

SYNOPTIC KEY TO THE PHYLA, CLASSES, AND ORDERS OF ANIMALS

WITH PARTICULAR REFERENCE TO FRESH-WATER
AND TERRESTRIAL FORMS OF THE MOIST
TEMPERATE REGION IN NORTH AMERICA

Compiled by

W. C. ALLEE

Zoological Laboratory, University of Chicago

Based on a compilation originally made by

V. E. SHELFORD

The Vivarium, University of Illinois

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THE UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS

THE BAKER & TAYLOR COMPANY
NEW YORK

THE CAMBRIDGE UNIVERSITY PRESS
LONDON

THE MARUZEN-KABUSHIKI-KAISHA
TOEYO, OSAKA, KYOTO, FUKUOKA, SENDAI

THE MISSION BOOK COMPANY
SHANGHAI

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Published June 1923

Composed and Printed By
The University of Chicago Press
Chicago, Illinois, U.S.A.

PREFACE

This synoptic key is an introduction to the classification of the animal kingdom and to the general reference books most used by teachers and high-school or college students in identifying an unknown animal. The key is based on books of wide circulation and is intended for the use of persons who are not expert systematists but who must make excursions into this field, much neglected in modern zoölogical training. It is hoped that this compilation may make such excursions less laborious and more profitable, and that particularly it may encourage the introduction of exercises in classification of common animals into elementary courses in zoölogy.

The form used is based on that in Ward and Whipple's *Fresh-Water Biology*. The number introducing each key paragraph is followed by numbers in parentheses indicating possible alternative choices. When a choice is made, the next step is indicated by the number or other direction immediately following. Page references are given to general taxonomic works in which the classification may be further traced. Unusual or technical terms are explained in the glossary.

The key is based on a compilation made over fifteen years ago by Professor V. E. Shelford, who has kindly consented to its publication. The content has been much changed; the form recast; and the references brought up to date by the present compiler, who takes entire responsibility for the accuracy of this version. I wish here to express my thanks to the many students and laboratory assistants who have called attention to errors in the mimeographed copies; to all authors who have contributed knowingly or otherwise; and particularly to Professor H. S. Pratt for permission to use largely from his *Manual of Common Invertebrates*. I am sorry that his forthcoming *Manual of Vertebrates* is not yet available.

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GENERAL TAXONOMIC REFERENCES

- BAKER, *Mollusca of the Chicago Area* (general key lacking).
- CALKINS, *Protozoölogy* (particularly for pathogenic forms).
- CHAPMAN, *Birds of N.E. United States* (good for birds in the hand).
- COMSTOCK, *Manual for the Study of Insects* (more complete than Lutz).
- , *The Spider Book*.
- CORY, *The Mammals of Illinois and Wisconsin*, "Field Museum, Zoöl. Series," No. 11.
- DICKERSON, *The Frog Book*.
- DITMARS, *The Reptile Book*.
- FANTHAM, STEVENS, AND THEOBALD, *Animal Parasites of Man* (referred to as "F. S. and T.").
- FORBES AND RICHARDSON, *Fishes of Illinois*.
- JORDAN, *Manual of the Vertebrates of the Northern United States*.
- LUTZ, *Field Book of Insects* (best general handbook).
- MINCHIN, *The Protozoa*.
- PRATT, *Manual of the Common Invertebrate Animals*.
- REED, *Bird Guide* (in two parts; best for field).
- WARD AND WHIPPLE, *Fresh-Water Biology* (frequently referred to herein as "W. and W.").
- Some additional special references will be found on page 46.

