

- * The Order name is derived from the Greek humen (meaning membrane), and so the Order name literally means membrane winged. Hymen was also the Greek God of marriage, and some (including your text) say that this serves as the basis for the Order name, and refers to the hamuli uniting the front and hind wings. Linnaeus usually named his orders based on the texture of the wings.
- * The Hymenoptera is considered to be the most **beneficial** order of insects. The order contains predators, parasites (parasitoids), and bees (honey, wax, pollination).
- * Most of the characters of the order can be found on the study sheet provided. The mouthparts are usually chewing or some modification of chewing (e.g. chewing-lapping). They usually have 4 membranous wings (many non-winged). Most Hymenoptera have a mechanism to keep the front wings and the hind wings hooked together. There is a series of small hooks, called **hamuli**, along the front margin of the hind wings, which fit into a fold or groove along the posterior margin of the front wing.
- * The wing venation is reduced (to almost lacking in some species). The antennae are usually long, ranging from 3 to 70 segments. The tarsi are usually 5-segmented. They usually have a well-developed ovipositor, which may be modified into a sting in many families.
- * The immatures are usually grublike or maggot-like, except in most of the Symphyta (sawflies and horntails) they are more caterpillar-like. They differ from true Lepidoptera immatures by having more than 5 pairs of prolegs, and the prolegs lack crochets.

HYMENOPTERA CHARACTERS

I. Head

A. Antennae

1. The number of segments is a superfamily character and, in Apocrita, sometimes a sexual character: male, 13 segments; female, 12 segments. See figs. 28-10A-E in text.
2. Elbowed antennae (geniculate) - first segment elongated and remaining segments coming off first segment at an angle.
3. You should review the parts of the antennae (scape, pedicel, flagellum, radicula, funicle, club).

B. Subantennal suture (your text refers to this as the subantennal sulcus; see figs. 28-17A-C, labeled sas) - used in bee families; often hidden by hair. May be two under each antenna or may be single; if single, may join antennal suture on outer or inner margins.

C. Gena - see fig. 28-6 B, labeled ge.

D. Mouthparts

1. The structure of the tongue provides some excellent characters for identification in bees, but it is usually folded up under the head and should be extended if at all possible. See figs. 28-6A-D in your text.
2. maxillary palps.
3. galea - outer lobe of maxilla.
4. glossa - one of pair of lobes at apex of labium between paraglossae.
5. labial palpi.

II. Wings

A. We will use a combination of the new (figs. 28-1, 28-2) and old (fig. 28-3) systems of venational terminology. Unless otherwise indicated, all venational characters refer to the front wings.

B. Wing cells

1. open cell - wing cell extending to wing margin, not entirely surrounded by veins.
2. closed cell - wing cell completely surrounded by veins and not reaching wing margin. The number of marginal or submarginal cells refers to the number of closed cells.

C. Stigma

III. Thorax

- A. The shape of the pronotum as seen from the side serves to separate superfamilies of Apocrita. Learn how it looks dorsally as well.
1. Pronotum short and collarlike with small rounded lobe on each side (fig. 28-4D). Usually can't see in Apoidea because of all the hair. Figure b on handout.
 2. Pronotum laterally more or less triangular and extending nearly or quite close to tegulae (fig. 28-4C). Posterior margin in dorsal view U or V-shaped (fig. 28-82A). Figure a on handout.
 3. Somewhat quadrate and not quite reaching tegulae (figs. 28-4A-B). Posterior margin in dorsal view usually straight or slightly arcuate, sometimes (Mutillidae ♂; Scoliidae) broadly arcuate. Figure c on handout.
 4. **tegula** - small scalelike structure overlying base of front wing (fig. 28-4, labeled tg).
 5. plumose or branched hairs - in bees, at least some of body hairs, particularly those on thorax, are branched or plumose.
 6. **cenchrus** - roughened pad on metanotum of most sawflies serving to hold wings in place when folded over dorsum.
- B. Legs
1. 1 or 2 trochanters; the 2nd trochanter sometimes referred to as the **trochantellus**.
 2. Tarsi usually 5-segmented; 1st tarsal segment may be long or large and confused with tibiae in some bees and wasps.
 3. Tarsal claws - simple; toothed or bifid.
 4. Tibial spurs (tsp on handout).

