Odonata
The order Odonata is composed of two suborders: The Anisoptera or dragonflies, and the Zygoptera or damselflies. The nymphs of both are aquatic and predatory. They have an extensible labium which is used to capture prey. Nymphs of Anisoptera have internal anal gills while those of Zygoptera have 3 external leaf-like anal gills. They feed on other aquatic insects, tadpoles and small fish. The adults are also predatory and capture other insects in flight. Odonata are predators of biting fly larvae, and are thus beneficial to humans. Make sure you can distinguish the two suborders of the order Odonata. Observe and sketch some of the specimens provided, and note the following important characteristics.

Anisoptera: The dragonflies, hold their wings horizontally when at rest, they have thick bodies and are very active fliers. Note the following physical characteristics:
• can not fold wings when at rest
• body shorter than wings
• head transversely elongate
• copulatory organs anterior

Zygoptera: The damselflies, hold their wings nearly vertical when at rest, have very slender bodies, and are less agile during flight. Note the following physical characteristics:
• front and hind wings similar in shape
• can fold wings at rest
• head rounded
• body longer than wings
Orthoptera
The Orthoptera is composed of 14-27 families depending on the classification system. You will be responsible for recognizing 3 of these families. Sketch some of the available specimens and note the following characteristics of each family.

Family Acrididae
The short-horned grasshoppers are phytophagous, and lay their eggs in soft, sandy soil. Many species have a locust phase, triggered by overcrowding in the egg beds. This results in the well known and devastating migratory swarms.
Note the following physical characteristics:
• short antennae
• 3-segmented tarsi
• short ovipositor
• auditory organ (tympanum) on abdominal segment 1

Family Tettigoniidae
The long-horned grasshoppers lay their eggs in plant tissue. They can occasionally occur in large numbers and damage pastureland.
Note the following physical characteristics:
• very long antennae
• 4-segmented tarsi
• auditory organ on front tibia
• sword-like ovipositor
• wings fold over abdomen

Family Gryllidae
The crickets are mainly phytophagous and cause some economic damage by inserting their eggs into plant tissue. Of course, a cricket on the hearth is supposed to be good luck.
Note the following physical characteristics:
• resemble tettigonids (long antennae, auditory organ on front tibia)
• 3-segmented tarsi
• short, needle-like ovipositor
• wings bent downward at sides
Coleoptera
The beetles are represented by more than a quarter million known species, or more than 1/3 of all known insect species. Beetles are characterized by their sclerotized forewings (the elytra) and chewing mouthparts. The elytra serve as protective covers for the hindwings. In all other respects beetles are extremely diverse morphologically and ecologically. They inhabit both terrestrial and fresh water ecosystems. They are particularly plentiful, and often morphologically spectacular, in tropical regions. Diptera and Hymenoptera are more numerous in northern boreal and arctic regions. You will be responsible for recognizing the following 15 families. Sketch some of the available specimens and note the listed characteristics of each family.

Family Carabidae (ground beetles)
- antennae filiform
- 5-segmented tarsi
- striate elytra (striped)
- long, pointed head which is narrower than pronotum, with narrow clypeus
- adults and larvae predaceous
- nocturnal
- cusorial legs

Family Cincindelidae (tiger beetles)
- brightly colored
- distinct pattern on elytra
- head wider than pronotum with wide clypeus
- cusorial legs
- hind trochanter with greatly enlarge lobe

Family Dytiscidae (diving beetles)
- aquatic
- predaceous
- in wild can be identified from other aquatic beetles by their habit of hanging the head downward from the surface of the water, done to renew air in plastron
- oval shape
- visible scutellum
- hind legs flat, fringed (natatorial)
- male front tarsi modified for suction (flat, round)

Family Silphidae (carrion beetles)
- common near dead vertebrates
- females oviposit in carrion and larvae feed on it
- very large clavate antennae
- 5-segmented tarsi
- orange or yellow and black markings
- 1-3 abdominal segments exposed
Family Staphilinidae (rove beetles)

- predaceous
- crossed mandibles
- elytra short with five or more terga exposed
- resemble Dermaptera but no cerci
- raise rear of abdomen as defense mechanism
- common near decaying material

Family Lampyridae (fireflies/ lightning bugs)

- soft body
- pronotum enlarged and covering head
- leathery elytra, rounded at posterior end
- 2 red stripes on thorax
- bioluminescence

Family Elateridae (click beetles)
Family Buprestidae (metallic wood borers)
- metallic coloration
- striated elytra
- bulbous head
- elongated abdomen
- larvae flat-headed borers, due to flattened prothoracic segment, which is much larger than other segments

Family Dermestidae (carpet and larder beetles)
- small, round, spotted
- clubbed antennae
- shield-like pronotum
- larvae very hairy (campodeiform)- pests of insect collections!!

