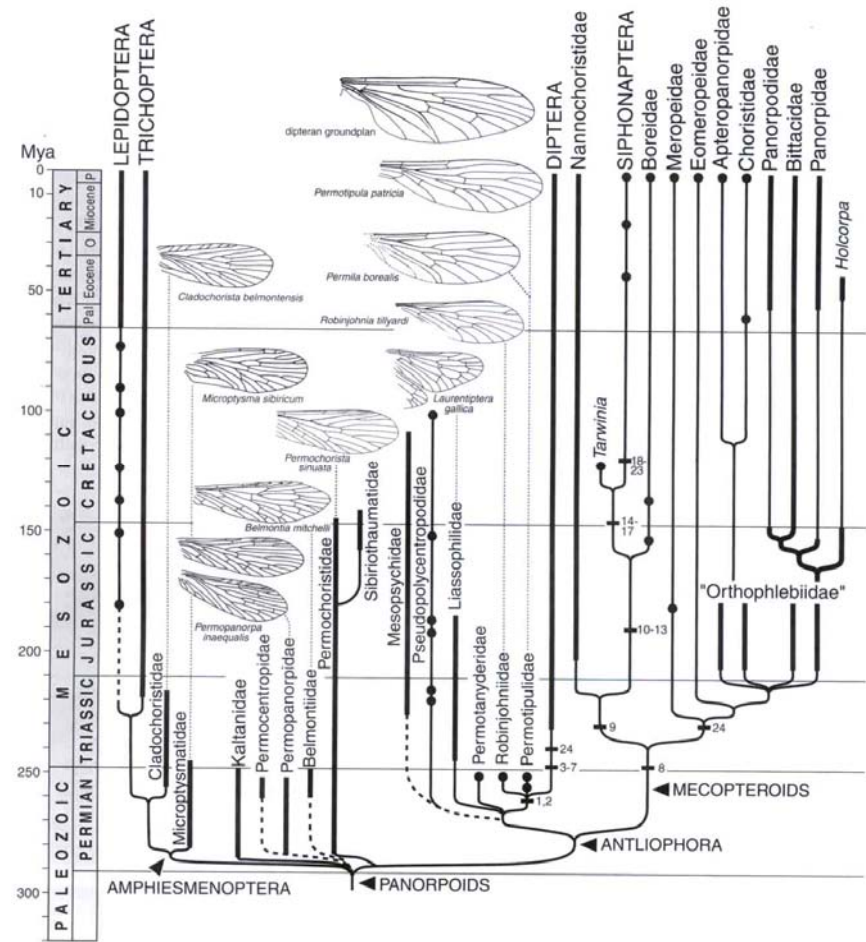


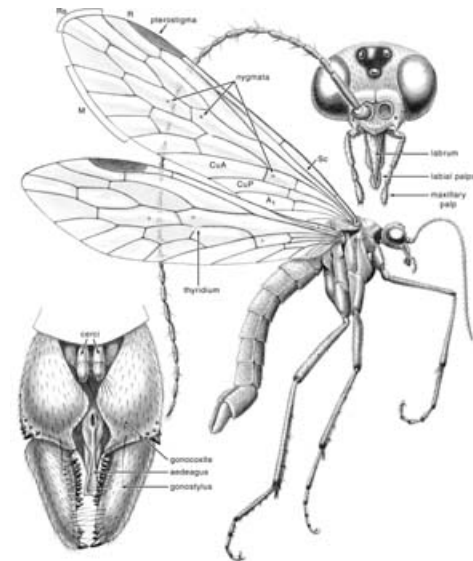
# Insect Orders V: Panorpoidea

- The Panorpoidea contain 5 orders: the Mecoptera, Siphonaptera, Diptera, Trichoptera and Lepidoptera.
- Available evidence clearly indicates that the Lepidoptera and the Trichoptera are sister groups.
- The Siphonaptera and Mecoptera are also closely related but it is not clear whether the Siphonaptera is the sister group of all of the Mecoptera or a group (Boreidae) within the Mecoptera. If the latter is true, then the Mecoptera is paraphyletic as currently defined.
- The Diptera is the sister group of the Siphonaptera + Mecoptera and together make up the Mecopteroids.