IV. Abdomen

- A. Sawflies - abdomen broadly joined to thorax
- B. Suborder Apocrita - basal segment of abdomen (**propodeum**) is fused with thorax and separated from remainder of abdomen by a constriction, the resulting 4-segmented tagma is called the **mesosoma** (trunk).
1. tagma - group of body segments specialized for a given function (head, thorax, abdomen)
 2. **propodeum** - posterior portion of thorax, which is actually first abdominal segment united with thorax.
 3. **mesosoma** - the three thoracic segments + first abdominal segment fused into a single tagma.
 3. **metasoma** (sometimes also referred to as the **gaster**) - all segments of body posterior to propodeum (figs. 28-18, 28-20 in text). Numbering of metasomal segments shown in fig. 28-20 in text.
 4. **petiole** - narrow stalk or stem by which metasoma is attached to thorax; in ants, nodelike first segment of metasoma
[Problems: some Braconidae with large hind coxae (fig. 28-45 in text) and some bees and wasps (fig. 28-71 in text) might appear to be Symphyta]
 5. lateral "felt lines" (Mutillidae) - narrow longitudinal bands of relatively dense, closely appressed hairs

HYMENOPTERA FAMILIES

- I. Suborder Symphyta - sawflies and horntails. Traditionally, we have split the Hymenoptera into two suborders: the Symphyta (sawflies) and the Apocrita (ants, bees, and wasps). More recent studies have shown that the Symphyta is a paraphyletic group; that is, it is a group that contains its most recent ancestor, but it does not contain all of the descendants of that ancestor. It is now believed that the sawfly family Orussidae is the sister group to the Apocrita. Still, the Symphyta is a convenient group to refer to. The name Symphyta means together (sym-) eating (-phyta), and refers to the fact that in many species the immatures feed in aggregations. The base of abdomen is broadly joined to the thorax (lacks the petiole). The hind wing nearly always with at least 3 closed basal cells (except *Tremex columba*, family Siricidae, and some species of Argidae). The trochanters are 2-segmented (not exclusive to Symphyta).

* Most members (except Orussidae) are phytophagous or xylophagous, and most are external feeders on foliage; larvae of few species bore in stems, fruit, wood, or leaves.

We can split group the sawfly families into two groups based on how many spurs are on the apex of the front tibia:

A. Front tibiae with 2 apical spurs

Superfamily Xyeloidea

1. **Xyelidae [Not Required]** - About 24 species in North America. Medium-sized to small (usually less than 10mm). Members of this family differ from all other sawfly families by having 3 marginal cells (fig. 28-8C in text, labeled MC), and a very long 3rd antennal segment (fig. 28-10D). Larvae feed on various trees; adults collected early in spring on catkins of willow, birch.

Superfamily Tenthredinoidea

2. **Cimbicidae** - cimbicid sawflies - There are only 12 North American species. The antennae are clubbed, with 7 or fewer segments. These are large, robust sawflies, often resembling bumble bees. This family includes the very large species, the elm sawfly. The immature of the elm sawfly will curl into a spiral while at rest or when it is disturbed. Often when it is disturbed it will eject a fluid from glands just above the spiracles for distances up to several centimeters. Immatures feed on Rosaceae, willow, birches.
3. **Diprionidae** - conifer sawflies - There are 45 North American species. Antennae with 13 or more segments, serrate in females and pectinate or bipectinate in males. The larvae feed mainly on conifers and several species are sometimes considered to be important pests of conifers. Immatures are often gregarious.
4. **Tenthredinidae** - common sawflies - There are about 800 North American species. Antennae are usually filiform and 9-segmented (7-10 segmented). The ovipositor is saw-like. This is the largest family of sawflies with over 5000 species worldwide. Many of the adults are predaceous. The larvae are usually external feeders of foliage, usually on trees.

B. Front tibiae with 1 apical spur

Superfamily Cephoidea

1. **Cephididae** - stem sawflies - There are only 13 North American species. These are usually relatively small sawflies that have the bodies compressed from side to side. Usually black or patterned black and yellow. They lack a cenchrus, and they are fairly narrow waisted, and the larvae are legless. The larvae usually burrow into the stems of grasses, willows, and berry plants. This family includes the wheat stem sawfly (*Cephus cinctus*), an important pest of wheat in the western states.

Superfamily Siricoidea

2. **Siricidae** - horntails - Both sexes have a spearlike plate or spine on last abdominal segment. In the female, it is dorsally located, longer and often spear-shaped; in the male, it is ventrally located, short, and triangular. The female ovipositor is often long and is permanently exerted. Text refers to females which are more common. The larvae bore into wood, where they feed on fungi transmitted by the mother at time of oviposition.
3. **Xiphydriidae [Not Required]** - wood wasps - similar to siricids, but lack the horny plate at apex of abdomen.

