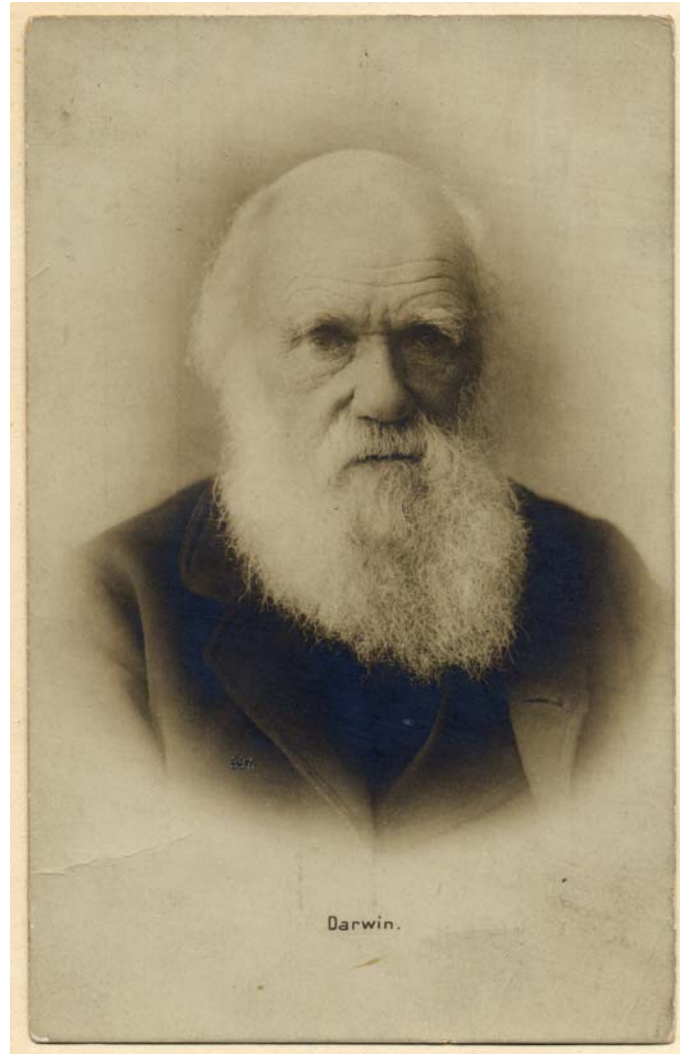
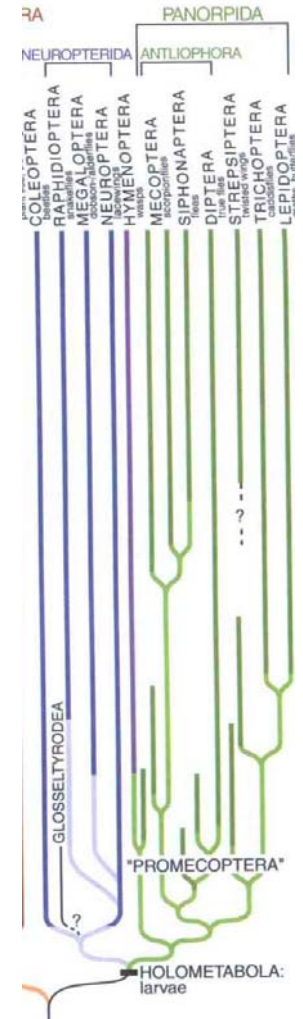
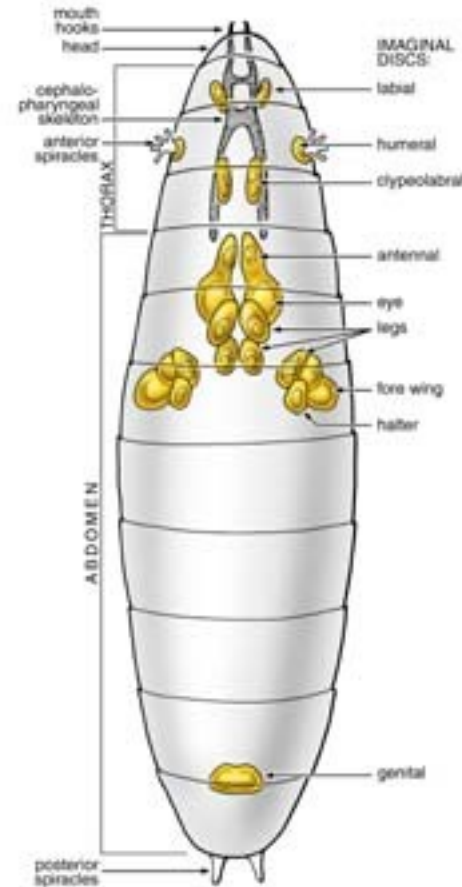


