Entomology
Orders and Families of Hexapoda
compiled by Wendy L. Hodges and C. Riley Nelson
with numerous past contributors

Page and figure numbers refer to Borror, Triplehorn, & Johnson 1989

Phylum Arthropoda
subphylum Atelocerata
Class Hexapoda
subclass Entognatha

About the subclass Entognatha: Your text classifies Entognatha as the sister taxon to Insecta. Members of Entognatha are considered primitively wingless and are grouped together in this subclass because the mouth parts are more or less withdrawn into the head.

Order: Protura page 165
Diagnosing Features:
0.6-1.5 mm long, whitish
eyeless
no antennae
Habitat: moist soil/humus, leaf mold, under bark, decomposing organic matter
Food habits: decomposers
Metamorphosis: anamorphosis
Preservation: alcohol/slide

Order: Collembola (springtails) pages 165-168
Diagnosing Features:
0.25-6 mm long
furcula/tenaculum
0 to 8 ommatidia
collophore
Habitat: soil or leaf litter, under bark, decaying logs, in fungi, ant nests, termite nest
Food habits: decomposers
Metamorphosis: ametabolous
Preservation: alcohol/slide
Notes: The furcula is a forked structure on the ventral side of the fourth abdominal segment which folds into the tenaculum on the ventral side of the third abdominal segment. The collophore is an appendage for water uptake.

Order: Diplura pages 169-170
Diagnosing Features:
<7 mm, pale colored
two caudal filaments
eyeless/no ocelli
1-segmented tarsi
lacks scales
Habitat: damp places, soil, under bark, stones or logs, rotting wood , caves
Food habits: decomposers
Metamorphosis: ametabolous
Preservation: alcohol
Notes: In one family, the Japygidae, the cerci are formed into pincers.

Phylum Arthropoda
subphylum Atelocerata
Class Hexapoda
subclass Insecta

Order: Microcoryphia (bristletails or jumping bristletails) pages 171-172
Diagnosing Features:
up to 15 mm long
cylindrical body, often arched in live specimens
compound eyes large and contiguous
ocelli
body with scales
3-segmented tarsi
middle and hind coxae usually bear styli
3 caudal filaments which are more or less parallel
maxillary palps large and prominent
Habitat: under leaves in grassy/wooded areas, on cliff sides, rocky areas, under bark, stones, dead wood
Food habits: decomposers
Metamorphosis: ametabolous
Preservation: alcohol
Notes: Most are nocturnal and eyes glow at night under flashlight. These animals resemble Thysanura quite closely. They have the plesiomorphic condition, however, of monocondylic mandibles.

Order: Thysanura (silverfish) pages 172-174
Diagnosing Features:
elongate and flattened
3 caudal filaments, often with cerci projecting at near right angles from the median caudal filament
body with scales
usually with compound eyes that are small and widely separated
ocelli may be present
3-5-segmented tarsi
Habitat: homes, soil, books, bookshelves, ant nests, caves
Food habits: generally decomposers; can be household pests
Metamorphosis: ametabolous
Preservation: alcohol
Notes: Their mandibles are dicondylic, a feature they share with all the orders of insects which follow. One family, the Nicoletiidae, is found locally in older nests of the red imported fire ant, *Solenopsis invicta*.

Order: Ephemeroptera (mayflies) pages 175-185
Diagnosing Features:
small to medium-sized, elongate
soft-bodied
2 or 3 long caudal filaments
membranous wings with numerous cross veins
forewings large and triangular
hind wings rounded, small or absent
antennae short, small, and setaceous
Habitat: rivers, streams, lakes, and ponds
Food habits: generally decomposers
Metamorphosis: hemimetabolous
Preservation: alcohol
Notes: Mayfly wings are held together above the body when at rest. Immature stages are aquatic. This order is unique in having a winged subimago stage. The subimago molts to become an adult. Both subadult and adult stages have wings. Subimagoes may be distinguished from imagoes (adults) by the milky color of the wings and hairier bodies and wings. Mayflies are effective bioindicators of habitat quality.

Order: Odonata (dragonflies and damselflies) pages 187-201

Diagnosing Features:

wings are elongate, many-veined and membranous
large and many-faceted compound eyes
setaceous antennae
secondary genitalia on abdominal sternite 2
small prothorax
mesothorax and metathorax large and tilted
long and slender abdomen
chewing mouthparts

Habitat: near water

Metamorphosis: hemimetabolous

Preservation: adults preferably stored in glassine envelopes, they may be pinned and spread

Notes: Wings are held out from body when at rest due to the lack of appropriate muscles to fold them against the dorsum. Odonata use direct flight mechanisms rather than indirect. Immatures are aquatic and called nymphs or naiads.

