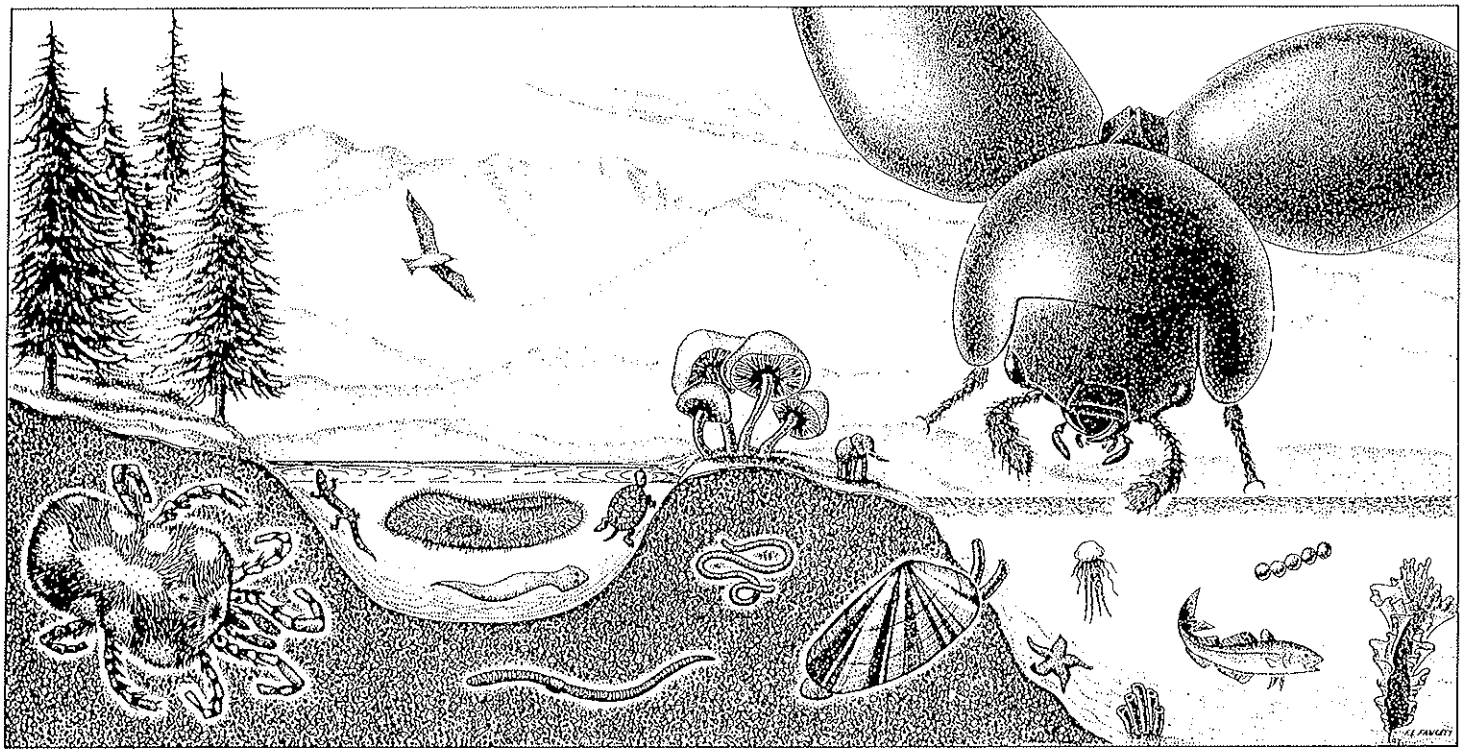
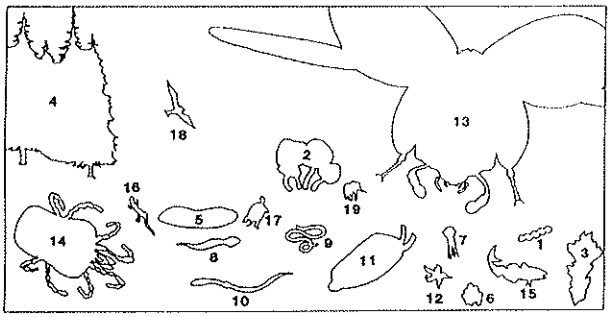




Size of individual organisms represents number of described species in major taxon.
Unit Area: □ = approximately 1,000 described species.

	Taxon	No. of Described Species			
1	Monera (Bacteria, Blue-green Algae)	4,760	11	Mollusca (Mollusks)	50,000
2	Fungi	46,983	12	Echinodermata (Starfish etc.)	6,100
3	Algae	26,900	13	Insecta	751,000
4	Plantae (Multicellular Plants)	248,428	14	Non-insect Arthropoda (Mites, Spidors, Crustaceans etc.)	123,161
5	Protozoa	30,800	15	Piscos (Fish)	19,056
6	Porifera (Sponges)	5,000	16	Amphibia (Amphibians)	4,184
7	Coelenterata (Jellyfish, Corals, Comb Jellies)	9,000	17	Reptilia (Reptiles)	6,300
8	Platyhelminthes (Flatworms)	12,200	18	Aves (Birds)	9,040
9	Nematoda (Roundworms)	12,000	19	Mammalia (Mammals)	4,000
10	Annelida (Earthworms etc.)	12,000			

Source of statistics: E.O. Wilson, Ed., 1988. Biodiversity. Nat. Acad. Sci. Press, Washington.