KEY TO ANIMAL PHYLA

- 1(2) Animals consisting of a single cell, or of a colony of similar cells, or of a mass of protoplasm with a number of nuclei irregularly arranged, always lack tissues; almost always microscopic. Fresh-water, or marine or moist situations. Phylum **Protozoa**, p. 6
- 2(1) Animals consisting of many cells arranged in tissues; the Metazoa. 3
- 3(5, 9) Body without definite planes of symmetry or radially symmetrical; never spirally coiled. 4
- 4 Sponges with the body more or less indefinite in form; a sessile crust or mass with a rough, spiny wall pierced by numerous microscopic pores and by one or more large openings. Tentacles absent.
Phylum **Porifera**, p. 10
- 5(3, 9) Body radially symmetrical; wall not pierced by pores, a closable mouth present. 6
- 6(7, 8) Jelly-like animals with eight rows of ciliated swimming plates. Tentacles, if present, without nematocysts. Marine forms. (Pratt, 150.) Phylum **Ctenophora**
- 7(6, 8) Body without eight rows of ciliated plates, tentacles present bearing nematocysts. No anus present. Sessile (hydroids and sea anemones) or free swimming (jellyfish). If sessile, may be either solitary or colonial. Parts arranged in fours or sixes or indefinite.
Phylum **Coelenterata**, p. 11
- 8(6, 7) Parts of body usually in fives; outer covering spiny or leathery; anus usually present. Tentacles usually absent and never bear nematocysts. Starfish, sea urchins, sea cucumbers. All marine.
Phylum **Echinoderma**, p. 18

- 9(3, 5) Body bilaterally symmetrical or spirally coiled in part; never radially symmetrical; sometimes bent so that the mouth and anus lie near each other. 10
- 10(33) Body soft and wormlike or covered with a hard shell or other hard outer covering; no internal skeleton of bone or cartilage making a skull and spinal column; no gill slits opening to the pharynx. 11
- 11(12) Small, more or less transparent aquatic forms in fresh water, usually bearing a girdle or crown of cilia at the anterior end upon a more or less disklike, often lobed region. An internal gizzard with movable jaws. Posterior part of body frequently segmented and wormlike. Cilia may be restricted to ventral surface, or absent in marine forms. Phylum **Trochelminthes**, p. 15
- 12(11) Without such cilia in adult condition. 13
- 13(22) Body not divided into segments either by constrictions on the surface, by segmental bristles or segmental appendages. 14
- 14(18, 17) Flattened wormlike animals. 15
- 15(16) Worms with a long proboscis inclosed in a sheath which lies on the dorsal side of the animal dorsal to the digestive tract. The proboscis is capable of extrusion through an opening at the anterior end which may or may not coincide with the mouth. Marine forms may be large, fresh-water ones are small. (Pratt, 205; W. and W., 454.) Phylum **Nemertini**
- 16(15) Without a proboscis of the kind described above. Anus always absent. Body usually flattened dorsoventrally, may be leaf or ribbon-like. Free-living forms with naked body bearing cilia, at least on the ventral surface; parasitic forms covered by a thin cuticle. Marine or fresh water. Flat worms, trematodes; simplest tapeworms. Phylum **Platyhelminthes**, p. 13

- 17(14, 18) Worms with a cylindrical or filiform body with a thick smooth outer covering. Anus usually present; in water, soil, or parasitic. Phylum **Nemathelminthes**, p. 14
- 18(17, 14) Not wormlike, frequently covered by calcareous horny or gelatinous secretion. If shell is absent, animal with well-developed head. 19
- 19(20, 21) Sessile animals, frequently in colonies which are covered by horny or calcareous or gelatinous covering. Anus present, near the anterior end of the body. A circle or crown of ciliated tentacles about the mouth. Marine and fresh water. Phylum **Bryozoa**, p. 16
- 20(19, 21) Sessile, solitary, marine, mollusk-like animals; the body inclosed in a bivalve, asymmetrical, horny or calcareous shell, one valve of which is dorsal, the other ventral; hinged at posterior end; usually attached by a muscular peduncle which protrudes near the hinge. Tentacular arms prominent within the shell. (Pratt 264.)
Phylum **Brachiopoda**
- 21(19, 20) Animals usually free moving (always so in fresh water), either bilaterally symmetrical or in part spirally coiled. A fold of the body wall, the mantle, usually present and inclosing the body. A calcareous shell consisting of one (snails), two (clams and mussels), and rarely of several pieces (marine). This normally incloses the body but may be reduced to a thin dorsal plate, invisible externally (marine) or entirely absent. In last two cases (as in slugs), the head is well developed. The ventral surface is almost always provided with a locomotor organ, the foot, which may be used for creeping, swimming, or attachment. Animals rarely parasitic. Phylum **Mollusca**, p. 18
- 22(13) Body divided into segments as indicated by constrictions on the surface, by the number and arrangement of bristles or appendages or by the arrangement of internal organs. 23