Suborder: Anisoptera (dragonflies) page 194

-hind wings are broader at base than the fore wings, held out perpendicular to body midline, cannot be flexed or folded to make them more compact

-nymphs have internal gills in the form of ridges in the rectum – nymphs draw water into the rectum through the anus and expels it to breathe. They can also use this as a form of jet propulsion if the insect needs to make a quick escape

-head is round

Family: Aeshnidae (darners)

-large, with compound eyes largely contiguous, touching a considerable distance on dorsal surface of head
-largest individuals, >75mm
-brace vein present on proximal end of stigma

Family: Libellulidae (common skimmers)

-anal loop of hind wing forms a boot (leg and toe)
-20-75 mm in length usually, several up to 100 mm
-hind margin of the eye straight or with a small lobe
-males are not lobed on second abdominal segment

Family: Corduliidae (green-eyed skimmers)

-anal loop elongate with a bisector (“leg”, but no toe)
-triangle in hind wing opposite the arculus or nearly so
-genearlly dark or metallic with little color on body
-eyes brillant green in life, hind margin of eye slightly lobed
-35-45 mm in length usually
-males do not have a small lobe on each side of second abdominal segment

Family: Gomphidae (clubtails)

-50-75 mm in length
-posterior tip of abdomen is typically swollen
-generally dark colored with green or yellow markings
-stigma less than 8 mm
-median lobe of the labium is not notched

Suborder: Zygoptera (damselflies) page 198

-front and hind wings have the same basic shape, can hold wings flexed over body in a somewhat compact fashion
-nymphs have external gills in the form of 3 leaf-like structures at the caudal end of the abdomen
-adults are usually smaller and more delicate than dragonfly adults
-wings are usually attached to the body in a petiolate manner
-head is flat between the eyes

Family: Calopterygidae (broad winged damselflies)
-wings not on long petiolate stalks

Family: Coenagrionidae (narrow winged damselflies)
-M_3 arising near nodus, wings flexed over abdomen at rest

Family: Lestidae
-M_3 arising near arculus, wings outstretched at rest

Order: Grylloblattaria (rock crawlers) page 203

Diagnosing Features:
15-30 mm, pale
slender, elongate
wingless
eyes small or absent, no ocelli
long and filiform antennae
long cerci
sword-shaped ovipositor in female
Habitat: glaciers and cold caves & fissures
Food habits: predators and scavengers on ice fields and below ground
Metamorphosis: paurometabolous
Preservation: alcohol
Notes: This order was discovered in 1914.

Order: Phasmida (walking sticks or leaf insects) pages 205-207

Diagnosing Features:
tarsi are usually 5-segmented sometimes 3
elongate and stick like body
wings are reduced or absent in North American forms
Habitat: trees or shrubs
Food habits: defoliators
Metamorphosis: paurometabolous
Preservation: pinned; move appendages close to the body when preparing for storage
Notes: Some tropical forms are flattened and expanded laterally with well-developed hind wings to look like leaves. Walking sticks can emit a foul-smelling substance from glands as a means of defense.

Family: Heteronemiidae (common walkingsticks)
-wings absent
-first abdominal tergum much shorter than metanotum
-vertex without stout spines

Order: Orthoptera (grasshoppers, katydids and crickets) pages 208-226

Diagnosing Features:

3-4-segmented tarsi
biting/chewing mouth parts
winged or wingless
forewings many-veined and thickened (tegmina)
hind wings broader and membranous
body elongate
cerci well-developed
antennae long, many-segmented, and filiform
tympana

Habitat: trees, shrubs, grasses
Food habits: most defoliators, some predators and decomposers
Metamorphosis: paurometabolous
Preservation: pinned near posterior margin of pronotum; some in alcohol
Notes: The hind wings fold under the tegmina.

Family: Acrididae (short-horned grasshoppers) pages 214-216

-antennae are shorter than the body
-auditory organs (tympana) are on sides of first abdominal segment
-3-segmented tarsi
-short ovipositor

Family: Tettigoniidae (long-horned grasshoppers or katydids) pages 217-218

-long, hair-like antennae
-wings held tent-like
-tympana on base of front tibia
-tarsi are 4-segmented
-laterally flattened blade-like ovipositor

Family: Gryllidae (crickets) pages 222-223

-long, hairlike antennae
-wings held flattened on dorsum of abdomen
-tympana on base of front tibia
-tarsi are 3-segmented
-needle like ovipositor
-forewings bend down sharply on sides of body

Family: Gryllacrididae (cave & camel crickets) pages 220-222

-wingless, often very humpbacked
-lack tympana
-tarsi are 4-segmented

Notes: They can often be collected by setting out a trail of oatmeal at night and checking the trail periodically. The adults of this family are preferentially stored in alcohol.

Order: Mantodea (Praying mantids) page 227-228

Diagnosing Features:
large (50 mm long or longer in this area), elongate
raptorial forelegs
extended pronotum which is loosely attached to the pterothorax
head is freely movable, they can look over their "shoulders"

Habitat: trees and shrubs
Food habits: predators
Metamorphosis: paurometabolous
Preservation: pinned through the base of the wing

Family: Mantidae

Notes: Some species are very cryptic, resembling leaves, twigs, or even flowers. Females often eat males during or after mating. This is the only native family in the United States.