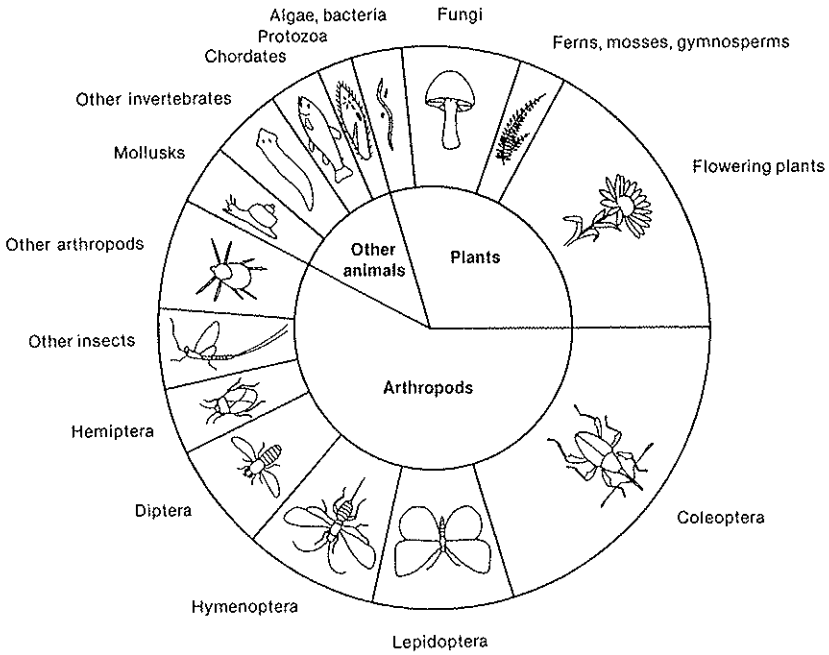


Figure 1.1 Relative numbers of species of arthropods, other animals, and plants.

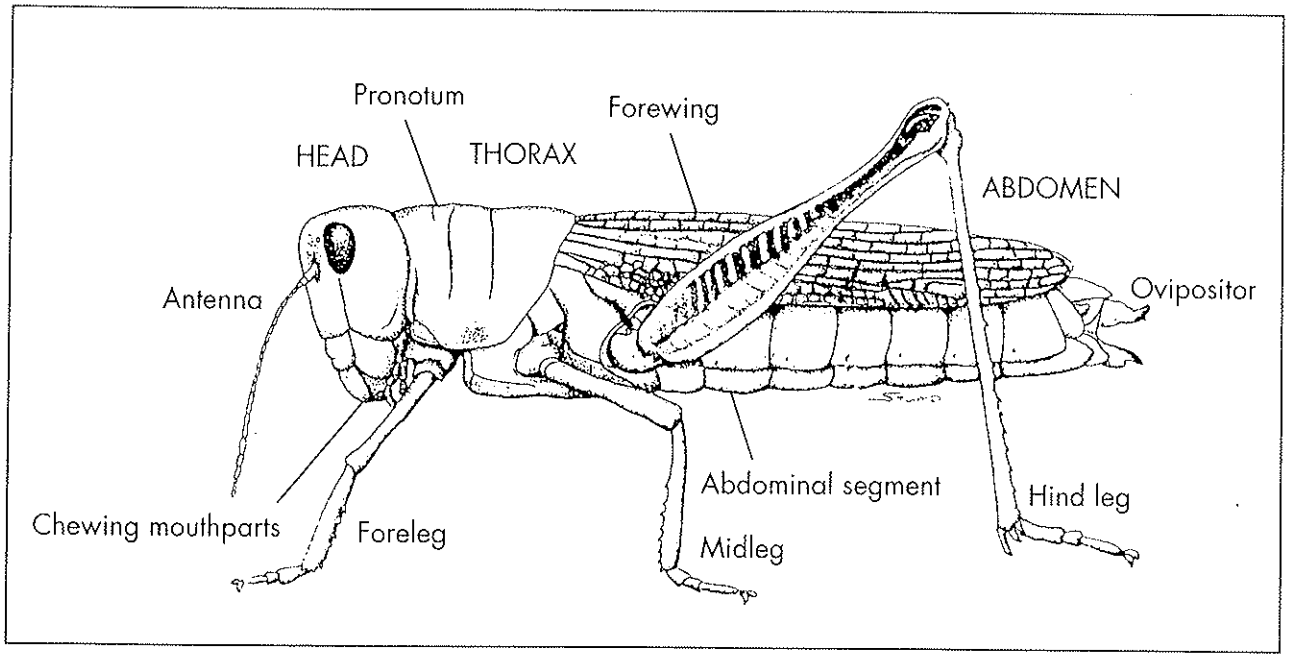
Relative sizes of insect orders in different geographic regions using species estimates

