LABORATORY EXERCISE 2:
Apterygota, Paleoptera and Neoptera

Six-legged arthropods are all called hexapods, but the superclass is almost certainly an unnatural, polyphyletic assemblage of rather distantly related taxa. Besides Insecta, three other classes of Hexapoda exist: **Collembola** (springtails), **Protura** (proturans), and **Diplura** (diplurans). These three classes may be distinguished from the true insects by their entognathous, as opposed to ectognathous, mouthparts; i.e., their mandibles and maxillae are enclosed within a pouch formed by the fusion of the floor of the mouthpart cavity with the lateral margins of the head. Nevertheless, many entomologists continue to classify all four hexapod classes within the subclass of primitively wingless insects, **Apterygota**, so a few of these minute, primarily soil- or litter-dwelling arthropods are on display.

The modern view of insect classification views Apterygota as a paraphyletic (i.e., not truly monophyletic) assemblage of small, primitive insects consisting of but two orders, **Archaeognatha** (=**Microcoryphia** or Machiloidea) or bristletails, and **Zygentoma** (=Lepismatoidea or **Thysanura**) or silverfish and firebrats. These primitively wingless insects may be distinguished from other wingless Hexapoda by their ectognathous mouthparts, and are separated from one another by certain important details of mandibular articulation. In other respects, however, they are superficially quite similar to one another. In particular, both orders are characterized by a relatively low degree of tagmosis (functional differentiation of groups of body segments), as well as by the retention of several abdominal appendages (styli) that are presumed to be walking limb homologues. Examine a silverfish or firebrat adult (order Zygentoma) from a dorsal perspective, and draw (**Drawing #2**) your specimen, labeling the body tagmata (head, thorax, abdomen), legs, abdominal styli, median caudal filament, cerci, mouthparts, and antennae.

The first winged insects to evolve from wingless ancestors were the **Paleoptera**: "old-winged" insects. These were unable to fold their wings back against their abdomens because they lacked certain specializations of the wing-thorax articulation area. Only two orders of Paleoptera persist today, although in Carboniferous times many paleopterous orders flourished. Order **Ephemeroptera** (or **Ephemerida**) includes the mayflies, characterized by aquatic nymphal (immature) stages and very short-lived adults; they resemble Zygentoma in many respects, including possession of a median caudal filament. Order **Odonata** includes damselflies and dragonflies, which are highly efficient predatory insects with aquatic nymphal stages like the mayflies. Examine demonstration specimens of both orders; note that some representatives can fold their wings above their backs, but never along their abdomens.

Neoptera, the "new-winged" insects, evolved from paleopterous stock back in Carboniferous times; their major adaptive specialization was their wing-folding ability. This group today includes many rather small orders with incomplete metamorphosis, as well as several generally more diverse orders characterized by complete metamorphosis. The former, called **Exopterygota** or Hemimetabola, are the more primitive. The exopterygote orders may be further defined as having "orthopteroid" or "hemipteroid" affinities: **orthopteroid** exopterygotes are generalized, cockroach-like insects with chewing mouthparts, while **hemipteroid** exopterygotes tend toward piercing-sucking mouthparts and specialized internal anatomical features.

Examine representatives of the orthopteroid orders on display; typical of such insects is the narrow, coriaceous front wing and expanded, fan-like hind wing of most cockroaches. Draw

(**Drawing #3**), in outline form, the wings from one side of the body of a cockroach (Dictyoptera/Blattodea).

Classification summary:

HEXAPODA
- COLLEMBOLA (=Oligentomata) (springtails)
- PROTURA (=Myrientomata) (proturans)
- DIPLURA (=Diplurata) (diplurans)
- **INSECTA** (true insects)
  - APTERYGOTA (=Zygentomata) (primitively wingless insects
    - Archaeognatha [Microcoryphia] (bristletails)
    - Zygentoma [Thysanura] (silverfish & firebrats)
  - PTERYGOTA (winged insects)
    - PALEOPTERA (“old-winged” insects)
      - Ephemeroptera (mayflies)
      - Odonata (dragon- and damselflies)
    - NEOPTERA (“new-winged” insects)
    - EXOPTERYGOTA (insects with incomplete metamorphosis: HEMIMETABOLA)
      - ORTHOPTERODEA [POLYNEOPTERA] (orthopteroid insects)
        - Plecoptera (stoneflies)
        - Embioptera [or Embiidina] (webspinners)
        - Grylloblattodea [or Notoptera] (ice-crawlers)
        - Mantophasmatodea [or Notoptera] (rock-crawlers)
        - Dictyoptera
          - Blattodea (cockroaches)
          - Isoptera (termites)
          - Mantodea (mantises)
        - Dermaptera (earwigs)
        - Phasmatodea (stick & leaf insects)
        - Orthoptera (grasshoppers & crickets)
      - HEMIPTERODEA [PARANEOPTERA] (hemipteroid insects)
    - ENDOPTERYGOTA (insects with complete metamorphosis: HOLOMETABOLA)
      - (to be continued...)