Order: Blattaria (cockroaches) pages 229-233

Diagnosing Features:
oval, dorsoventrally flattened body
cursorial legs
5-segmented tarsi
head concealed dorsally by pronotum

Habitat: house, apartment, place of work or local university, wooded areas and under tree bark
Food habits: decomposers; several species are household pests
Metamorphosis: paurometabolous
Preservation: pinned through the middle of the fore wing

Family: Blattidae

-Front femur with row of stout long spines equal in length
-large, 18mm or more in length
-well-developed wings in most cases, but sometimes short
-female subgenital plate divided longitudinally

Family: Polyphagidae

-anal area of hindwing flat, not folded fanwise at rest
-females often wingless
-frons thickened and bulging
-smaller, ususally less than 16mm in length

Notes: One species is found in leafcutter ant nests in Texas and Louisianna.

Order: Isoptera (termites) pages 234-241

Diagnosing Features:

usually white, always soft-bodied
abdomen broadly joined to thorax
most wingless
if winged, wings are membranous-forewings and hind wings equal in size
moniliform or filiform antennae

Habitat: under rocks in soil, in decaying wood

Food habits: decomposers; cellulose specialists

Metamorphosis: paurometabolous

Preservation: alcohol

Notes: This social insect contains protozoa which digest the cellulose that termites ingest. This endosymbiotic relationship is an obligate mutualism where both parties need each other. Isopteran caste structure consists of soldiers, workers, and reproductives.

Family: Rhinotermitidae

-common family in Texas
-soldiers with large heads, longer than broad
-elongate, functional mandibles without marginal teeth

Order: Dermaptera (earwigs) pages 242-245

Diagnosing Features:

elongate, slender, somewhat flattened body
forceps like cerci
wings shorter than body, don't project much over the abdomen
filiform antennae
3-segmented tarsi
chewing mouth parts (mandibulate)

Habitat: under bark or other debris, decaying plant matter

Food habits: decomposers, some defoliators and predators

Metamorphosis: paurometabolous

Preservation: pinned through wing or mesothorax

Notes: Some dermapterans emit a foul-smelling substance as defense.

Family: Forficulidae

-second tarsal segment dilated and broad, extends distally beneath base of third tarsal segment
-antennae 12-16 segmented
-body brownish or yellowish
-15-20 mm in length

Family: Carcinophoridae

-antennae 14-24 segments
-tegmina with rounded flaps not meeting at base – or wingless
-male right forceps more strongly curned than left
-9-25 mm in length

Order: Embioptera or Embiidina (web spinners) pages 247-249

Diagnosing Features:
- fore leg with basal tarsi enlarged
- less than 10 mm long
- antennae filiform or moniliform
- chewing mouth parts
- prognathous mouthparts
- legs are short and stout
- tarsi 3-segmented
- metathoracic femora enlarged

Habitat: silken galleries in leaf litter, under stones, in soil cracks and bark crevices
Food habits: decomposers
Metamorphosis: paurometabolous
Preservation: alcohol
Notes: The basal segment of the fore tarsus is enlarged and contains silk glands. Embioptera live in social groups in their silken galleries. They can run equally well forward and backward, an uncommon feature in insects

Order: Plecoptera (stoneflies) pages 250-257

Diagnosing Features:
- hind wing usually has large anal lobe
- soft-bodied and flattened
- wings reticulated and fold flat over abdomen
- fore wings elongated and narrow
- long antennae
- usually 3-segmented tarsi
- chewing mouth parts

Habitat: near streams or rocky lake shores, nymphs are aquatic
Food habits: some decomposers, others predators
Metamorphosis: hemimetabolous
Preservation: alcohol
Notes: Stoneflies are indicators of the quality of aquatic habitats.

Family: Perlidae (common stoneflies)
- -20-40 mm in length, most commonly collected in the United States
- -front wing with cu-a (if present) opposite basal anal cell, or distad of it by no more than its own length
- -remnants of branched gills on thorax

Order: Zoraptera pages 258-259

Diagnosing Features:
- 3 mm long or less
- wings usually absent but occasionally present
- winged forms are dark colored, wingless forms light
- cerci with long terminal segment

Habitat: under slabs of wood, bark and rotting logs, old mill shavings, sometimes found in berlese samples
Food habits: decomposers
Metamorphosis: paurometabolous
Preservation: alcohol

Order: Psocoptera (book lice) pages 260-274
Diagnosing Features:
6 mm long or less
soft-bodied
swollen clypeus
winged or wingless
forewings held tent-like over body, hind wings greatly reduced or vestigial
long antenna
2 or 3-segmented tarsi
no cerci
Habitat: in bark or foliage of trees or shrubs, in dead leaves, or in old books or papers
Food habits: decomposers
Metamorphosis: paurometabolous
Preservation: alcohol/slides

Order: Phthiraptera (lice) pages 275-283
Diagnosing Features:
wingless
eyes reduced or absent
ocelli absent
antennae 3-5-segmented
Habitat: hairs or feathers of bird or mammal hosts, near skin
Food habits: parasites
Metamorphosis: paurometabolous
Preservation: alcohol/slides
Notes: Lice are ectoparasites on birds and mammals. Some are vectors of serious diseases. Look for on fresh roadkill.

