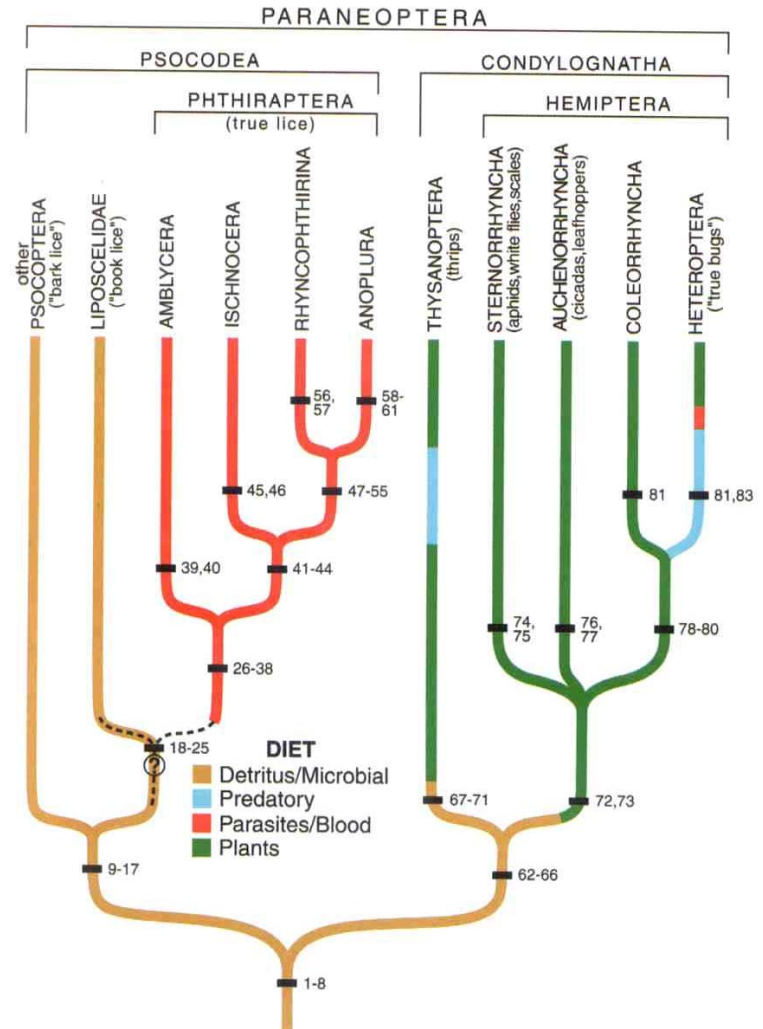


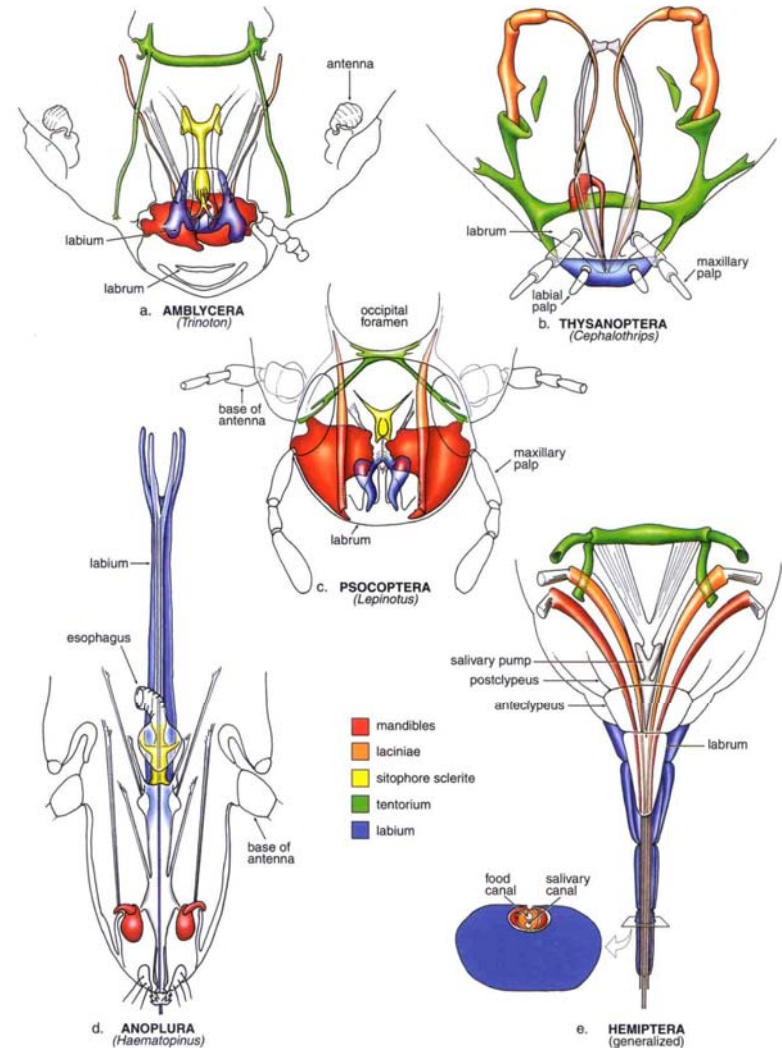
# Insect Orders III: Paraneoptera

- The group Paraneoptera consists of 4 insect orders, the bark lice, true lice, thrips and hemipterans. The Paraneoptera is clearly monophyletic based on morphological and molecular evidence.
- The evolutionary history of the Paraneoptera is a history