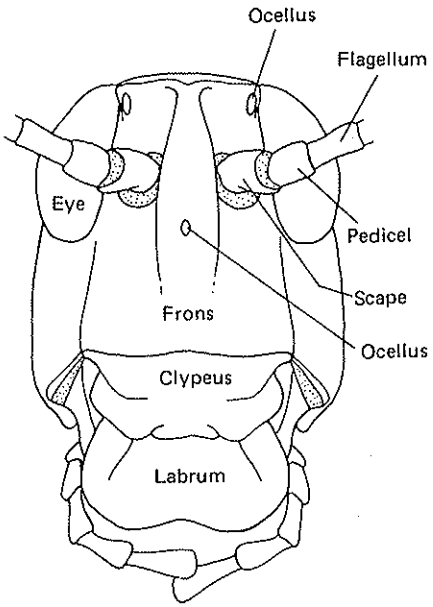
Order	North Carolina[a]	New York[b]	North America (NA) north of Mexico[c]	Australia[d]	World[e]	Families in NA
Protura	0	1	73	30	500	3
Collembola	169	200	812	1630	>6000	12
Diplura	1	2	125	31	800	4
Microcoryphia	1	2	24	7	350	2
Thysanura	5	3	20	28	370	3
Ephemeroptera	121	61	599	84	2100	21
Odonata	148	159	435	302	6000	11
Orthoptera	**235**	**121**	**1210**	**2827**	**>20,000**	**16**
Phasmatodea	4	2	33	150	>2500	4
Grylloblattodea	0	0	10	0	25	1
Mantophasmatodea	0	0	0	0	3	0
Dermaptera	7	4	23	63	1840	6
Plecoptera	94	59	622	196	2000	9
Embidiina	0	0	11	65	<250	3
Zoraptera	1	0	2	0	30	1
Isoptera	5	1	44	348	>2300	4
Mantodea	2	2	30	162	1900	2
Blattodea	17	11	67	428	<4000	5
Hemiptera	**1327**	**1591**	**11298**	**5650**	**114,072**	**90**
Thysanoptera	68	71	695	422	5100	7
Psocoptera	37	36	264	299	>3000	28
Phthiraptera	175	64	941	255	>12000	18
Coleoptera	**3336**	**4546**	**24085**	**28200**	**>350,000**	**128**
Neuroptera	68	61	400	649	5500	15
Hymenoptera	**2463**	**2300**	**20372**	**14781**	**150,000**	**74**
Trichoptera	161	174	1415	478	>7000	26
Lepidoptera	**1428**	**2439**	**11673**	**20816**	**300,000**	**84**
Siphonaptera	14	26	314	88	2380	8
Mecoptera	27	20	83	27	500	5
Strepsiptera	11	2	91	159	550	5
Diptera	**2595**	**3615**	**19782**	**7786**	**>150,000**	**103**
Total	12520	15573	95553	78175	**1,151,070**	698

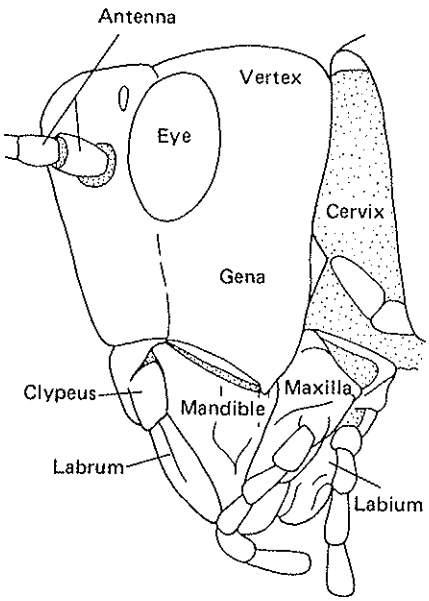
a. Wray, D.L. 1967. Insects of No. Carolina. 3rd Suppl., No. Carolina Dept Agr., Raleigh, NC, 181pp.
b. Leonard, M.D. 1928. A list of the Insects of New York. Mem. 101, Cornell Agr. Exp. Station, Ithaca, NY, 1121 pp.
c. Poole, R.W. and P. Gentilli (Eds.) 1996. Nomina Insecta Nearctica. 4 vols. Entomology Information Services, Rockville, MD.
d. CSIRO (Ed.) 1991. The Insects of Australia, 2 vols. Melbourne University Press, Carleton, Vic. Australia
e. from many sources, mostly Parker, P.S. (Ed.) 1982. Synopsis and Classification of Living Organisms, McGraw-Hill, NY.
Minelli, A. 1993. Biological Systematics: the State of the Art. Chapman & Hall, London.

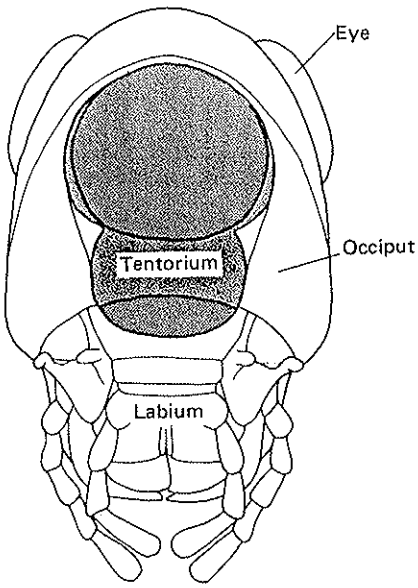
"Think about it, Ed...The class Insecta contains 26 orders, several thousand families, and over a million described species -- but I can't shake the feeling that we're all just a bunch of bugs."