- 23(32) Without jointed appendages, body wormlike. 24
- 24(29) Without segmentally arranged bristles. 25
- 25(26) Internal parasites lacking mouth, anus and whole digestive tract; body long, flattened, increasing in size posteriorly. Segments distinct and numerous. Posterior ones may become free. The tape worms.
Phylum **Platyhelminthes**, Class **Cestoda**, p. 14
- 26(25) Mouth, anus, and alimentary canal present; posterior end not markedly larger than anterior. 27
- 27(28) Without spiracles, tracheal gills, or trachea. With a sucker at each end of the body except in a few marine forms. The leeches. Mainly fresh water.
Phylum **Annelida**, Class **Hirudinea**, p. 17
- 28(27) Without a sucker at each end of the body. With spiracles, trachea, or tracheal gills. Trachea frequently visible through the body wall as white lines. Fleshy, unjointed prolegs, present or absent; head large and conspicuous or small and retractile within the body; mouth parts present. Includes forms fed by other members of the colony, parasitic forms, wood-borers, fresh-water and terrestrial free-living forms.
Phylum **Arthropoda**, Larval **Insecta**, p. 37
- 29(24) With segmentally arranged bristles. 30
- 30(31) Without trachea, tracheal gills, or spiracles; in fresh-water forms never with large tufts of bristles at one end of the body; aquatic and terrestrial. In marine forms, the bristles (setae) are borne usually on outgrowths of the body wall called parapodia or are rarely absent. Phylum **Annelida**, p. 17
- 31(30) With trachea, tracheal gills, or spiracles; often with large tufts of bristles at one end of the body; with a

head usually well differentiated and always with some kind of mouth parts, frequently with antennae. Fresh water and terrestrial.

Phylum **Arthropoda**, Larval **Insecta**, p. 37

- 32(23) With jointed appendages at least on the anterior segments. (In a few of the parasitic Crustacea the appendages are modified or disappear in the adult.) Aquatic and terrestrial.

Phylum **Arthropoda**, p. 21

- 33(10) Gill slits present, opening into the pharynx, usually with internal skeleton of bone or cartilage, outer surface bare, or covered with scales, feathers, or hairs; dorsally placed nervous system.

Phylum **Chordata**, p. 46

KEY TO CLASSES AND ORDERS OF ANIMALS

PHYLUM P R O T O Z O A

- 1(6) Without flagella or cilia or sucking tentacles in the adult condition. 2
- 2(3) Body naked, or partially inclosed in a shell, movement by means of pseudopodia. The pseudopodia may have rigid axial filaments. Class **Sarcodina**, p. 6
- 3(2) Body covered with a well-developed ectoplasmic membrane. 4
- 4(5) Free living, encysted forms which if placed in proper conditions will become active and may then be identified.
- 5(4) Parasitic in cells, tissues, and open spaces of other animals; pseudopodia and all other locomotor organs lacking in the adult; shell and skeleton lacking. Class **Sporozoa**, p. 7
- 6(1) Cilia or flagella or sucking tentacles present. 7
- 7(8) With one or more flagella. Class **Mastigophora** (Flagellata), p. 8
- 8(7) With cilia or sucking tentacles present. Class **Infusoria** (Ciliata), p. 10

CLASS S A R C O D I N A

- 1(4) Central capsule absent, marine or fresh water or terrestrial. 2
- 2(3) Body naked or with shell, with very changeable pseudopodia which lack an axial filament (Pratt, 14; W. and W., 219.) Order **Rhizopoda**

- 3(2) Body naked or with shell, with stiff raylike pseudopodia which contain an axial filament. (Pratt, 21; W. and W., 234.) Order **Heliozoa**
- 4(1) Central capsule present, marine animals; form relatively permanent; pseudopodia raylike. (Pratt, 24.) Order **Radiolaria**

CLASS **S P O R O Z O A**

- 1(2) Spore formation occurring only at the end of the vegetative period. Reproduction takes place by budding or splitting from the outer surface of the body.
Subclass **Telosporidia**, p. 7
- 2(1) Spore formation occurring throughout the vegetative period. Reproduction by a process of internal gemination.
Subclass **Neosporidia**, p. 7