Happy 200th Birthday, Charley!



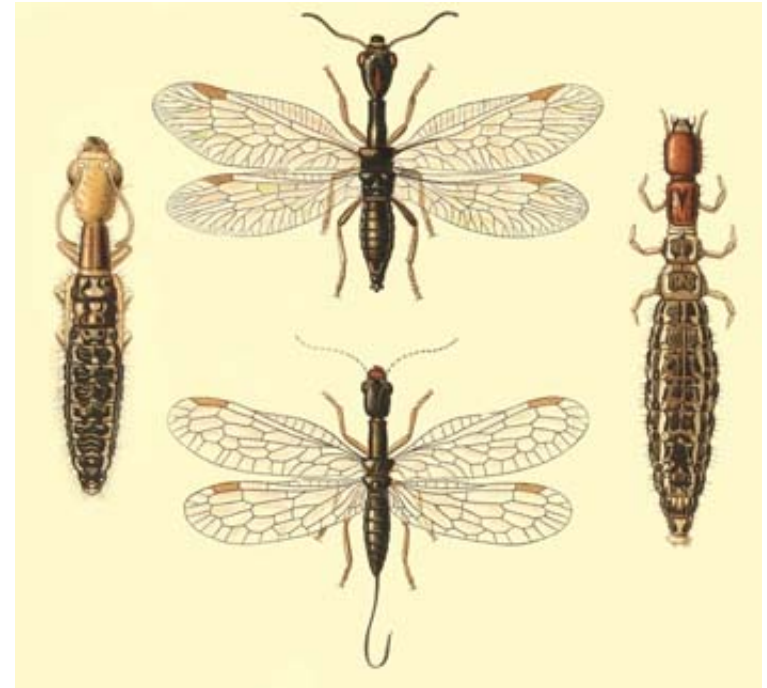
Insect Orders IV: Holometabola

- Holometabola are those insects with complete metamorphosis. Holometabolous insects have soft-bodied, wingless, morphologically reduced *larval* stage and a mostly quiescent *pupal* stage.
- The larva is the truly defining feature of Holometabola. During metamorphosis, which takes place as a pupa, much or all of the larval cuticle is replaced with the adult cuticle. The new cuticle is derived from imaginal discs, including the legs, eyes, genitalia and wings. Imaginal discs are pockets of specialized larval epidermal cells. Internal development of wings is why Holometabola are also called Endopterygota.
- The holometabolous lineages account for nearly 85% of all insects, and complete metamorphosis is considered one of the two most important innovations of insects along with wings.
- There is no doubt that Holometabola is a monophyletic lineage. There are 11 orders within the Holometabola, representing two major monophyletic lineages, the Neuropterida + Coleoptera and the Panorpida.



Raphidioptera (Snakeflies)

- **Classification.** 220 extant species divided into 2 families. Most basal group in the Neuropterida. Principally occur in cold temperate regions of the Holarctic. A relict group.
- **Structure.** Prothorax of adult elongate, but without raptorial forelegs as seen in mantispids. Female have a sturdy elongate ovipositor.
- **Natural history.** Live exclusively on trees and require at least some period of cold, near-freezing temperatures in order to complete development. Long ovipositor is used to place eggs under bark, which the larvae of many species develop. Larvae of other species are found in litter at the base of shrubs or trees or in rock crevices. Larvae and adults are predator of insect eggs and larvae. Snakeflies may be good, under appreciated biological control agents.