External Anatomy of Insects





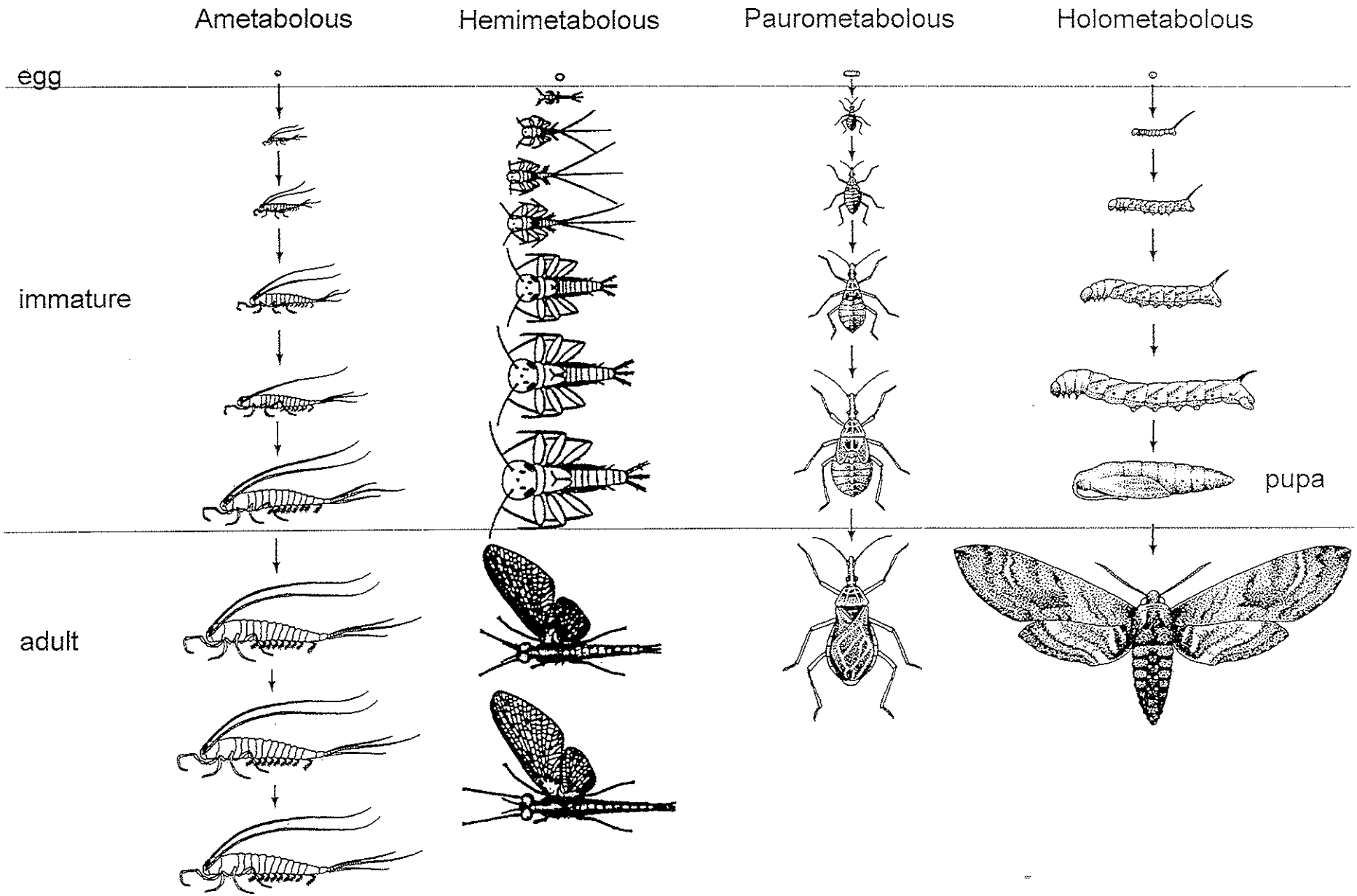


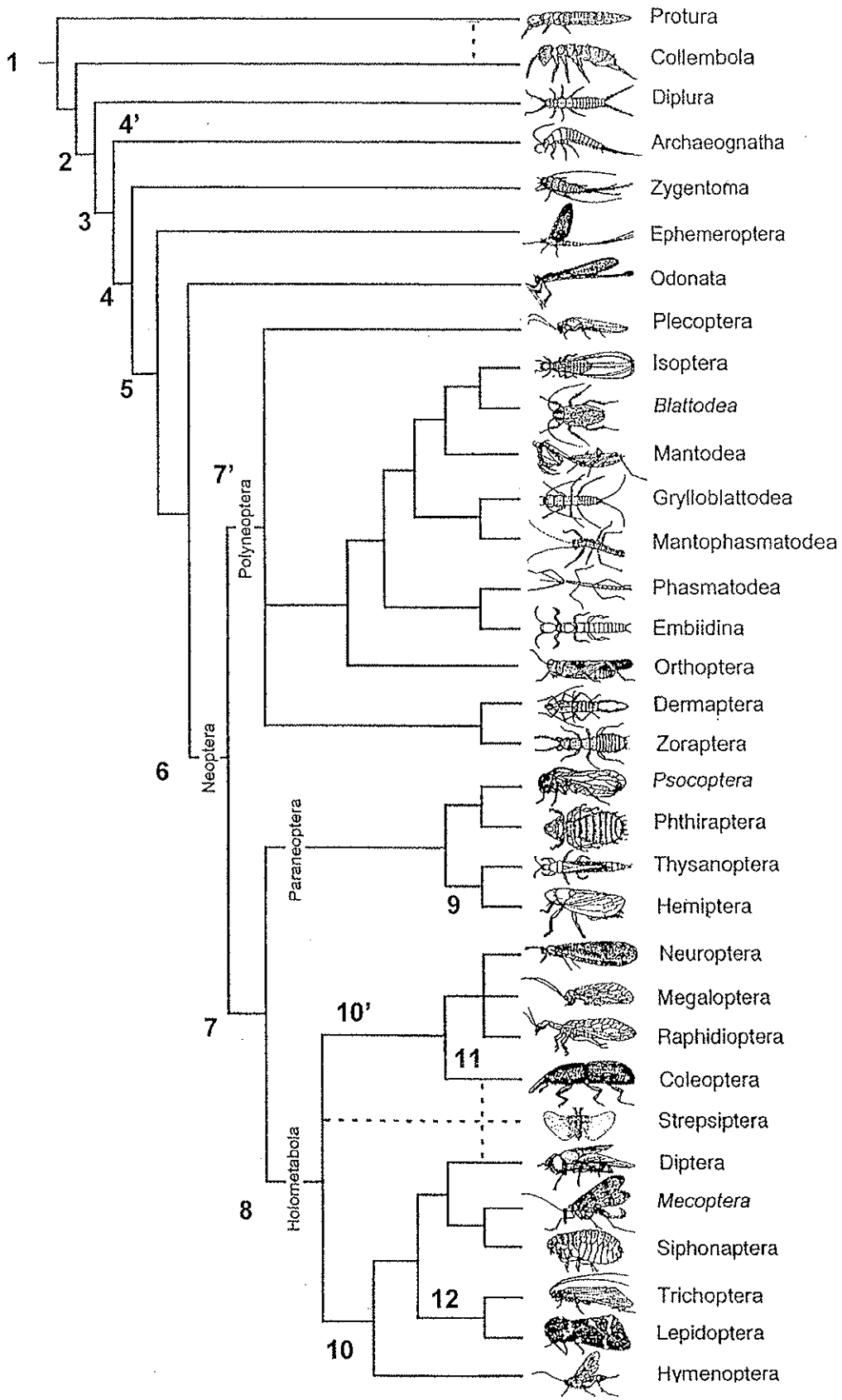


Winged Insects

- 2 wings
  - Wings on 2nd thoracic segment
    - **Diptera** Flies
  - Wings on 3rd thoracic segment
    - **Strepsiptera** Twist wing insects
- 4 wings
  - No scales on wings
    - Chewing mouth parts
      - Front wings parchmentlike
        - Front leg modified for grasping
          - **Mantodea** Mantises
        - Front leg not modified for grasping
          - hind leg modified for jumping
            - **Orthoptera** Grasshoppers
          - hind leg not modified
            - **Blattodea** Cockroaches
      - Front wings hard—not flexible. No obvious veins
        - Pincers at tip of abdomen
          - **Dermaptera** Earwig
        - No pincers on abdomen
          - **Coleoptera** Beetles
      - Front wings membranous
        - Wings lay flat over body when at rest
          - Hind wing larger than fore wing
            - **Plecoptera** Stoneflies
          - Wings of same size.
            - Front leg not swollen at tip
              - **Isoptera** Termites
            - Front leg swollen at tip
              - **Embiidina** Web spinners
        - Wings not flat over body
          - Hind wing much smaller than fore wing
            - **Hymenoptera** Wasps, bees
          - Hind wing nearly same size (or larger) than fore wing
            - many veins in wings >10mm long
              - Head shaped like a beak or wedge. Abdomen of male like that of scorpion.
                - **Mecoptera** Scorpionflies
              - Not like Mecoptera. Have net-like wings.