II. Suborder Apocrita - Base of apparent abdomen (**metasoma**) constricted; basal segment of abdomen (**propodeum**) is fused with the thorax (now a 4-segmented **mesosoma**) and separated from remainder of abdomen (**metasoma**, or sometimes called the **gaster**) by a constriction (**petiole**). The hind wings with 2 or fewer closed basal cells. The trochanters are either 1 or 2-segmented (most of the parasitic groups have 2 segments).

- * Many species are parasitic in larval stage, others are predaceous, and some are plant feeders. Adults feed chiefly on flowers, sap, other plant materials, and honeydew. Text summarizes habits.
- * This suborder is sometimes divided, arbitrarily, into two divisions: the **Parasitica** and the **Aculeata**. The Parasitica consists of the non-social Apocrita in which the ovipositor retains the function of egg placement. It is never modified into a stinging organ (some of the larger ones can sting, however).

These species are usually ectoparasites or endoparasites of other insects or spiders (a few are phytophagous). They never provision their nests.

- A. Evanioidea - Pronotum triangular; metasoma attached high above hind coxae. Trochanters 2-segmented. Antennae 13 to 14 segmented. Costal cell in front wing present.
1. **Evaniidae** - ensign wasps - Black or black and red. Metasoma very small and oval and attached by slender petiole to propodeum considerably above base of hind coxae; it is carried almost like a flag - hence the common name of the family. These are parasites of the egg capsules of cockroaches and likely to be found where cockroaches occur.
- B. Superfamily Ichneumonoidea - Antennae filiform, usually with 16 or more segments. Hind trochanters 2-segmented. Costal cell absent. Ovipositor arises anterior to tip of abdomen and is permanently exerted. Pronotum laterally more or less triangular. Very large and important group. Its members are parasites of other insects or other invertebrate animals. With rare exceptions, they do not sting.
1. **Braconidae** - There are more than 1900 North American species. The adults are usually relatively small (less than 15mm). One recurrent vein (fig. 28-31C, 1st rv or 1 m-cu) or none. First submarginal (1 R) and first discoidal (1 M) cells usually separated, sometimes fused; areolet sometimes present. The 2nd and 3rd metasomatic tergites are fused. This is a very diverse family of many types of parasites. There are many subfamilies.
 2. **Ichneumonidae** - This is one of the largest families in all of Insecta, with over 3300 North American species. Two recurrent veins (1m-cu, 2m-cu; few exceptions - see couplet 91). First submarginal (1R) and first discoidal (1M) cells usually confluent forming a "horse's head"; The second submarginal cell (1Rs), which lies opposite the 2nd recurrent vein (2m-cu), is often quite small (called the **areolet**, fig.28-31A, are) or is lacking (fig. 28-31B). Most ichneumonids are parasitoids; some would be considered to be predators (egg cases). The ovipositors can be quite long. [Note, It is sometimes difficult to identify the first rv (1m-cu) when cells are confluent; the presence of second rv (2m-cu) most important]
- C. Chalcidoidea - Pronotum somewhat quadrate and not quite reaching tegulae (fig. 28-4A). Antennae usually elbowed with 15 segments or less. Costal cell is present (or no cells at all); usually with much reduced venation. Ovipositor is not terminal. Some are quite small (Mymaridae: < 0.5mm; some Trichogrammatidae parasitize the eggs of thrips, 0.18mm). Mainly parasites of eggs or larvae of Lepidoptera, Diptera, Coleoptera, and Homoptera. Important for biological control programs; some have been imported.
- [1. **Mymaridae** - fairyflies - all are egg parasites of various insects - a series of unique sulci on head].
 - [2. **Eulophidae** - Parasites of a wide variety of insects, usually eggs or larvae - 4-segmented tarsi].
 - [3. **Aphelinidae** - Attack sessile insects (scales, etc., pupae) - 5-segmented tarsi, less than 8 segmented antennae].
 - [4. **Encyrtidae** - mesopleural groove for femur lacking (present in most chalcidoids) - Most are parasites of Homoptera].
 - [5. **Eupelmidae** -].
 - [6. **Torymidae** - large hind coxa].
 - [7. **Pteromalidae** -].
 - [8. **Eurytomidae** -].
 9. **Chalcididae** - Hind femora greatly swollen and toothed. Hind coxae considerable larger than front coxae, not sharply ridged above; wings not folded longitudinally at rest. [Note: Above characters will separate Chalcididae from the subfamily Chalcedectinae in the Pteromalidae which are usually metallic in color (chalcids are not), the Leucospididae, and some Torymidae with enlarged hind femora]. These are parasites.
- D. Cynipoidea - They have reduced wing venation. Most species are black in color and the metastoma is usually somewhat compressed laterally. The antennae are filiform. The pronotum is generally triangular laterally, reaching back to the tegulae. The ovipositor is usually anterior to tip of abdomen. Most of these are gall formers.