Suborder: Anoplura
-flattened body, small heads
-sucking mouthparts
-well-developed claws
-generally on mammals

Suborder: Mallophaga
-flattened body, egg shaped head
-chewing mouthparts
-simple claws
-generally on birds

Order: Hemiptera (true bugs or half-wings) pages 284-311
Diagnosing Features:
wings held flat on body with tips crossing apically
forewings-hemelytra, hind wings membranous
piercing-sucking mouthparts
antennae fairly long (4-5 segments)
well-developed compound eyes in most cases
0-2 ocelli
most with a distinct scutellum
Habitat: plants, water, some predacious, widely distributed
Food habits: diverse, all suck fluids
Metamorphosis: paurometabolous
Preservation: pinned in scutellum; many are small and should be pointed
Notes: Many hemipterans have lateral thoracic scent glands which give off a foul odor.

Order: Hemiptera (cont'd)

Family Corixidae (water boatmen) page 295
-hind legs are oar-like; natatorial
-swim dorsal side up
-elongate, oval body, somewhat flattened, usually gray mottled
-front tarsi forming a one segmented scoop
-beaks are broad, conical and one segmented

Family Notonectidae (backswimmers) page 296
-hind legs are oar-like; natatorial
-swim ventral side up
-body more or less cylindrical
-often with some ivory white color on body
-some have hemoglobin
-hind tarsi without claws

Family Naucoridae (creeping water bugs) page 296
-aquatic
-oval from above, dorsoventrally flattened
-raptorial forelegs with enlarged femora
-no veins in hemelytra

Family Gerridae (water striders) page 298
-elongate middle and hind legs, short fore legs
-all tarsi two segmented

Family Belostomatidae (giant water bugs) page 294
-the largest bugs in the order
-elongate-oval and somewhat flattened body
-raptorial forelegs
-paternal egg care

Family Miridae (plant or leaf bugs) pages 299-300, also see Fig. 24-4
-cuneus present in hemelytra
-only one or two closed cells on the wing membrane
-antennae and beak are four segmented
-lack ocelli
-most are plant feeders, but a few are predaceous
-soft-bodied, most 4-10 mm,
-often brightly colored

Family Reduviidae (assassin bugs) pages 301-303
-head elongate with constriction behind the eyes yielding a neck-like appearance
-beak is short and three-segmented and the tip fits into a prosternal groove
-abdomen often widened in middle, exposing lateral abdominal margins beyond wings

Family Lygaeidae (seed bugs) pages 304-305, also see Fig. 24-4
-four or five simple veins in the membrane of the wing
-large variation in size, shape and color
-sometimes with front femora enlarged, appearing raptorial
-many are conspicuously marked with spots or bands of red, white or black
-four segmented antennae
-four segmented beak
-ocelli present

Family Largidae
-generally black insects with bright orange or red markings
-large number of veins, complex pattern
-rounded pronotum laterally
-6th visible abdominal sternum in female is cleft
Notes: some have very short elytra and mimic ants

Family Coreidae (leaf-footed bugs) page 306
-most species have flattened flange on hind tibia giving a leaf-like appearance
-medium to large-sized insects
-well-developed scent glands laterally between the middle and hind coxae
-hind femora often enlarged and spiny on the males for defense of territory

Family Pentatomidae (stink bugs) pages 307-309
-round or ovoid shape (body looks like a shield) in dorsal view
-5 segmented antennae
-many brightly colored or conspicuously marked forms
-generally large scutellum

Order: Homoptera (cicadas, hoppers, whiteflies, aphids, scales) pages 312-347
Diagnosing Features:
sucking mouthparts arising from posterior of head (appear to arise between front coxae)
forewings have uniform texture, either membranous or thickened and leathery
hind wings membranous
wings held tent-like over body
setaceous or filiform antennae
0-3 ocelli
Habitat: widely distributed, vegetation
Food habits: plant suckers
Metamorphosis: paurometabolous, some with pupa-like stage
Preservation: pinned or pointed, except scales, mealybugs, psyllids, and aphids go in alcohol or on slides
Notes: All homopterans are plant feeders, the only completely phytophagous insect order.

Family Cicadidae (cicadas) pages 322-325
-large, membranous wings
-setaceous antennae, arise anterior to eye
Notes: Many spend several years underground as nymphs feeding on root fluids.

Family Cicadellidae (leafhoppers) pages 325-332
-uniform row of many spines on hind tibia
-antenna anterior to eye
-ocelli on scutellum

Superfamily Fulgoroidea (planthoppers) pages 315-316, 334
-antenna below eye
- may have uniform row of many spines on hind tibia
Notes: There are several families that are relatively easy to distinguish.