Family Coccinellidae (ladybird beetles)
- oval body
- brightly colored, with spots on elytra
- clavate antennae
- 4-segmented tarsi

Family Scarabaeidae (scarab beetles)
- flexible union between pro- and meso thorax, permits click mechanism to right themselves from upside down
- short flat head
- pronotum with sharp posterior angles to flange
- 5-segmented tarsi
- larvae heavily sclerotized- wireworms
Family Cerambycidae (longhorned beetles)

- vary greatly in size, color and habits
- lamellate antennae
- heavy bodied
- 5-segmented tarsi
- head almost as wide as thorax
- larvae c-shaped

Family Chrysomelidae (leaf beetles)

- very long serrate antennae
- notched eyes
- phytophagous
- larvae wood boring

Family Curculionidae (weevils)

- morphologically similar to cerambycids but more oval-shaped and shorter antennae
- lines on elytra
- tarsal formula appears to be four but is actually five
- 40,000 species!
- prolonged head (snout)
- reduced mouthparts
- eyes elongated
- geniculate, clubbed antennae
- all are phytophagous (many pest species)

Family Scolytidae (bark or engraver beetles)
- head elongate in side view
- small, cylindrical shaped body
- short, clubbed antennae
- brown or black
- serious forest pests in North America
**Lepidoptera**

The Lepidoptera is one of the best studied insect orders. As a group, the Lepidoptera have very similar life histories and habits. Almost all adults feed on nectar, honey dew or similar liquids. The larvae are mostly phytophagous and feed on both angiosperms and gymnosperms. They are collectively the most numerous terrestrial herbivore group in the insects (100 000 species worldwide). The larvae are eruciform and have an elongate body, a large head capsule, 3 pairs of thoracic legs, and up to five pairs of prolegs. The prolegs bear small, hooked spines or crochets, a feature that distinguishes them from similar-looking larvae from different groups. An appreciation for the importance of lepidopterans as pests is gained by knowing that almost every crop plant cultivated by humans has AT LEAST one species of Lepidoptera as a major pest. Lepidopterans are also important as pollinators.

Recall the following major characteristics of the order Lepidoptera:

- Maxillae form long, coiled tube (proboscis)
- Wings and much of body covered with scales
- Larvae usually eruciform

You will be responsible for recognizing the following 10 families.

**Family Pyralidae** (snout moths)

- Labial palps often long, beak-like, projecting and scaled = snout
- Forewings triangular
- Hindwing broad and rounded

**Family Saturniidae** (giant silkworm moths)

- Large
- Conspicuously colored
- Often have transparent 'eye' spots
- Bipectinate antennae, not to tip
- Furry body

**Family Geometridae** (land measurers, inchworms)

- Forewing triangular
- Female wingless in some species
- Wings usually marked with fine, wavy lines
- Larvae have prolegs on segments 6 and 10

**Family Noctuidae** (miller moths)
Family Arctiidae (tiger moths)
- Brightly spotted or banded wings
- Heavy bodied
- Does not have prominent palps as in Noctuidae
- Larvae very hairy (wooly bears)

Family Sphingidae (hawk moths)
- Heavy bodied, hairy
- Long, narrow front wings, hind wings reduced in width-fitting in notch in forewing
- Larvae typically have horn on segment 8

Family Papilionidae (swallowtail butterflies)
- Most have tail-like elongation on hind wing
- Tibial epiphysis
Family Nymphalidae (fritillaries and anglewings)

- Wings with black markings and wavy lines or dots (fritillaries)
- Wing margin irregularly notched (anglewings)
- Prothoracic leg much smaller than mesothoracic leg

Family Lycaenidae

- Medium-sized
- Antennae ringed with white
- Notched eye

Family Pieridae

- Light colored wings, tipped with yellow or orange
- Often a dark spot on each wing
**Hymenoptera**
The order Hymenoptera is probably the most biologically diverse of the insect orders. Habits range from herbivory to entomophagy and sociality. There are an estimated 200,000 species worldwide.

Note the generalized wing venation of this order:

![Wing Venation Diagram](image)

In the Hymenoptera, abdominal segment 1 is fused with posterior thorax. The order Hymenoptera is broken down into 2 suborders, Symphyta and Apocrita.

General characteristics of the **suborder Symphyta** include:
- Phytophagous
- Long antennae
- Chewing mouthparts
- Abdomen not constricted
- Large ovipositor adapted for boring

You will be responsible for recognizing the following 2 families within the suborder Symphyta.

**Family Tenthredinidae (sawflies)**
- Primitive wing venation
- Filiform antennae
- Saw-like ovipositor
- Waist not constricted

  - Larvae: many abdominal prolegs, eruciform, important pest

**Family Siricidae (horntails)**
General characteristics of the **suborder Apocrita**:
- Ovipositor modified for piercing and stinging
- Antennae reduced
- Base of abdomen constricted
You will be responsible for recognizing the following 7 families within the suborder Apocrita.

**Family Ichneumonidae** (parasitic wasps)
- C+Sc+R+M fused, have 2 recurrent veins
- Long antennae
- Very long ovipositor
- 2-segmented trochanters

**Family Braconidae**
- similar to Ichneumons
- one or none recurrent veins
- antennae thread-like, usually 16 or more segments
- abdominal tergites 2+3 fused

**Family Chalcidae**
- small, metallic wasps
- hind femur swollen and toothed
- antennae geniculate
- venation very reduced, only costal vein remains
- 2-segmented trochanters

**Family Formicidae** (ants)
Family Sphecidae (thread-wisted wasps)

- petiole very long
- wing with only one recurrent vein
- rounded pronotum
- body relatively bare
- 1st segment of hind tarsus similar in width and thickness to remaining segments and not longer than remaining segments combined

Family Vespidae (wasps)

- 1 M cell long, usually 1/2 as long as wing
- wings folded longitudinally, at rest

Family Apidae (bees, bumblebees)

- hairy body, especially thorax
- honey bee = *Apis mellifera*