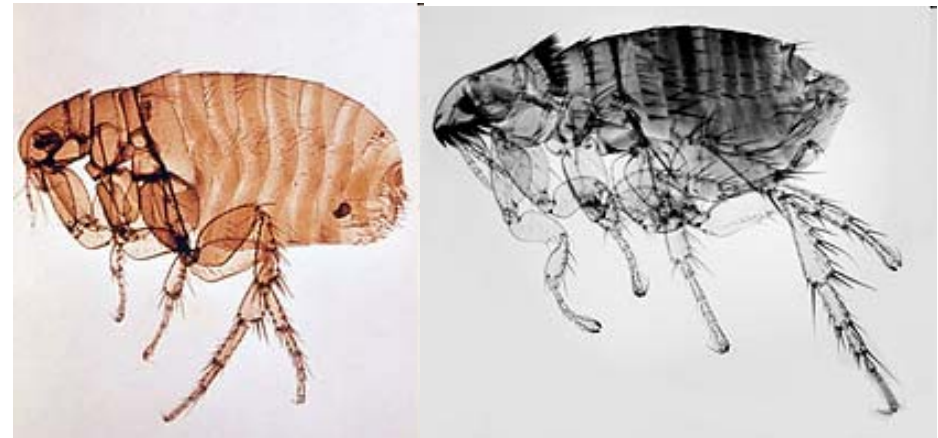
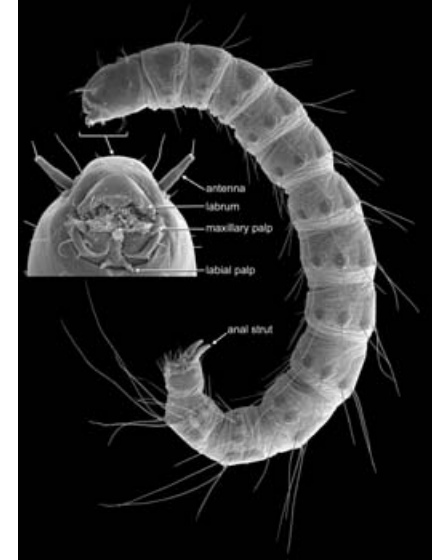
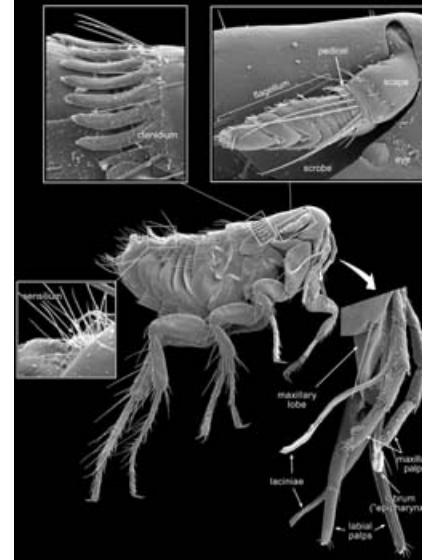
# Mecoptera (Scorpionflies, hangingflies)

- **Classification.** 400 species worldwide, arranged into 9 families (5 in the US). A very old group, many fossils from the Permian (260 mya) onward.
- **Structure.** Most distinctive feature is the elongated clypeus and labrum that together form a rostrum. The order gets its common name from the genital segment of the male in the family Panorpdiae, which is bulbous and often curved forward above the abdomen, like the sting of a scorpion. Larvae are caterpillar-like or grub-like.
- **Natural history.** Scorpionflies are most common in cool, moist habitats. They get the name “hangingflies” from their habit of hanging upside down on vegetation. Larvae and adult males are mostly predators or scavengers. Adult females are usually scavengers. Larvae and adults in some groups may feed on vegetation. Larvae of most species are terrestrial and caterpillar-like in body form. Larvae of some species are aquatic. In the family Bittacidae males attract females for mating by releasing a sex pheromone and then presenting the female with a nuptial gift. In some species the nuptial gift is an insect captured and killed by the male. In other species the nuptial gift is a droplet of hardened saliva. If the female accepts the nuptial gift she eats it while the male mates with her. Males sometimes mimic the behavior of females, steal the nuptial gift from a competing male and then use it to attract females of their own. In other instances a male will retrieve the nuptial gift from the female after he has mated with her and try to attract other females with the same gift.



# Siphonaptera (Fleas)

- **Classification.** 1400 extant species worldwide, arranged into 17 families. Numerous autapomorphic characters make sister group relationship difficult to determine.
- **Structure.** Body of adults bilaterally flattened. Compound eyes reduced, ocelli absent. Sucking mouthparts with labral and lacinial stylets, mandibles absent. Antennae short, recessed into cranial grooves. Legs and thorax of adults specialized for jumping. Thorax contain elastic material called resilin that is used in jumping. Larvae worm-like and apodous (without legs.)
- **Natural history.** Adults of all species parasitic on endothermic vertebrates. Adult males and females feed exclusively on blood of their hosts. Species vary in degree that they are dependent on their hosts. Adults of most species can survive for long periods off the body of their hosts. Larvae of most species are free-living and do not feed on blood. Instead they feed on detritus found in the nest or living quarters of their hosts. Larvae of dog and cat fleas are not found on pets, but are free-living in carpets or other areas where pets frequent. Host specificity varies among species. Lack of host specificity makes fleas important vectors of disease. Extraordinary jumping ability facilitates host switching in adult fleas. Breeding cycle of fleas closely tied to hosts. Reproductive cycle of European rabbit flea is determined by hormone levels in its host. Fleas respond to variation in corticosteroid levels in blood taken from host. Fleas reproduce at the same time as their hosts to facilitate transmission to uninfected individuals. Fleas are important vectors of human disease, such as the bubonic plague (the black death). Host reservoir of the disease is in rodent populations. Fleas move the disease from rodents to humans.