Family Cercopidae (spittlebugs or froghoppers) pages 325, 327
-nymphs in a froth of spittle on plants
-crown of short spines at apex of hind tibia in addition to one or two long spines

Family Membracidae (treehoppers) pages 325-326
-enlarged pronotum covering wings and abdomen in adults

Family Aphididae (aphids or plant lice) pages 336-338
-cornicles present on dorsum of abdomen

Superfamily Coccoidea (scale insects and mealybugs) page 341
-slow-moving or sessile
-generally wingless but the rarely encountered males have only two wings
-secrete waxy substances, used as dyes commercially

Order: Thysanoptera (thrips) pages 350-355
Diagnosing Features:
0.5-5.0 mm, slender body
sucking mouthparts
if present, wings are like sclerotized rods with fringe of hairs, few or no veins
short antennae
1-2-segmented tarsi with 1 or 2 claws
Habitat: composite flowers, foliage, debris
Food habits: plant raspers, some predators
Metamorphosis: paurometabolous but with pupa-like stage
Preservation: alcohol/slides

Order: Neuroptera (alderflies, dobsonflies, snakeflies, lacewings, antlions, owlflies) pages 357-367
Diagnosing Features:
multi-veined, especially in costal area
soft-bodied
4 membranous reticulated wings
wings held tent-like over body but somewhat flattened in Corydalidae
mandibulate mouthparts
long antennae, filiform, pectinate, clubbed
5-segmented tarsi
no cerci
Habitat: some larvae are aquatic others are terrestrial, some adults are near water
Food habits: predators
Metamorphosis: holometabolous
Preservation: pinned through the mesothorax
Notes: The neuropterans are sometimes divided among three different orders:
Megaloptera, Rhaphidioptera, and Neuroptera.

Family Corydalidae (dobsonflies and fishflies) pages 359, 363-364
-anal area of wing enlarged and folded
-aquatic larvae
-prominent ocelli
-large body
-some males with huge mandibles
-sometimes placed with Sialidae in the Megaloptera

Family Chrysopidae (green lacewings) pages 360, 365
-usually green or yellow, sometimes with a few red body markings
-fore wing with a single, unbranched radial sector (Fig. 27-3B)
-costal field with unforked minor veins
-eggs laid on “stalks” due to predaceous larval habits

Family Hemerobiidae (brown lacewings) pages 360, 365
-usually brown
-fore wing with several radial sectors (Fig. 27-2A)
-costal field often with forked minor veins

Family Myrmeleontidae (antlions) pages 362, 366-367
-clubbed antennae
-antennae as long as head and thorax combined

Family Ascalaphidae (owlflies) pages 367-368
-antennae as long or nearly as long as body, capitate
-short hypostigmatic cell
-larvae are found in leaf litter primarily, some arboreal

Order: Coleoptera (beetles) pages 370-476
Diagnosing Features:
elytra, which meet at midline
highly diverse sizes from less than 1 mm to 125 mm
chewing mouthparts
nearly all lack ocelli
variety of antennal types
Habitat: ubiquitous
Metamorphosis: holometabolous
Preservation: pinned through right elytron
Notes: Absolutely the most species rich group in the animal kingdom.

Suborder Adephaga page 408
-1st abdominal sternum divided by hind coxae
-large hind trochanters
-prothorax with notopleural sutures
-nearly always with filiform antennae
-555 tarsal formula

Family Carabidae (ground beetles) page 409
-terrestrial
-most are predators
-cursorial legs
-head narrower than pronotum
-body usually elongate

Family Cicindelidae (tiger beetles) Pages 408-409
-10-24 mm long primarily
-long, toothed, sickle-shaped mandibles
-often brightly colored or marked with metallic or irridescent patterns
-antennae arise from front of head
-head as broad as pronotum

Family Dytiscidae (predaceous diving beetles) page 410-412
-aquatic predators
-hind legs like oars, fore legs have scoops and are raptorial
-short maxillary palps
-body more ovate than elongate

Suborder Polyphaga page 412
-hind coxae do not divide abdominal sternite
-various antennae, tarsal formulae
-normally without notopleural sutures

Family Staphylinidae (rove beetles) pages 414-416
-truncate elytra
-usually with functional hind wings beneath elytra
-6-7 visible abdominal sterna
-most are decomposers, some predators

Family Hydrophilidae (water scavenger beetles) page 417
-aquatic
-short clubbed antennae
-long maxillary palps
-metasternum often with elongate metasternal keel
-carry a plastron for respiration underwater
-decomposers, scavengers

Family Scarabaeidae (scarab and dung beetles) pages 419-426
-heavy bodied, oval-convex, elongate beetles
-front tibia somewhat dilated
-lamellate antennae
-diverse food habits, often root and dung feeders as larvae

Family Buprestidae (wood boring beetles) pages 426-427
-metallic, at least on venter; hard-bodied
-bullet-shaped in dorsal view
-head is hemispherical
-wood miners