1. **Cynipidae** - These are mainly gall wasps (Cynipinae), some of which can have very complex life cycles. They usually attack oaks or members of the rose family. Some are hyperparasites, attacking braconids.
- E. Proctotrupeoidea - These are all parasites, attacking the immature stages of other insects. Characters of the mesosoma and the ovipositor serve to separate this superfamily from the previous two. The pronotum appears triangular in lateral view and extends to the tegulae. The ovipositor is terminal.
1. **Pelecinidae** - There is only 1 (*Pelecinus polyturator*) species in North America, but it is relatively distinctive, and we have collected it in our area. The body is extremely long and slender (up to 60mm in length), especially in the females. They are parasites of June beetles.
 - [2. **Scelionidae** - egg parasites, males are rare - some important parasites of grasshoppers and stink bugs].
- * The members of the remaining families are often referred to as the aculeate Hymenoptera (Aculeata). The ovipositor of most species is modified into a sting whose primary function is to inject venom, either to paralyze the host or prey or as a defensive mechanism. They include the ants, bees, and wasps, and females can often inflict painful wounds. The egg emerges from the base of the ovipositor.
- D. Chrysoidea - p. 711. Pronotum somewhat quadrate in lateral view, posterior margin straight or slightly arcuate in dorsal view.
1. **Chrysididae** - cuckoo wasps - Body **metallic blue or green** and usually coarsely sculptured. **Metasoma with 3 or 4 visible terga, last one often dentate apically; concave ventrally.** Wing venation fairly complete in front wings but no closed cells in hind wings. When disturbed, they curl up into a ball. These are external parasites of other bees and wasps; one group attacks eggs of walking sticks.
- These characters apply to all the remaining families:** Antennae 12- (female) or 13-segmented (male). Hind trochanter 1-segmented. Costal cell present. Ovipositor issues from apex of abdomen.
- A. Sphecoidea
1. **Sphecidae** - Pronotum short and collarlike with rounded lobe on each side posteriorly that does not reach tegula; **posterior margin nearly always straight.** Body bare or hairy with **all body hairs unbranched.** First segment of hind tarsus similar in width and thickness to remaining segments and not longer than remaining segments combined (fig. 28-15A); inner side of base with brush of hairs in depression opposed by pectinate tibial spur. Inner margins of eyes not notched (usually notched in most vespoids). These are primarily solitary wasps, although many may nest in same general area. Females provision nests, progressive provisioning.
- B. Apoidea - Pronotum short and collarlike with rounded lobe on each side posteriorly that do not reach the tegula; posterior margin (dorsal view) more or less arcuate. Body usually quite hairy; at least some of body hairs, especially on thorax, branched or plumose. First segment of hind tarsus usually wider than remaining segments and generally as long or longer than remaining segments combined (fig. 28-15B-D) - for pollen collection and transport. Scopae - pollen hairs on ventral side of metasoma or on **corbiculae** (broad, shiny, convex areas on outer surface of hind tibiae). Some are parasites of bees - look more like wasps, but still have tarsal structure of bees.
- * Jugal lobe in hind wing as long as or longer than submedian cell ($M + Cu_1$ [SMD on HO]); galeae and glossa short.
1. **Colletidae** - Glossa truncate or bilobed at apex. 1 subantennal suture. (2 or 3 submarginal cells (SM); if 3, then second recurrent vein (2m-cu) sigmoid (fig. 28-13D). Some burrow in ground, but line nest with plaster. Some lack pollen brushes on hind legs - pollen is taken to nest in crop.
 2. **Haliictidae** - Glossa pointed. Basal vein (1st free segment of M) strongly arched (exceptions occur). 1 subantennal suture. Usually 3 submarginal cells (sometimes only 2); facial fovea absent. Often metallic in color.
 3. **Andrenidae** - Glossa pointed. Basal vein (1st free segment of M) straight or weakly arched. **2 subantennal sutures** (hard to see). Facial foveae, at least in females, present and distinct, often lined with dense feltlike pile.

* Jugal lobe in hind wing shorter than submedian cell (M + Cu₁) or lacking (except *Melissodes* and honeybees); galeae and glossa usually long.