SUBCLASS **TELOSPORIDIA**

- 1(2, 3) Body never ameboid, usually elongated. Young stages intracellular (apparently two celled). Full-grown forms free in open spaces of their hosts. Parasites of invertebrates. (Minchin, 326; Calkins, 57; Pratt, 42.) Order **Gregarina**
- 2(1, 3) Spherical or ovoid; intracellular; never free in cavities of hosts; parasitic in solid tissues. (Minchin, 341; Calkins, 62; Pratt, 46.) Order **Coccidida**
- 3(1, 2) Full-grown form wormlike or ameboid in blood corpuscles or plasma of vertebrates. (Minchin, 356; Calkins, 65; Pratt, 46.) Order **Haemosporidia**

SUBCLASS **NEOSPORIDIA**

- 1(2, 3, 4) Ameboid in cavities of host, or encysted in tissues. Multinucleate. Mostly in fishes and arthropods. Spores with two or four polar capsules containing more or less easily seen threads. (Minchin, 399; Calkins, 66; Pratt, 48.) Order **Myxosporidia**

- 2(1, 3, 4) Binucleate amebulae, spore large with three valves and three polar capsules. (Minchin, 409; Calkins, 68.)
Order **Actinomyxidia**
- 3(1, 2, 4) Spores very minute; the one polar capsule is invisible in the fresh state. Parasites of arthropods. (Minchin, 411; Calkins, 67.)
Order **Microsporidia**
- 4(1, 2, 3) Young stages in muscle fibers of higher vertebrates. Large saclike spore cases. (Minchin, 419; Calkins, 68; Pratt, 48.)
Order **Sarcosporidia**

CLASS MASTIGOPHORA (Flagellata)

- 1(2, 3) Small Mastigophora with definite anterior and posterior ends one of which bears one or more flagella. Lacking a transverse furrow. Subclass **Flagellidia**, p. 8
- 2(1, 3) With two flagella usually, one of which typically lies in a cross-furrow and the other in a longitudinal furrow directed backward. Sometimes naked and colorless; sometimes with a tabulated armor colored green or brown. Subclass **Dinoflagellidia**, p. 9
- 3(1, 2) Large marine Mastigophora with parenchymatous protoplasm. (Pratt, 41.) Subclass **Cystoflagellidia**

SUBCLASS FLAGELLIDIA

(Key arranged from Pratt)

- 1(14) Body colorless, often more or less ameboid and with one or more flagella. 2
- 2(3) Body spiral, with or without flagellum and more or less like bacteria. (Pratt, 26; Minchin, 466.)
Order **Spirochetida**
- 3(2) Body not spiral. 4
- 4(5) One flagellum with collar present. (Pratt, 28; W. and W., 257.)
Order **Choanoflagellidia**
- 5(4) No collar present. 6

- 6(13) Body with indistinct cuticula, often more or less
ameboid. 7
- 7(8) Body elongate with undulating membrane. (Pratt,
30; Calkins, 244; Minchin, 283.)
Order **Trypanosomatida**
- 8(7) No undulative membrane present. 9
- 9(10) Two or more flagella, one directed forward, the other
trailed behind. (Pratt, 29; W. and W., 248.)
Order **Heteromastigida**
- 10(9) Flagella always directed forward. 11
- 11(12) One or two flagella; body usually more or less ameboid.
(W. and W., 243; Pratt, 26.) Order **Monadida**
- 12(11) Three or more flagella. (Pratt, 30.)
Order **Polymastigida**
- 13(6) Body with distinct cuticula. (Pratt, 31; W. and W.,
251.) Order **Euglenida**
- 14(1) Body usually either yellow or green, often colonial. 15
- 15(16) Body with distinct cuticula, and usually solitary.
(Pratt, 31; W. and W., 251.) Order **Euglenida**
- 16(15) Body usually with a hyaline, gelatinous or cellulose
house, colonial. (Pratt, 34; W. and W., 249.)
Order **Phytoflagellida**

SUBCLASS **DINOFLLAGELLATA**

- 1(2) Without furrows, the two flagella free in the water,
the transverse with movement the same as though
the furrow were present. (Pratt, 39.) Order **Adinida**
- 2(1) With furrows, one transverse, the other longitudinal.
(Pratt, 40; W. and W., 269.) Order **Diniferida**