                - Strong, swift fliers. Eyes make up most of head.
                - **Odonata** Dragonflies
                - Rather weak fliers. Eyes prominent but small.
                - **Neuroptera** Lacewings, etc.
            - few veins in wings <6 mm long
              - **Psocoptera** psocids
    - Reduced or non-functional mouth parts
      - Antennae short 2–3 long threadlike tails. Netlike vein pattern of wings
        - **Ephemeroptera** Mayflies
      - Antennae as long as body. Wings hairy
        - **Trichoptera** Caddisflies
    - Sucking mouth parts
      - Wings *not* narrow or fringed with hairs.
        - **Hemiptera** Bugs, Cicada, Leafhoppers, Aphids
      - Wings long and narrow and fringed with hairs. Minute insect
        - **Thysanoptera** Thrips
  - Wings covered with scales. Occasionally hind wings may be clear and without scales
    - **Lepidoptera** Butterflies, Moths

Insect metamorphosis




1
2
3
4
4'
5
6
7
7'
8
9
10
10'
11
12
Neoptera
Polyneoptera
Paraneoptera
Holometabola
Protura
Collembola
Diplura
Archaeognatha
Zygentoma
Ephemeroptera
Odonata
Plecoptera
Isoptera
Blattodea
Mantodea
Grylloblattodea
Mantophasmatodea
Phasmatodea
Embiidina
Orthoptera
Dermaptera
Zoraptera
Psocoptera
Phthiraptera
Thysanoptera
Hemiptera
Neuroptera
Megaloptera
Raphidioptera
Coleoptera
Strepsiptera
Diptera
Mecoptera
Siphonaptera
Trichoptera
Lepidoptera
Hymenoptera

The cladogram on the preceding page is derived mostly from molecular characteristics that uniquely define the orders (synapomorphies). However, many of the groups are well characterized by shared morphological characters as well. The following list refers to numbered nodes on the cladogram.