Megaloptera (alderflies, dobsonflies, fishflies)

- **Classification.** 270 species classified into two families. Distributed worldwide. Sister group of the Neuroptera.
- **Structure.** Distinctive aquatic larvae with short, strong mandibles and lateral abdominal gills. Pupal stage is naked with functional legs and mandibles. Mandibles used in defense, not for feeding. Males in some species of dobsonflies (Corydalidae) have greatly elongate, sickle-shaped mandibles, which are presumably a product of sexual selection.
- **Natural history.** Aquatic larvae are predaceous on small aquatic insects. Adults feed little or not at all. Development probably extends over two or more years. Larvae crawl out of the water and pupate in burrows or under stones.



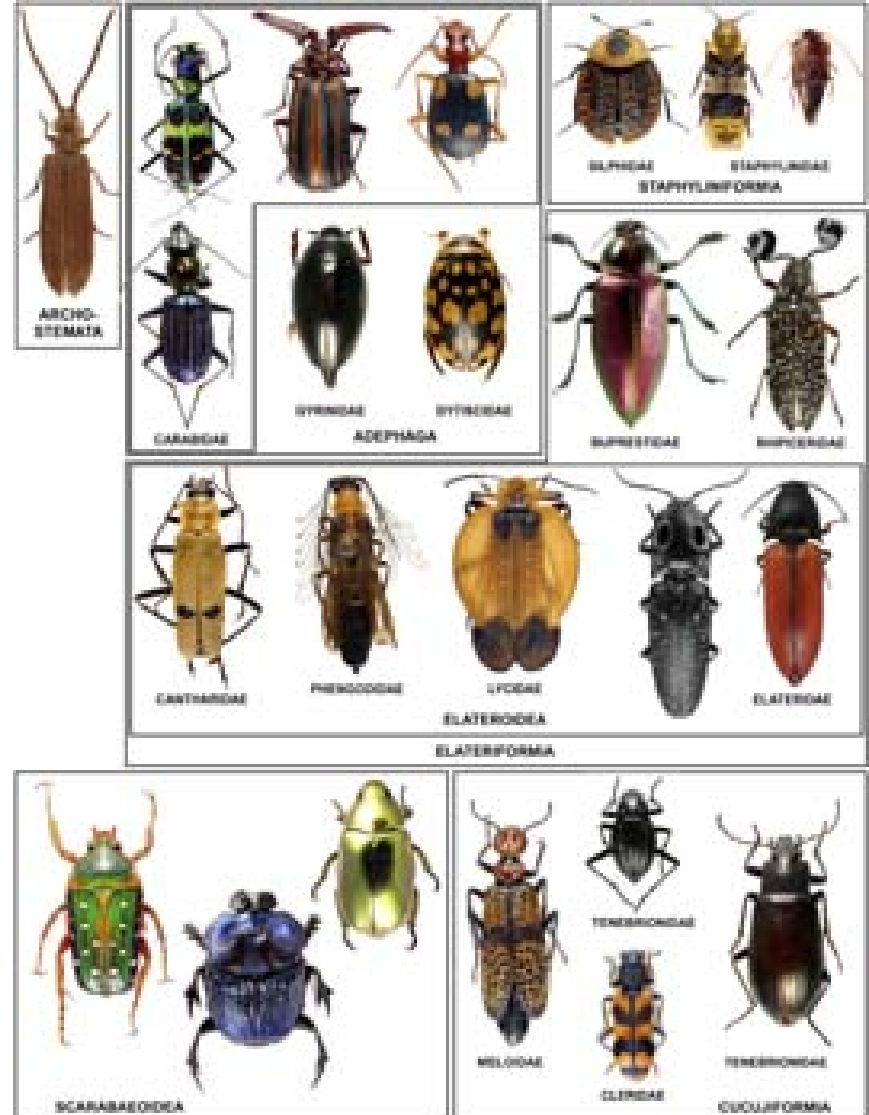
Neuroptera (Lacewings, antlions and relatives)