CLASS INFUSORIA

- 1(2) Cilia present; sucking tubes absent. Subclass *Ciliata*, p. 10
- 2(1) Cilia absent in adults; sucking tubes present. (Pratt, 67; W. and W., 298.) Subclass *Suctatoria*

SUBCLASS CILIATA

- 1(4) Cilia usually present on all parts of the body. 2
- 2(3) Cilia short, nearly equal in length except in mouth region where they may be longer. (Pratt, 50; W. and W., 271.) Order *Holotricha*
- 3(2) Mouth surrounded by an adoral zone of cilia much longer than those on other parts of the body. (Pratt, 57; W. and W., 283.) Order *Heterotricha*
- 4(1) Cilia not present on the whole body surface. 5
- 5(6) Cilia absent on the dorsal surface. Cilia of the ventral surface fused to form thickened processes upon which the animal supports itself and moves about. (Pratt, 60; W. and W., 286.) Order *Hypotricha*
- 6(5) A spiral of cilia or membranellae present in mouth region. Other cilia absent save sometimes a girdle of cilia near aboral region. (Pratt, 64; W. and W., 291.) Order *Peritricha*

PHYLUM PORIFERA

- 1(2) Small, marine, with calcareous spicules. Class *Calcarea*, p. 11
- 2(1) Larger sponges, skeleton silicious, horny or absent; never calcareous; some in fresh water. 3
- 3(4) Marine. Glass sponges with six-rayed spicules. (Pratt, 77.) Class *Hexactinellida*
- 4(3) Marine or fresh water; skeleton of silicious spicules, spongin, or both or wanting. Class *Demospongiae*, p. 11

CLASS CALCAREA

- 1(2) Body wall thin and porous, central cavity lined with collar cells; Ascon type. (Pratt, 75.)
Order **Homocoela**
- 2(1) Body wall thicker, central cavity without collar cells; Sycon type. (Pratt, 76.)
Order **Heterocoela**

CLASS DEMOSPONGIAE

- 1(4) Skeleton containing silicious spicules with or without horny substance (spongin). 2
- 2(3) Four-rayed silicious spicules present; spongin and needle-like spicules absent. (Pratt, 78.)
Order **Tetractinellida**
- 3(2) Needle-like spicules present; spongin fibers present or absent; some in fresh water. (Pratt, 80; W. and W., 306.)
Order **Monactinellida**
- 4(1) Skeleton lacking silicious spicules. 5
- 5(6) Skeleton of spongin, marine. The bath sponges. (Pratt, 84.)
Order **Ceraospongiae**
- 6(7) Skeleton wanting. (Pratt, 85.)
Order **Myxospongiae**

PHYLUM COELENTERATA

- 1(4) Small hydroid polyps with either small or large medusae or none. 2
- 2(3) Hydroid form when present without gastric ridges or filaments. Reproductive organs almost always ectodermal. Medusa, when present, with a velum. Hydroid frequently branching. Some fresh-water forms.
Class **Hydrozoa**, p. 12
- 3(2) Hydroid small, if present, and bears gastric ridges. Medusa almost always present but without a velum; marine. (Pratt, 126.)
Class **Scyphozoa**

- 4(1) Polyps solitary or colonial, large, medusa always absent; marine; the sea anemones, corals, etc. (Pratt, 132.) Class **Anthozoa**

CLASS **H Y D R O Z O A**

- 1(10) Hydroid form present, frequently prominent, mostly marine but with some fresh-water forms. 2
- 2(3) Almost always fresh-water animals; polyps solitary, without medusa forms or medusa-like buds. (Pratt, 92; W. and W., 320.) Order **Hydrariae**
- 3(2) Usually marine forms (rare in fresh water). 4
- 4(5) Colonies with a coral-like skeleton surrounding the bases of the branching polyp forms. Medusa buds usually remaining attached to the colony. (Pratt, 93.) Order **Hydrocorallinae**
- 5(4) Colonies without a coral-like skeleton. 6
- 6(7) Colony free swimming, containing a large number of individuals of different kinds usually supported by an air-bladder float. Portuguese man-of-war. (Pratt, 121.) Order **Siphonophora**
- 7(6) Colony not free swimming although they may give off free-swimming medusae. 8
- 8(9) Without protective cup (hydrotheca) about the hydranth, or (gonangium) about the medusa buds; medusae with gonads on the manubrium and when set free with photoreceptors and lacking lithocysts. (Pratt, 94.) Order **Tubulariae** (Anthomedusae)
- 9(8) With a hydrotheca and gonangium; medusae with gonads on the radial canals and when set free with lithocysts but lacking photoreceptors. (Pratt, 104.) Order **Campanulariae** (Leptomedusae)
- 10(1) Hydroid form lacking (or minute if present). 11