1. Hexapoda: Six legs
2. Development is epimorphic (the number of body segments is determined in the embryo)

3. Insecta: Antennae flagellate; tentorium; cervical sclerites
4. Mandibles dicondylic (2 articulations)
4'. Mandibles monocondylic (1 articulation)

5. Adults with wings (may be secondarily lost, e.g., fleas)
6. Neoptera: Wings can be folded over the back
7. Reduced number of Malpighian tublues; fusion of abdominal nervous system; small hindwings
7'. Polyneoptera: Many Malpighian tublues; abdominal nervous system with segmental ganglia, large vannal area of hind wings

8. Holometabola: pupal stage between immature and adult
9. Mouthparts modified for piercing
10. Head without a gula ventrally
10'. Head with a gula or pregular bridge
11. Forewings modified into elytra
12. Scales or hairs on wings

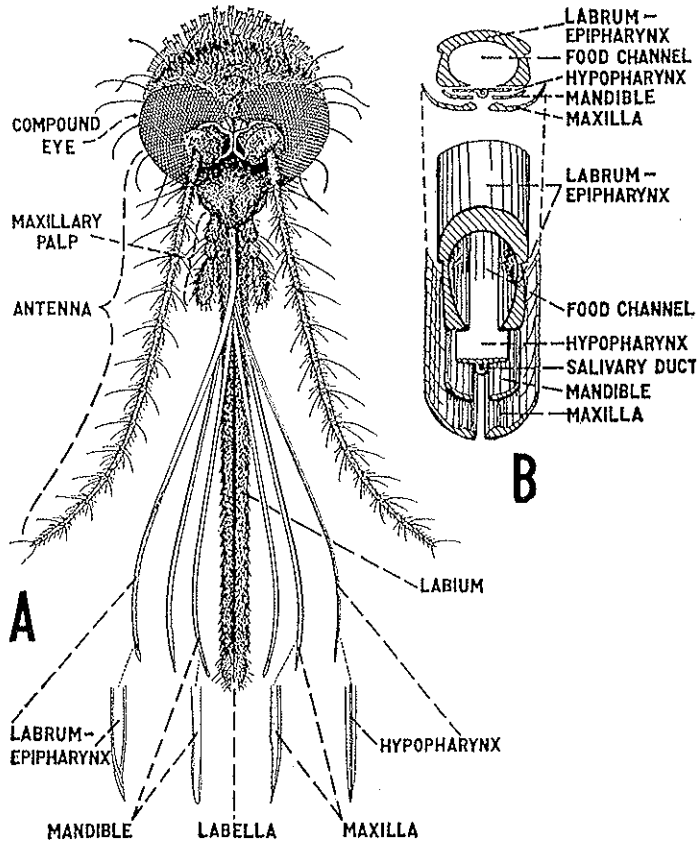


FIG. 66.—Piercing-sucking mouth parts as found in a female mosquito; common biting-fly subtype. *A*, front or dorsal view of head and mouth parts with the stylets spread out of the labium and their tips more enlarged below. *B*, cross-section and isometric projection of the stylets as described by Howard, Dyar, and Knab.

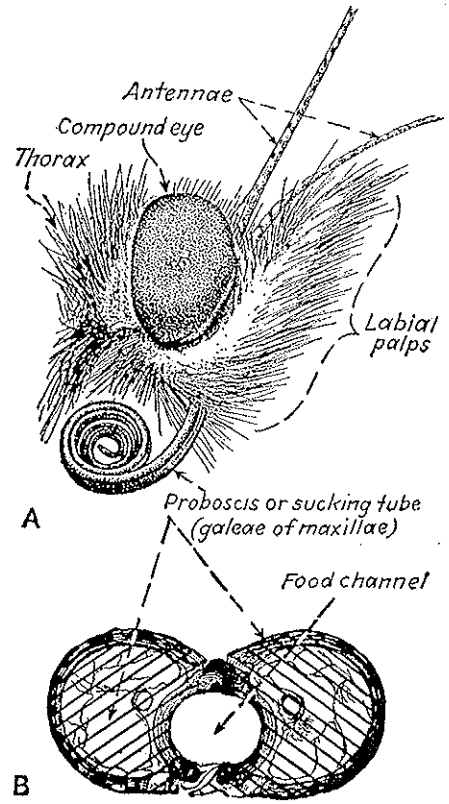


FIG. 75.—Siphoning type of mouth parts as found in a moth or butterfly. *A*, side view of the head with the proboscis partly coiled. Note the labial palps which are so covered with hairs that the segmentation cannot be distinguished. *B*, cross-section of the proboscis to show how the right and left galeae lock together to form the food channel. Highly magnified. (*Redrawn after Comstock.*)