- **Classification.** Over 4000 extant species classified into 3 suborders. The Myrmeleontidae (antlions) is the largest family with around 2000 species. Neuroptera are distributed throughout the world.
- **Structure.** Mandibles of larvae are long and sickle-shaped. Food is sucked up through a channel formed between the mandibles and the maxillae. Mandibles are short and dentate in adults. Pupal stage is enclosed in a cocoon made of silk produced by the Malpighian tubules and spun by the anus. Forelegs of adults are cursorial except in the mantispids, in which they are raptorial. Adult owlflies and antlions hold their wings outward like odonates, whereas lacewings fold them roofwise over their abdomen.
- **Natural history.** Adults and larvae are predaceous, feeding mostly on small insects such as aphids, psyllids and scales. Antlion larvae form cone-shaped pits in the ground surface and feed on insects that fall into them. Larvae of mantispids are parasitic on spider egg cases. Larvae of one family feed on freshwater sponges. Some species of owlflies roost gregariously when inactive. Next to the Hymenoptera and the Diptera, Neuroptera is probably the most important group of potential biological control agents.



Coleoptera (Beetles)

- **Classification.** Coleoptera is by far the most diverse insect order with over 300,000 described species. Species divided into 4 suborders, with the Polyphaga accounting for 90% of all species.
- **Structure.** Fore wings are sclerotized into elytra (singular elytron) with indiscernible venation. Hind margins of the elytra contiguous in resting position. Prothorax freely articulates with the rest of the thorax and is large and shield-like. Heavily sclerotized abdominal sternites and less sclerotized tergites. Larvae of varied body form, but mostly grub-like. Generalized chewing mouthparts present in both adults and larvae.
- **Natural history.** Most species are phytophagous, but several families are primarily predaceous. There is debate over which diet is the basal condition. Species that feed on wood, wool, hair, feathers and dry cereal have special organs called mycetomes that house symbiotic yeasts and bacteria which aid in digestion. Species in several families produce light for mate attraction. Light is produced by the oxidation of luciferin by the enzyme luciferinase. Sound production is also found in beetles, but its function is not well studied. Many species have aquatic larvae, but very few species remain aquatic in the adult stage. Larvae have tracheal gills, but adults respire by trapping air under their elytra (dytiscids) or in dense pubescence around the abdomen (dryopids).



Strepsiptera (Twisted-wing parasites)

- **Classification.** 600 named species. Strepsiptera is a problematic group that has been associated with the Coleoptera, Diptera, Hymenoptera and Lepidoptera.
- **Structure.** Strepsiptera have many autapomorphies that unite the group. Absence of trochanter on legs, absence of a tentorium in the head, bulging larval-like eyes in the adult male. First pair of wings in males transformed into halteres. Sexual dimorphism is extreme. Adult females of parasitic species are larval-like, lacking eyes, wings and legs and body segmentation very indistinct.
- **Natural history.** Most species are parasitic. Hosts include insects in the orders Thysanura, Blattaria, Mantodea, Orthoptera, Hemiptera, Diptera and aculate Hymenoptera. The host is not always killed, but parasitization (stylopization) may result in castration of the host or the production of intersexuals. Life cycle is complex and involves hypermetamorphosis, or an active first instar larva (triungulin). Females produces numerous tiny, very active larvae which escape from the body of the host and disperse throughout soil and/or vegetation. They locate and enter the body of a host and metamorphosize into immobile legless larvae. After several larval instars they pupate in the host. Males emerge from the host and seek females. Females remain in the host with the anterior part of their body protruding between abdominal segments of the host.