- 11(12) Tentacles from the margin of the umbrella; gonads on the radial canals; margin entire. (Pratt, 117.)

Order **Trachymedusae**

- 12(11) Tentacles arise aborally from the exumbrella; gonads on the manubrium; margin scalloped; hydroid unknown. (Pratt, 120.)

Order **Narcomedusae**

PHYLUM **P L A T Y H E L M I N T H E S**

- 1(2) Cilia present at least on the ventral surface; almost all free living.

Class **Turbellaria**, p. 13

- 2(1) Surface of body of adult not ciliated; parasitic. 3

- 3(4) Body usually flattened, rarely cylindrical, mouth and alimentary canal present, the latter forked. Sucker or suckers and hooks serving for attachment, on ventral surface, or terminal, or both; ecto- or endoparasitic.

Class **Trematoda**, p. 14

- 4(3) Body of adult worm usually divided into segments (proglottids) without mouth or alimentary canal. Organs for attachment at the anterior end; endoparasitic, adult in alimentary canal; young imbedded in tissues.

Class **Cestoda**, p. 14

CLASS **T U R B E L L A R I A**

- 1(4) Alimentary canal not highly branched. 2

- 2(3) Without a distinct alimentary canal; digestion occurs in spaces in the parenchyma; mouth ventral, opening into a short pharynx; marine. (Pratt, 158.)

Order **Acoela**

- 3(2) Alimentary canal present; alimentary tract a single blind tube, rodlike, saclike, or slightly lobed. (Pratt, 160; W. and W., 333.)

Order **Rhabdocoelida**

- 4(1) Alimentary canal highly branched. 5

- 5(6) Alimentary canal with three primary branches, one extending forward, two backward; each primary branch bearing secondary branches (diverticula); marine, fresh water and terrestrial. (Pratt, 164; W. and W., 354.) Order **Triclada**
- 6(5) Alimentary canal with many primary branches which possess diverticula; marine. (Pratt, 169.) Order **Polyclada**

CLASS TREMATODA

- 1(2, 3) Posterior organs of attachment powerfully developed. Suckers at least three in number; hooks and anchors usually present; usually ectoparasitic. (Pratt, 173; W. and W., 374.) Order **Monogenea**
- 2(1, 3) No hooks in suckers or sucking disks; posterior end without suckers or with weakly developed suckers. Either a large ventral sucking disk or a midventral row of suckers. No oral sucker. Mostly endoparasitic. (Pratt, 178.) Order **Aspidocotylea**
- 3(1, 2) Suckers two in number; one ventral, the other anterior about the mouth; endoparasitic; no hooks in suckers or sucking disks. (Pratt, 179; W. and W., 379.) Order **Digenea**

CLASS CESTODA

- 1(2) Body not divided into proglottids (segments). (Pratt, 192; W. and W., 429.) Subclass **Cestodaria**
- 2(1) Body consisting of head or scolex and a chain of proglottids. (Pratt, 192; W. and W., 430.) Subclass **Cestoda**

PHYLUM NEMATHELMINTHES

- 1(2) A longitudinal lateral line present on each side of the body. Mouth and alimentary canal present. Endoparasitic or small worms in water, soil, or plants. (Pratt, 214; W. and W., 482; F. S. and T., 374.) Class and order **Nematoda**

- 2(1) Without lateral lines; alimentary canal incomplete or absent in adults. 3
- 3(4) Without a spiny proboscis at the anterior end. Adults free living, long and very slender. (Pratt, 225; W. and W., 537.) Class and order **Gordiacea**
- 4(3) With a spiny proboscis at the anterior end. Without a mouth and alimentary canal. Endoparasitic. (Pratt, 228; W. and W., 545.) Class **Acanthocephala**