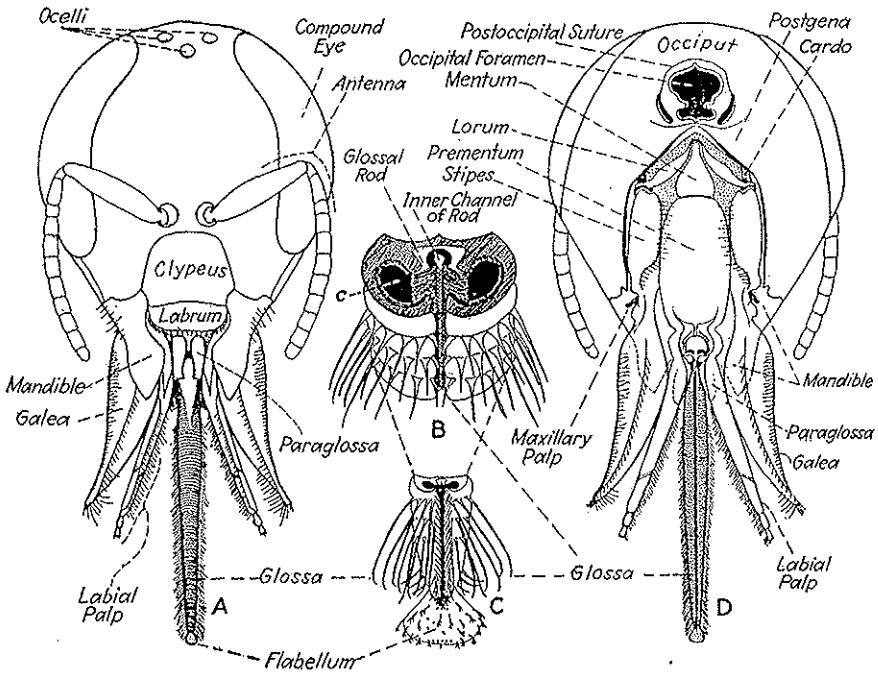


FIG. 76.—Mouth parts of the chewing-lapping type as found in the honeybee. *A*, cephalic or front view of head and mouth parts. Note that labrum and mandibles are of the chewing type, the latter specially shaped for molding the waxen combs, while the galeae, labial palps, and glossa make a five-part tongue for lapping up nectar. *B*, cross-section and isometric view of a portion of the glossa, greatly magnified, showing the ventral groove which communicates with the canal, *c*, the rings of long hairs, the glossal rod embedded in its anterior wall, and the hair-guarded inner channel of the latter. The ventral canal may be used to conduct saliva to the tip of the tongue but is not believed to be important in sucking up nectar. *C*, tip of the tongue or glossa, greatly magnified, ventral or posterior view, showing the close-set hairs that guard the ventral canal and the spoon-shaped flabellum at its tip. *D*, caudal view of head and mouth parts, showing the cardo, stipes, maxillary palp, and galea of the maxilla; and the lorum, mentum, prementum, paraglossae, and glossa of the labium.