# Diptera (True flies)

- **Classification.** More than 150,000 extant species arranged in two suborders each with numerous infraorders. The **Nematocera** include in part the Tipulomorpha (crane flies), and the Culicomorpha (mosquitos, black flies and midges) and is not monophyletic. The **Brachycera** include in part the Tabanomorpha (horse flies, robber flies, bee flies, and dance flies) and the Muscomorpha (phorid flies, syrphid flies, fruit flies, flesh flies, tachinid flies and house flies).
- **Structure.** Most distinctive structural feature of the Diptera is the presence of a single pair of wings (the forewings). The hind wings have been reduced to small knobbed structures called halteres. These organs are used to maintain equilibrium during flight. Mouthparts of adults are highly variable. Some groups have mouthparts modified for piercing and sucking. In other groups they are modified for sponging and lapping. Larvae of the Nematocera have normal chewing mouthparts that are hinged to work in the lateral plane. In larvae of the Muscomorpha, the mandibles are reduced to specialized structures called mouth-hooks that are hinged to work in the vertical plane.
- **Natural history.** Adult flies are usually polyphagous, with other specialized as predators (robber flies), and others visiting flowers for pollen and nectar. Other species take only blood meals as adults (mosquitos and black flies). The parasitoid lifestyle have evolved many times in Diptera compared to only once in Hymenoptera. Larvae of the vast majority of the Nematocera are aquatic. Most Brachycera develop in terrestrial habitats, although the larval medium is frequently liquid (rotting fruit, decomposing flesh, host hemocoel). Larval respiration is usually directly from the medium, however some aquatic groups (mosquitos) take air. Chironomid midges absorb oxygen dissolved in water with the help of haemoglobin in the hemolymph. Reproductive habits of flies are highly variable. Most species deposit eggs in the larval substrate, but many tachinids incubate their eggs and then deposit larvae on or near their hosts. Many species form dancing swarms during courtship and mating. Other species form leks around the larval substrate (dung, host aggregations) or around other objects (vegetation). Diptera is an extremely important group to humans. Many species vector major human diseases (malaria, yellow fever, dengue fever, sleeping sickness, etc.) Other species are important agricultural pests and still others are important biological control agents.



# Trichoptera (Caddisflies)

- **Classification.** 12,000 extant species worldwide, arranged into 45 families. Cases made by larvae are distinctive and used to identify and classify species.
- **Structure.** Mouthparts of adults are non-functional or adapted to liquid food. Wings of adults with hairs and sometimes scales. Aquatic larvae make distinctive cases from material in the environment (leaves, twigs, sand grains, pebbles) held together by silk produced from modified salivary glands. Pupae have well developed mandibles that they use to cut through the larval case or cocoon when they are ready to emerge as adults.
- **Natural history.** Adults occur near water. Some species are found around tide pools or other highly saline water sources. Adults usually active in evening or at night. They tend to favor cool, dark, damp situations when inactive. Species that make larval cases are phytophagous. Net-making species are omnivorous that feed on material that becomes trapped in their nets. Free-living species that build neither cases nor nets are predaceous.



# Lepidoptera (Butterflies & moths)

- **Classification.** More than 100,000 extant species worldwide, arranged into numerous superfamilies including the Papilionoidea (butterflies), Hesperioidea (skippers), Geometroidea (geometrid moths), Bombycoidea (saturniids and silkworm moths) and Sphingioidea (sphingid moths), and many others. Diversification of Lepidoptera is usually attributed to exploitation of higher plants during the Upper Cretaceous and Tertiary Periods (70 mya).
- **Structure.** Wings of most species are covered with broad, colored, overlapping scales, an autapomorphic character of this order. Adults have sucking mouthparts that take the form of a long proboscis, which is coiled up under the head when not in use and uncoiled when feeding. Larvae have chewing mouthparts. Pupal stage is enclosed in a protective cocoon or chrysalis.
- **Natural history.** Vast majority of species are phytophagous. Adults feed on liquid food (nectar, blood) sucking it up with their highly modified proboscis. The proboscis is also used to collect minerals and other nutrients from a variety of liquid sources including urine, water puddles, rotting fruit and vertebrate tear ducts. Larvae of most species feed on leaves or other vegetative material of plants. Some species are predaceous on egg masses of other lepidopterans, spiders, or ant larvae. Larvae that feed in exposed situations are from more derived families and protect themselves against predators by being cryptic, distasteful or poisonous, mimetic or possessing spines or urticating hairs. Larvae protect themselves from parasitoids by associating with ants or encapsulating parasitic eggs or larvae. Adults of many species migrate over long distances (monarch butterflies, painted ladies, many tropical sphingids). Adults of many moths are endothermic, regulating their temperature shivering to produce body heat. Many species locate mates by using mating **pheromones**. The antennae of male moths are so sensitive to the female's sex pheromone that a single molecule of the correct substance can trigger an action potential and orient the male toward the female. Many species of butterflies are involved in mimicry complexes.