beautifully reflected in structure and function of their mouthparts.
- The mouthparts of the Paraneoptera also reflect diverse feeding habits. Basal groups are microbial surface feeders, whereas more advanced groups feed on plant fluids (phloem) or animal fluids (blood).



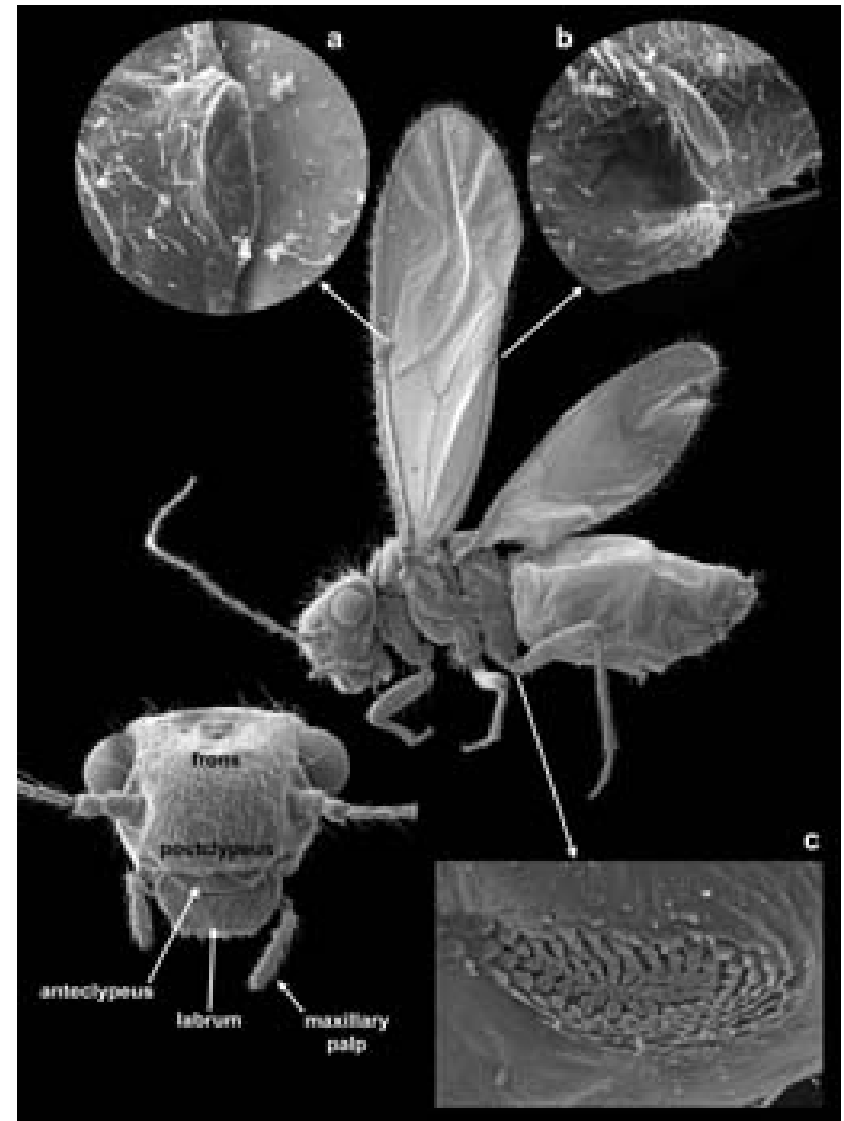
# Modification of mouthparts in the Paraneoptera

