collected in hot springs. Females produce one large egg at a time and often oviposit on mats of algae. Two families: Microsporidae, Hydroscephidae.



Adephaga-- Includes about 10% of all beetle species; most members of this suborder are predacious beetles, with only a few species secondarily phytophagous or algophagous (sea weed). This suborder contains both terrestrial and aquatic groups.



Polyphaga-- this suborder includes almost 90% of the Coleoptera families.



COLEOPTERA: Biology and Ecology

Holometabolous: Egg, larva, pupa, adult

Egg features:

Eggs are often laid singly but some groups (e.g. Coccinellidae and Chrysomelidae) lay eggs in clusters. **Oothecae (ootheca singular)** or egg cases are produced in some families (e.g. Hydrophilidae; and some Hydraenidae [minute moss beetles] enclose eggs singly or in groups within silken cocoons produced by colleterial glands--(a paired accessory reproductive gland, present in most female insects). Some Chrysomelidae produce oothecae that are composed of feces (scatoshells), colleterial gland secretions or both.

Truly **viviparous** species which eliminate the egg stage and bear live young are rare among Coleoptera. Some species within Staphylinidae and Chrysomelidae lay eggs that

hatch immediately or during deposition (**ovoviviparous**)--- producing young by means of eggs that are hatched within the body of the parent.

Parental care, which includes mass provisioning and guarding of eggs and/or larvae is exhibited by some Coleoptera (example: some Carabidae; Silphidae; Staphylinidae; Scarabaeinae; Geotrupidae: Geotrupinae; Chrysomelidae: Hispinae).

Egg bursters (hatching spines) are common in Coleoptera suborders Adephaga and Polyphaga (absent in other suborders). An egg burster is a tooth or spines on the head, thorax and abdomen of a late stage embryo that is used to rupture the egg shell when hatching; it is often retained by 1st instar larvae.

Larvae:

The number of larval instar in Coleoptera varies from 1 to 30, but is normally 3-5. Adephaga, Staphylinoidea and Scarabaeoidea go through 3 instars; some Leiodidae species (Bathysciinae-- round fungus beetles adapted to ice caves: 1 larval instar), produce large eggs and newly hatched larvae are almost fully grown.

Larval characters may differ in form and function from first to last instar (# antennal segments, tergal pigmentation, skeleton, etc.). A prepupal stage is common before the pupal stage.

Hypermetamorphosis (or **larval heterometamorphosis**, i.e., extreme differences in form and function between larval instar) occur within some groups. A common type of hypermetamorphosis in Coleoptera: an active first instar that is involved in active or passive dispersal (**Triungulin**: name based on apparently 3-clawed first instar of some Meloidae) followed by inactive or non-mobile instars. This type of development is often found in parasitic groups; some species of Carabidae, Staphylinidae, Rhipiceridae and Cucujidae actively seek larval hosts as first instars and some Meloidae and phoretic on adults until transported to larvae. In some nonparasitic groups that exhibit hypermetamorphosis, eggs are laid on or near the subsurface of soil, and first instar then seek out and infest subsurface roots (example: several species of Buprestidae, Cerambycidae). A unique situation occurs in Cantharidae (soldier beetles) where the first instar is the inactive stage (called the **prolarva**) and subsequent instar are mobile; this has been termed **foetometamorphosis**. The most complex types of hypermetamorphosis may involve two or more larval types (i.e. Meloidae).

Various terms are used to describe different larval types (forms).

Polypod larvae are characterized by cylindrical bodies with short thoracic legs and abdominal prolegs (pseudopods) (some Lepidoptera, Hymenoptera, many Mecoptera, and few Coleoptera). These larvae are also termed as “Eruciform” (cylindrical type).

Based on number and location of prolegs, these larvae are further classified as:

- a) Caterpillar
- b) Semilooper and
- c) Looper.

a. **Caterpillar:** It is a type of polypod larva which bears 3 pairs of thoracic legs and 5 pairs of prolegs. The prolegs are present on 3, 4, 5, 6, & 10th abdominal segments e.g. Larva of Lemon butterfly, larva of gram pod borer etc.

b. **Semilooper:** It is a type of polypod larva which bears 3 pairs of thoracic legs and 3 pairs of prolegs. Prolegs are present on 5, 6, and 10th abdominal segments e.g. Castor Semilooper, cotton Semilooper etc.

c. **Looper:** It is a type of polypod larva which bears 3 pairs of thoracic legs and two pairs of prolegs on 6th and 10th abdominal segments e.g. Cabbage looper.



a

b

c

Oligopod larvae lack some abdominal prolegs but have functional thoracic legs and frequently prognathous mouth parts (many Coleoptera);

Apod larvae lack true legs and are usually worm-like or maggot-like living in soil, mud, dung, decaying plant and animal material or within the bodies of other organisms as parasitoids (some Coleoptera, Diptera, Hymenoptera).

Beetle larvae may be found in almost any habitat, but certain habitats can be particularly fruitful for collecting (i.e. leaf litter/soil; rotten wood; bracket fungi; rotten cambial layer beneath bark of logs or standing dead trees).