1. **Megachilidae** - leafcutting bees - **2 submarginal cells of about equal length**. Pollen brushes, when present, located on ventral side of metasoma. Stout bodied. Line nests with pieces cut from leaves.
2. **Apidae** - carpenter bees, cuckoo bees, digger bees, bumble bees, and honey bees. Usually 3 submarginal cells
 - a. **Xylocopinae** - carpenter bees - Genae are very narrow. Hind tibiae with apical spurs. Jugal lobe present in hind wing (*Melissodes* spp. have long jugal lobe, fig. 28-14C). Maxillary palps well-developed. Clypeus not protuberant; nest in wood or plant stems. Large ones resemble bumble bees, but have the dorsum of the metasoma largely bare.
 - b. **Apinae** - honey bees, bumble bees, and orchid bees. Genae broad. Maxillary palps vestigial.
Honey bees: jugal lobe present and long (fig. 28-14D); hind tibiae without apical spurs. Coloration more brown and black. Single introduced species in the U.S. Live in man-made nests or tree hollows, etc. Nests last more than one year; workers overwinter; swarms. Africanized bees - accidental release in Brazil in 1956 - now in southern U.S. Fertilized eggs produce females; unfertilized eggs produce males; royal jelly will produce reproductives. Communication.
Bumble bees: jugal lobe absent (fig. 28-14B); hind tibiae with apical spurs. Robust and hairy, black and yellow, a few with orange. Usually nest in ground; nests are annual, only fertilized queens overwinter.
 - c. **Nomadinae [not required]** - cuckoo bees - parasites in nests of other bees. Look more like wasps; lack pollen transportation devices; clypeus somewhat protuberant.

C. Tiphioidea (another text calls this the Scolioidea).

1. **Tiphiidae** - Pronotum somewhat quadrate in lateral view; in dorsal view posterior margin usually straight or only slightly arcuate. **Mesosternum with 2 posterior lobelike extensions which project between and partly cover bases of middle coxae**. Male usually with an upcurved spine at end of metasoma. Some parasitize scarab beetle larvae (1 species introduced to help control Japanese beetle), some parasitize tiger beetle larvae.
2. **Mutillidae** - velvet ants - Females wingless, antlike and covered with dense pubescence. Most have mesosomatic segments completely fused into boxlike structure (except Myrmosinae, formerly in Tiphiidae). Males are winged, usually larger than females and also densely pubescent. Most species have "felt lines" laterally on the second metasomatic tergum. (Pronotum similar to Scoliidae, quadrate or triangular in lateral view, broadly arcuate dorsally). Females have a very painful sting. These are external parasites of various wasps and bees. Some can stridulate.

D. Pompiloidea

1. **Pompilidae** - spider wasps - Pronotum somewhat quadrate in lateral view; in dorsal view posterior margin usually straight or only slightly arcuate. Mesopleuron with transverse sulcus (similar suture sometimes seen in Mutillidae and Scoliidae, but these families are pubescent). Body glabrous. (Long, spiny legs; hind femora **usually** extending to or beyond apex of metasoma.). Some flit their wings while they are not flying. Many things mimic these. They feed on spiders.

E. Scolioidea

1. **Scoliidae** - Meso- and metasternum together forming plate divided by transverse sulcus & overlapping bases of middle and hind coxae; hind coxae well separated. Wing membrane beyond closed cells with fine longitudinal wrinkles. Apex of male metasoma with 3 retractile spines. (Pronotum similar to Mutillidae, quadrate or triangular in lateral view, broadly arcuate dorsally). These are large and hairy wasps. They parasitize scarab larvae.

F. Vespoidea

1. **Vespidae** - paper wasps, yellowjackets, hornets, mason and potter wasps (includes Eumenidae)
 - Pronotum triangular in lateral view, U-shaped in dorsal view; wings usually folded lengthwise at rest.
 - a. **Vespiniae** (yellowjackets & hornets) and **Polistinae** (paper wasps) - Middle tibiae with 2 apical spurs. Tarsal claws simple.
 - b. **Eumeninae** (formerly Eumenidae) - mason wasps and potter wasps. Middle tibiae with 1 apical spur. Tarsal claws bifid or toothed.

G. Formicoidea

1. **Formicidae** - ants - About 8800 spp. worldwide. First metasomatic segment (or first 2 metasomatic segments) bearing hump or node. Antennae usually elbowed, at least in female, with 1st segment long. Pronotum more or less quadrate in lateral view, usually not reaching tegulae. (Winged adults also have suture on mesopleuron.)