- Mouthparts in the Paraneoptera show a striking evolutionary trend from the most generalized “picking” mouthparts of the Psocoptera with standard insect mandibles to the probing and puncturing mouthparts of thrips and anopluran lice and the distinctive piercing-sucking rostrum or beak of the Hemiptera.
- In these evolutionary transitions the mandibles become greatly reduced and modified. The laciniae of the maxilla, in contrast, become enlarged and modified and together with the mandibles stylets of the Hemiptera.



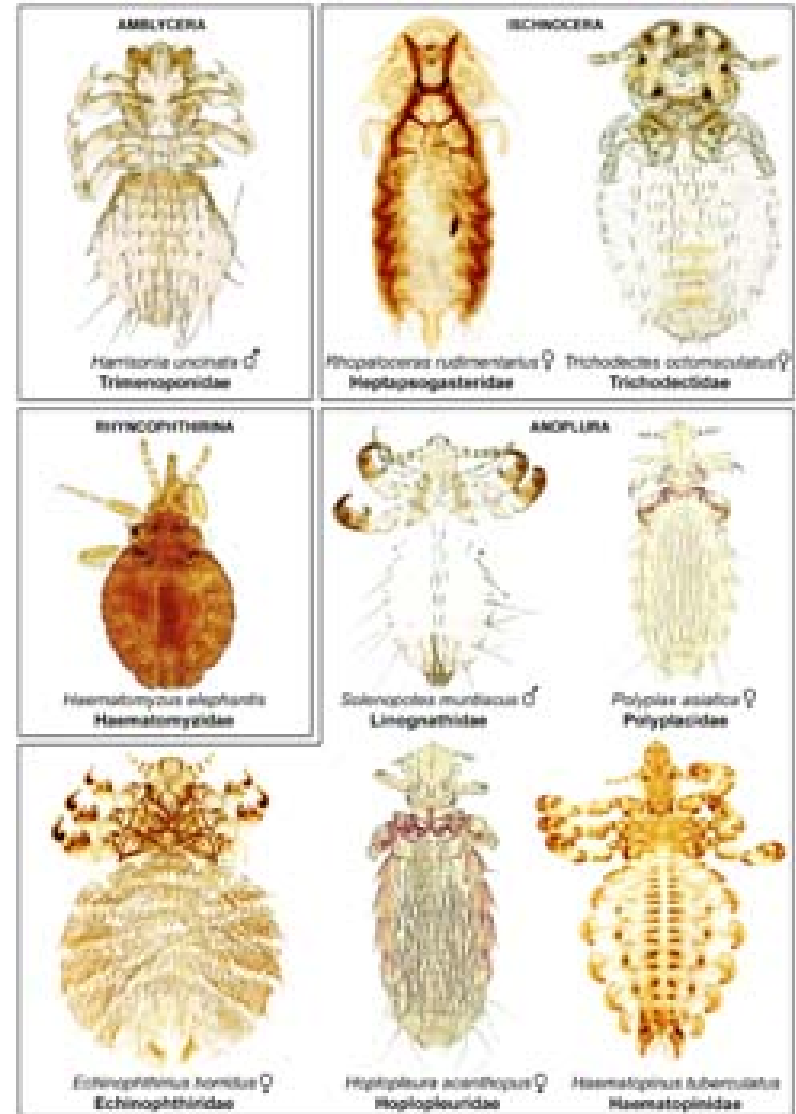
# Psocoptera (Bark lice)

- **Classification.** 4,400 described species arranged into 3 suborders (Trogiomorpha, Troctomorpha and Psocomorph) with 50 families and over 200 genera. First insect order to show the beginnings of a transition to sucking mouthparts. Sister group to the Phthiraptera (the lice).
- **Structure.** Lacinia of the maxilla is modified from the dentate form in orthopteroids into an elongate rod-like structure, proximately sunken well into the head capsule. The hind coxa of most psocopterans has a Pearman's organ with an adjacent tympanum that is suppose to be stridulatory. Postclypeus on the face is budging as are the eyes.
- **Natural history.** Psocopterans are found on foliage or branches of trees and shrubs or under back or leaf-litter. Most species are microbial surface feeders, some species feed on dead insects and a few species eat paper products (booklice). Many species live gregariously similar to webspinners and zorapterans. Mating behavior can be elaborate with the male of at least one species standing on its head.