Family Elateridae (click beetles) pages 429-431
-click mechanism (flexible at prothorax with prosternal spine fitting into mesosternal groove)
-posterior margins of prothorax with points or spines
-antennae usually serrate
-body parallel sided, and rounded at each end
-decomposers or root feeders

Family Lampyridae (fireflies) page 432, also see Fig. 28-51
-soft elytra
-pronotum obscures head from view from above
-pronotum often with clear windows
-not all produce light
-predators

Family Dermestidae (skin beetles) pages 433-434
-usually small, oval to convex
-short clubbed antennae
-usually hairy or scaly, especially on venter
-median ocellus present, a rare condition in beetles

Family Coccinellidae (ladybird beetle) pages 441-442
-body hemispherical
-short, clavate antennae
-333 tarsal formula
-head concealed by pronotum
-predators

Family Tenebrionidae (darkling beetles) pages 445-446
-usually hard-bodied
-eyes notched, with antennae arising from a cleft
-554 tarsal formula
-decomposers

Family Meloidae (blister beetles) pages 446-448
-loose connection between head and prothorax
-tips of elytra rounded and allow abdomen to be seen
-parasites of other insects; pollen feeders

Family Cerambycidae (long-horned beetles) pages 449-454
-antennae greater than one-half the length of body, often very long
-tarsal formula appears to be 444 with third segment bilobed and concealing fourth in notch
-body usually elongate, cylindrical
-wood miners

Family Chrysomelidae (leaf beetles) pages 455-459
-antennae shorter than in cerambycids
-tarsal formula appears to be 444 with third segment bilobed and concealing fourth in notch
-body usually hemispherical
-defoliators or leaf miners

Family Curculionidae (snout beetles or weevils) pages 464-473
-clubbed geniculate antennae
-often with long snouts
-diverse feeding strategies, usually on plants

Family Scolytidae (bark beetles) pages 474-476
-small and cylindrical
-posterior apex of body often obliquely truncate in lateral view, sometimes with tubercles

Order: Strepsiptera (twisted-wing parasites) pages 479-481
Diagnosing Features:
small, 0.5 - 2.0 mm
males with protruding raspberry-like eyes with few ommatidia
males free-living and winged
hind wings large and membranous, fan-like with reduced venation
forewings reduced to club-like structures like dipteran halteres
females are eyeless, wingless, and legless, in most cases
Habitat: in hosts (Hymenoptera , Homoptera, Orthoptera, Hemiptera, and Thysanura)
Food habits: parasites
Metamorphosis: holometabolous, hypermetamorphic
Preservation: alcohol, pinned if found in host

Order: Mecoptera (scorpionflies and hanging flies) pages 482-488
Diagnosing Features:
9-22 mm, slender body
head (clypeus) often prolonged below eyes as a beak (rostrum)
most have 4 membranous wings similar in size and venation
Habitat: around vegetation, dense decaying matter
Food habits: decomposers, scavengers of dead insects
Metamorphosis: holometabolous
Preservation: pinned through right side of mesonotum

Family Panorpidae (scorpionflies) page 486
-genital segments of males curls up over abdomen such that it resembles a scorpion
-very elongate rostrum

Order: Siphonaptera (fleas) pages 489-497
Diagnosing Features:
laterally flattened
wingless, small, 0.5 - 2.0 mm
numerous backward-projecting spines and bristles
long legs with enlarged coxae for jumping-saltatorial hind legs
short antennae in grooves on head
piercing, sucking mouthparts
Habitat: hosts, birds and mammals and their nests/homes
Food habits: parasites
Metamorphosis: holometabolous
Preservation: alcohol

Order: Diptera (flies) pages 499-575
Diagnosing Features:
one pair of wings
halteres
diverse mouthparts including: piercing, sucking, cutting, and lapping or sponging; but plesiomorphic biting and chewing type not represented
Habitat: ubiquitous
Food habits: diverse
Metamorphosis: holometabolous
Preservation: pinned or pointed
Notes: The halteres have been functionally modified as organs of equilibrium during flight.

Suborder Nematocera (long-horned flies) page 535
approximately 6 antennal segments
usually delicate flies with long legs

Family Tipulidae (crane flies) page 535
-V on mesonotum
-many veins in wings
-legs break off easily
-decomposers and predators

Family Culicidae (mosquitoes) pages 541-544
-long proboscis
-scales on wing veins and on mouthparts of males
-aquatic as larvae
-females often bloodsuckers
-plumose antennae

Family Chironomidae (midges) pages 546-547
-scutellum with midline suture
-front tarsi lengthened
-long, narrow wings without scales
-M unbranched
-often plumose antennae, especially prominent in males
-decomposers

Suborder Brachycera (short-horned flies) page 547
three to six antennal segments
usually stout flies

Family Tabanidae (horse/deer flies) pages 548-549
-R4 and R5 divergent, enclose wing tips-apical cell widely open forming a V
-calypteres large
-third antennal segment elongate, usually annulated
-male eyes contiguous
-female with blade like mouthparts
-blood feeders