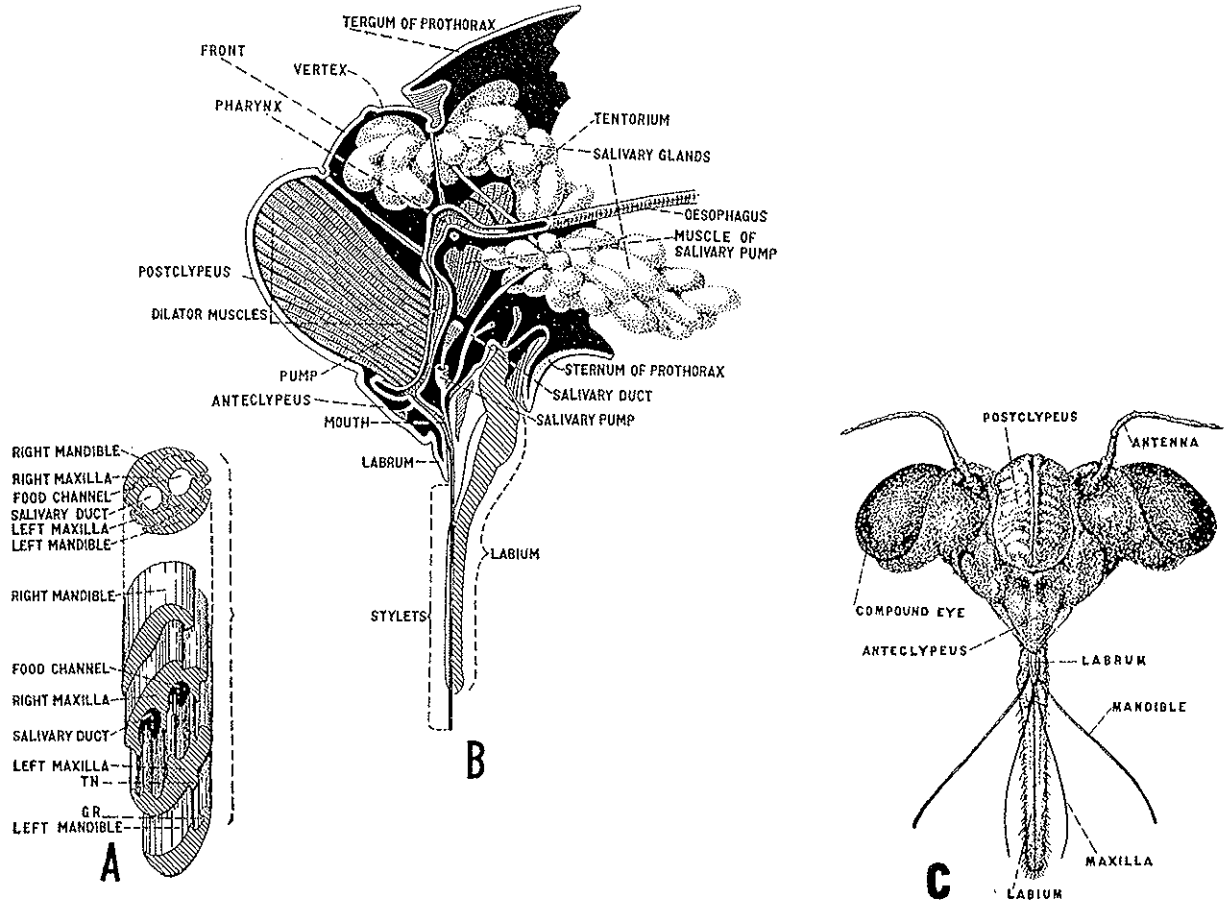


FIG. 65.—The piercing-sucking type of mouth parts as found in the squash bug and cicada. *A*, cross-section and isometric projection of the stylets as described by Tower, greatly magnified (*original*); *B*, sagittal section of the head of the periodical cicada showing the relation of the stylets to the mouth opening, the pump, the pharynx, and the salivary glands, duct and pump, much enlarged (*redrawn after Snodgrass, Proc. Ento. Soc., Wash.*); *C*, front or dorsal view of head and mouth parts of a dog-day cicada, much enlarged (*original*).

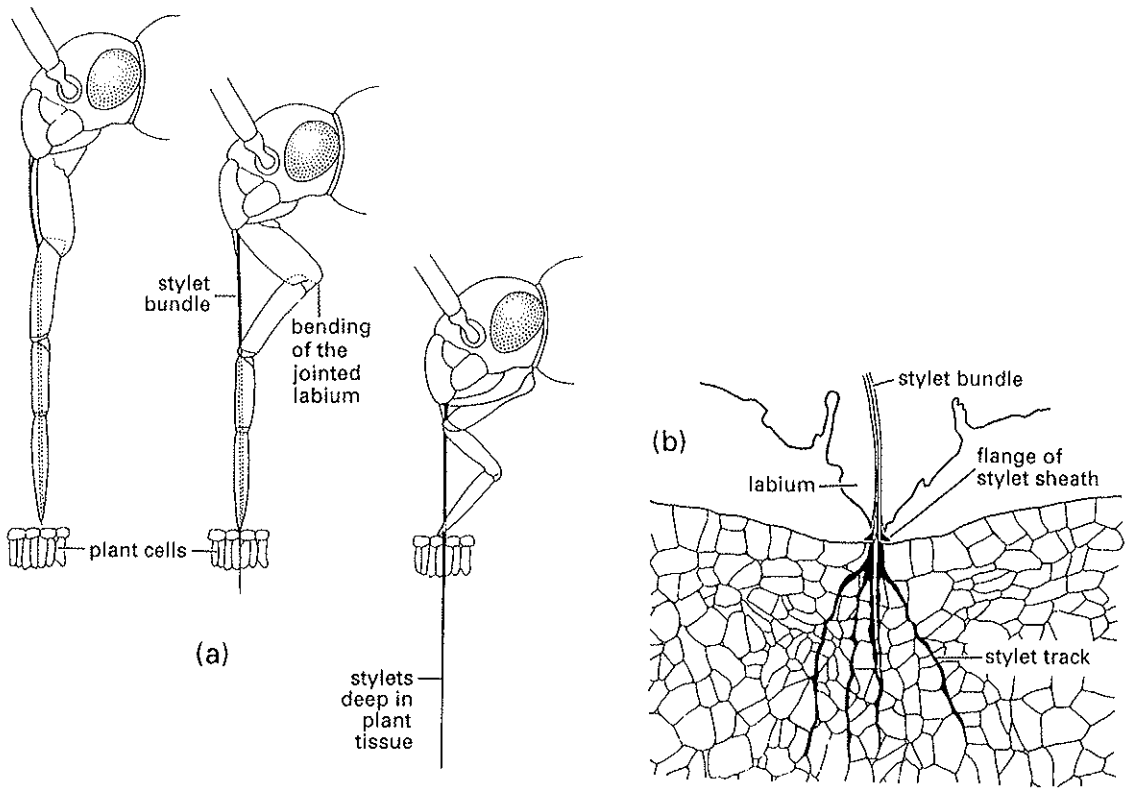


Fig. 10.4 Feeding in phytophagous Hemiptera: (a) penetration of plant tissue by a mirid bug showing bending of the labium as the stylets enter the plant; (b) enlargement of the feeding site of (b) showing multiple stylet tracks (formed of solidifying saliva) resulting from probing of the parenchyma. ((a) after Poisson, 1951.)