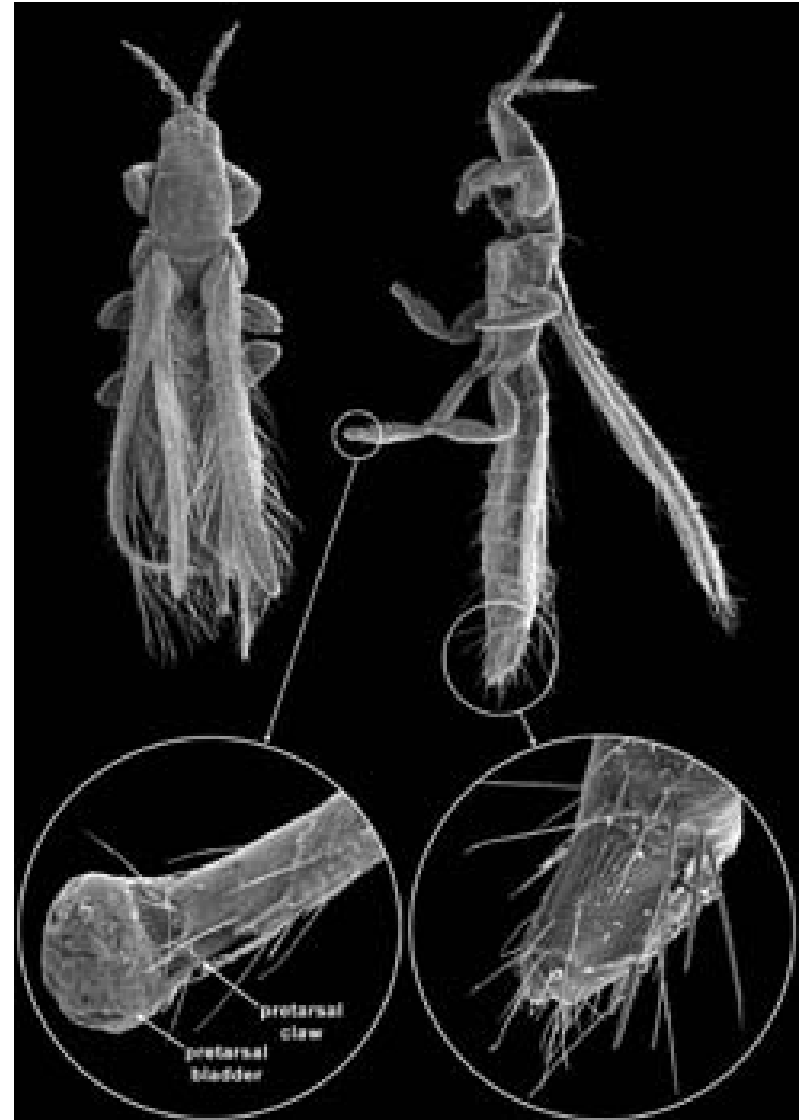
# Phthiraptera (True lice)

- Classification.** 5000 described species divided into 4 suborders. The **Amblycera** (chewing lice) is the most basal group and parasitize birds and mammals. The **Ischnocera** (chewing lice) is the largest suborder and parasitize mostly birds and some groups of mammals. The **Rhynchophthirina** (elephant lice) consists of only 3 species that parasitizes elephants and wild pigs in Africa. The **Anoplura** (sucking lice) parasitize only mammals.
- Structure.** Body is dorso-ventrally flattened and well sclerotized. Wings absent. Eyes absent or nearly so, antennae reduced to 3-5 segments. Legs strong with well-developed tarsi for holding onto fur or feathers of host. Amblycera have chewing mouthparts with lacinia modified as in Psocoptera. Anoplura have true sucking mouthparts with stylets.
- Natural history.** All species of lice are parasitic on all orders of birds and most orders of mammals (monotremes, edentates and cetaceans are not attacked). Chewing lice feed on feathers, hair and skin surface detritus, whereas sucking lice feed exclusively on blood. Most species of lice are host specific, with the sucking lice being more host specific than chewing lice. There is strong evidence for host-parasite coevolution in some groups. Because lice are wingless transfer between hosts usually involves direct contact during mating, brooding and nursing of young, sharing of communal nest sites or even during predator-prey interactions. Lice have the fewest number of life stages of any insect (egg, 3 larval instars, adult).