Family Bombyliidae (bee flies) page 555
-bee-like colors due to hairs or scales
-R_{2+3} and R_4 sinuous
-stylate antennae
-many with long proboscis
-parasites of many insect orders, especially Hymenoptera

Family Asilidae (robber flies) page 553
-sunken vertex, with a turret of ocelli
-face bearded, mystax
-large, generally hairy
-sclerotized proboscis
-stylate antennae

Infraorder Muscomorpha (Circular-seamed flies)
-aristate antennae, Rs bifurcate

Family Syrphidae (hover flies) pages 557-558
-spurious vein between R_5 and M_1
-bee and wasp mimics
-R veins sinuate
- bee-like colors often based in sclerites
-predators and decomposers

Section Acalypterata
No transverse suture on mesonotum
No calypteres
No dorsal longitudinal suture on pedicel

Family Drosophilidae page 566
-broken C at Sc and h
-sunken face
-pectinate arista
-decomposers

Section Calypterata
calypteres developed (fig. 32-4, p. 505)
longitudinal suture on pedicel
mesonotum with transverse suture

Family Muscidae pages 568-569
-no hypopleural or pteropleural bristles
-Cu2+2A does not reach wing margin (fig 32-13D)
-if stripes on mesonotum, there are 4
-decomposers

Family Calliphoridae page 569
-often metallic
-hypopleural bristles present
-arista plumose at tip
-2 notopleural bristles, comblike
-decomposers

Family Sarcophagidae pages 569-570
-usually 3 black mesonotal stripes
-hypopleural bristles present
-decomposers and parasites

Family Tachinidae pages 571-573
-subscutellum present, well-developed
-arista bare
-hypopleural bristles present
-parasites of insects

(Extras)

Family Tephritidae (fruit flies) pages 560-562
-patterned wings
-Sc bent abruptly (90 degrees), not quite reaching costa (fig 32-20B, p.524)
-fruit eaters and decomposers

Family Anthomyiidae pages 567-568
-Cu2+2A long reaching wing margin
-subscutellar hairs
-no hypopleural bristles

Family Sepsidae page 565
-antlike with apical spot in wing, like to twirl their wings
-bristle near metathoracic spiracle
-decomposers, especially decaying flesh

Family Chloropidae page 566
-shiny ocellar triangle
-decomposers, some plant feeders
-Cu-A has a kink in the vein

Order: Trichoptera (caddisflies) pages 576-587

Diagnosing Features:
small to medium-sized, most are dull-colored, slender body
four membranous wings which are very hairy and have scales
wings held tent-like over body
antennae long and slender, filiform
chewing mouthparts, well-developed palps but reduced mandibles in adults
larvae are aquatic
some build rock or stick cases

Habitat: near water
Food habits: decomposers and some predators
Metamorphosis: holometabolous
Preservation: alcohol, large adults pinned through mesonotum

Family: Hydropsychidae (net-spinning caddisflies)
-adults with 5 segmented maxillary palps, last segment elongated
-no ocelli, no warts on mesoscutum
-brownish coloration
-larvae with retreat made of pebbles, sand, debris with a cup-shaped net close by –found in strong currents

Family: Leptoceridae (long-horned caddisflies)
-slender, pale 5-17 mm in length
-very long antennae – up to twice as long as body
-mesothoracic tibiae without preapical spurs

Order: Lepidoptera (moths and butterflies) pages 588-664

Diagnosing Features:
scales on wings
adult mouthparts are sucking, larvae have chewing mouthparts
large compound eyes

Habitat: ubiquitous
Food habits: diverse; many are plant feeders
Metamorphosis: holometabolous
Preservation: pinned and spread
Notes: Lepidoptera can be split into 2 primary groups, the moths and butterflies. Moths are generally nocturnal and the fore and hind wings are hooked together by a frenulum or jugum. Butterflies are generally diurnal and have clavate or capitate antennae. Their hind wings overlap, but are not hooked together.

Butterflies

Family Papilionidae (swallowtails) page 638
-usually have one or more tail like elongations on the hind wing. Figs. 34-57

Family Pieridae (whites, sulphurs and orangetips) page 639
-medium-sized to small, usually white or yellowish in color with black marginal wing markings
-radius in the front wing is usually 3 or 4 branched
-front legs well developed

Family Lycaenidae (coppers, hairstreaks, blues, harvesters, and metalmarks) page 640
-small and delicate, brightly colored with slender body
-antennae usually ringed white
-line of white scales encircling the eyes
-some with delicate tails on hind margin of hind wing

Family Nymphalidae (brush-footed butterflies) pages 642-643
-reduced forelegs which lack claws (“brush-footed”)
-only the middle and hind legs are used in walking
-very common family

Family Danaidae (milkweed butterflies, monarchs) page 645
-large and brightly colored butterflies, usually brownish with black and white markings
-"brush footed" and don't use their forelegs for walking
-radius in the fore wing is 5-branched
-fore wing discal cell is closed by a well-developed branch
-short third anal vein in the fore wing

Family Hesperiidae (skippers) pages 636-637
-usually small and stout-bodied
-wing veins arise from discal cell (none of the five R branches in fore wing are stalked, Fig. 34-8)
-antennae are hooked (Fig. 34-56) and widely separated

Moths

Family Saturniidae (giant silkworm moth) pages 649-651
-North American species may have a wingspread of about 150 mm
-many are brightly or conspicuously colored and have transparent eye spots in the wings
-antennae are bipectinate
-mouthparts are reduced and the adults do not feed.