# Thysanoptera (Thrips)

- **Classification.** 5500 species classified into two suborders distinguished by the ovipositor. Terebrantia have a well-developed conical ovipositor, while the Tubilifera do not have a well-developed ovipositor. Instead the abdomen is drawn out in the shape of a tube.
- **Structure.** The mouth is in the form of an asymmetrical “mouth cone”, consisting of a piercing left mandibular stylet (right mandible lost) and lacinial stylets. Thrips have unique eversible bladders on their tarsi that provide adhesion to the substrate. Wings, when present, are linear with long marginal setae that look like fringe (hence the name of the order). Polymorphism in wings and body form is common in the order. Males in some species are distinctly dimorphic. Wingless males have enlarged heads that they use in competition for females, whereas winged males lack enlarged heads and disperse in search of females.
- **Natural history.** Thrips are commonly found on and in flowers. Most species are phytophagous, feeding on flowers. Some species feed on fungi and a few species are predaceous. Development in thrips is unique. In the Terebrantia the egg stage is followed by 2 larval instars, 1 “prepupal” instar, a “pupal” instar and the adult stage. The prepupal and pupal stages are quiescent and have rudimentary wings. In the Tubilifera there are two “prepupal” instars and one “pupal” instar. Wing rudiments are not present in the first “prepupal” stage. Social behavior ranges from solitary to eusocial with reproductive division of labor.



# Hemiptera: Sternorrhyncha (aphids, plant lice & scale insects), Auchenorrhyncha (Cicadas, plant hoppers & leaf hoppers)

- **Classification.** The Hemiptera are divided into 3 major suborders, the Sternorrhyncha (10,000 species), Auchenorrhyncha (25,000 species) and Heteroptera (see next slide).
- **Structure.** All species have well-developed piercing-sucking mouthparts usually placed well back from the front of the head. Front wings are uniformly thickened or membraneous and are not of the hemelytron type. Body form of some groups such as the scales are highly modified (females wingless and usually legless).
- **Natural history.** All species in the Sternorrhyncha and Auchenorrhyncha are phytophagous, with some being very specialized and others quite generalized. Many groups are tended by ants, including aphids, membracids and scales. They provide ants honeydew in exchange for protection from predators. Some cicadas have unusually long life cycles and emerge as adults only after 13 or 17 years. Aphids have polymorphic body forms that are correlated with host plant alternation and parthenogenetic reproduction. Winged sexual forms move between host plant species, while apterous asexual forms are sedentary and grow rapidly on host plants. Scales are sessile and spend their life under a protective waxy covering. Males emerge from their waxy covering and seek out females for mating. Many scales have unusual genetic systems.



# Hemiptera: Heteroptera (True bugs)

- Classification.** Over 20,000 species classified into 7 infraorders. Major infraorders include the Nepomorpha (aquatic bugs), Gerromorpha (semi-aquatic bugs), Cimicomorpha (assassin bugs, leaf bugs, bed bugs), and Pentatomorpha (seed bugs, squash bugs, leaf-footed bugs, stink bugs). Over 50% of described species are from three mostly phytophagous families (Miridae, Lygaeidae, Pentatomidae).
- Structure.** In most Heteroptera the basal portion of the forewing is thickened and leathery and the apical portion is membranous. This type of wing is called a hemelytron. Piercing-sucking mouthparts that are placed at the front of head.
- Natural history.** Feeding habits extremely varied. Most species are phytophagous, feeding on seeds or piercing plant tissue and feeding on xylem or phloem. Most aquatic species are predaceous as are some terrestrial families such as Reduviidae, some of which feed on blood. Many species have repugnatorial glands that release noxious chemicals. Nymphs of many Miridae reduce predation by mimicking ants. In bed bugs fertilization occurs when the male punctures the abdomen of the female and deposits sperm directly into the haemocoel. Parental care occurs in some groups. Male belostomatids carry eggs of one or more females on their backs until they hatch.