Family Sphingidae (sphinx , hawk, or hummingbird moths) pages 652-654
-medium-sized to large, heavy-bodied, somewhat spindle-shaped and tapering at both ends
-long narrow forewings
-antennae are slightly thickened in the middle or toward the tip
-larvae are called hornworms due to horn or spinelike process on dorsum of posterior end

Family Arctiidae (tiger moths) pages 655-657
-most are brightly spotted or banded, small to medium-sized, often white or brownish
-Sc and Rs in the hind wing are usually fused to about the middle of the discal cell (Fig. 34-26)
-larvae called woolybears
-pectinate or plumose antennae

Family Noctuidae pages 657-660
-mostly heavy-bodied
-forewings somewhat narrowed
-hind wings broadened (Figs. 34-85, 34-86)
-labial palps are long
-very thin antennae

Order: Hymenoptera (sawflies, parasitic wasps, ants, wasps, and bees) pages 665-744

Diagnosing Features:
- winged species have four membranous wings
- hind wings are smaller than forewings
- hamuli located on the anterior margin of the hind wings connect hind and forewings
- tarsi usually 5-segmented
- well-developed ovipositor
- some species' ovipositors are modified into a sting
- antennae long, usually +10 segments
- mandibulate mouthparts

Habitat: particularly near vegetation and flowers
Food habits: diverse
Metamorphosis: holometabolous
Preservation: pinned through right side of mesonotum

Suborder Symphyta page 701
abdomen broadly joined to thorax
trochanters 2 segmented
usually 3 closed cells at the base of hind wing (Fig. 35-1)

SuperFamily Tenthredinoidea (Families Tenthridinidae and Argidae)
-ovipositor saw like
-antennae between the eyes
-anterior tibia with 2 apical spurs
-costal cell not divided in the front wing by an intercostal vein and only 1-2 marginal cells
-larvae can be defoliators, gall makers, or leaf miners

Suborder Apocrita pages 704-705
basal segment of abdomen fused with thorax and separated from abdomen by constriction (petiolate)
1 or 2 segmented trochanters
no more than 2 closed cells at the base of hind wing

Family Ichneumonidae pages 708-711, also see Figs. 35-46, 35-32
-2 trochanters
-ovipositors longer than body
-16+ antennal segments
-2 m-cu recurrent veins (Fig. 35-31B)
-parasites

Family Braconidae pages 707-708, figs 35-44, 35-45
-small, less than 15 mm
-no costal cell
-2 trochanters
-one or no m-cu crossvein
-2nd and 3rd metasomatic tergites are fused

Superfamily Chalcidoidea pages 711-712, also see Figs. 35-48, 35-50, 35-51, 35-53
-minute
-elbowed antennae
-reduced wing venation
-parasites

Family Pompilidae (spider wasps) page 735, also see Figs. 35-34, 35-77
-collared pronotum
-transverse mesopleural suture
-predator/parasite of spiders
-antennae often curled

Family Sphecidae (digger wasps) pages 724-727, also see Figs. 35-62, 35-64, 35-65
-collared pronotum with lobes below tegula (fig. 35-4)
-vertical sulcus on mesopleuron
-usually not very hairy

Family Vespidae (paper wasps, yellow jackets, hornets) pages 736, also see Fig. 35-80
-pronotum forms a V
-predators, often specific in prey types gathered for young
-geniculate antennae

Family Mutillidae (velvet ants) page 734, also see Fig. 35-76
-females wingless, males winged
-covered with dense hairs
-parasites

Family Formicidae (ants) pages 737-739, also see Fig. 35-83
-1-2 nodes on petiole
-antennae elbowed usually
-diverse feeding strategies

Superfamily Apoidea (bees) pages 727-728
-pronotum terminates laterally in rounded lobes (as in sphecids)
-hairs of thorax plumose
-scopae or corbiculae for carrying pollen
-pollen and nectar gatherers
Note: The superfamily Apoidea includes the following three families along with some others.

Family Apidae page 732, also see Fig. 35-66, 35-73
-honey bees and bumble bees
-broad corbicula on hind leg
-pygidial plate absent

Family Halictidae sweat bees pages 729-730, also see Fig. 35-13C
-small to moderate size
-often metallic
-strongly arched first free segment of medial vein

Family Megachilidae pages 730-732, also see Fig 35-69
-females with hair patch on underside of abdomen (scopa)