PHYLUM **TROCHELMINTHES**

- 1(4) External cilia present. 2
- 2(3) Anterior ciliated disk present. (Pratt, 230; W. and W., 587.) Class **Rotifera**, p. 15
- 3(2) Only ventral surface ciliated; minute worms less than five mm. long; body usually forked behind and frequently covered with bristles. (Pratt, 243; W. and W., 624.) Class and order **Gastrotricha**
- 4(3) External cilia absent; marine. (Pratt, 244.) Class and order **Kinorhyncha**

CLASS **ROTIFERA**

(After Jennings in Ward and Whipple)

- 1(2) Rotifers with two ovaries; creep like a leech but can also swim by means of a crown of cilia. Body without an outer shell or lorica; usually nearly cylindrical; dorsal and ventral surfaces not greatly different; body composed of rings which may telescope into one another. (Pratt, 234; W. and W., 619.) Order **Bdelloida**
- 2(1) Rotifers with one ovary; do not creep like a leech. 3
- 3(4, 5) Mouth not near center of ciliary crown, which may be ventral or terminal; free-swimming or creeping rotifers but never creeping like a leech; one or two wreaths of cilia but with the outer never shorter than the inner.

Lorica present or absent. Foot usually with two toes. (Pratt, 235; W. and W., 587.) Order **Notommatida**

- 4(3, 5) Mouth nearly in center of large ciliary crown which is either circular or drawn out into lobes, points, or arms. Foot never ending in two toes placed side by side. Mostly attached or tube bearing rotifers, the foot forming a disk for attachment. A few free-living forms in which the foot ends in a single toe, sometimes accompanied by a dorsal spur. (Pratt, 232; W. and W., 609.) Order **Floscularida**

- 5(3, 4) Ciliary crown surrounded by two parallel wreaths of cilia with a furrow between; cilia of the outer wreath always shorter than those of inner. Furrow between the cilia sometimes clothed with short cilia. Foot never ending in two toes side by side, sometimes lacking. Eyes two, rarely absent. Fixed or free-swimming; the free-swimming species often without feet and frequently bearing appendages on the body. (Pratt, 233; W. and W., 611.) Order **Melicertida**

PHYLUM BRYOZOA

(After Pratt)

- 1(2) Tentacles not retractile within the hard case which surrounds the body (zoecium); anus lies within the circle of tentacles; one row of tentacles present; minute forms both in salt and fresh water. (Pratt, 246; W. and W., 951.) Class and order **Entoprocta**
- 2(1) Tentacles retractile within the zoecium; animals living in large colonies; anus outside the lophophore. Class contains great majority of Bryozoa.

Class **Ectoprocta**, p. 16

CLASS ECTOPROCTA

- 1(2) Mostly marine with a circular lophophore; mouth can usually be closed by an opercular flap. (Pratt, 249; W. and W., 951.) Order **Gymnolaemata**

- 2(1) Fresh-water animals with a horseshoe-shaped or oval lophophore; projection present over the mouth; statoblasts usually present. (Pratt, 262; W. and W., 952.) Order **Phylactolaemata**

PHYLUM ANNELIDA

- 1(2) Bristles (setae) absent; suckers present; leeches. Class **Hirudinea**, p. 17
- 2(1) Setae present; suckers absent (except in one parasitic family). Class **Chaetopoda**, p. 17

CLASS CHAETOPODA

- 1(4) Segmentation distinct as shown by setae or external rings or by internal arrangement; usually by all three. 2
- 2(3) Setae borne on parapodia; usually with special appendages in the head region; mostly marine. (Pratt, 282.) Order **Polychaeta**
- 3(2) No parapodia present; special appendages usually lacking from the head region; mostly fresh water and terrestrial. (Pratt, 303; W. and W., 638.) Order **Oligochaeta**
- 4(1) Segmentation indistinct or wanting in adult, marine. (Pratt, 314.) Order **Echiurida**

CLASS HIRUDINEA

- 1(2) Mouth a small pore in oral sucker, from which a muscular proboscis may be protruded; somites rarely consisting of five rings each; blood colorless. (Pratt, 317; W. and W., 651.) Order **Rhynchobdellida**
- 2(1) Mouth large, occupying the entire cavity of the sucker; no proboscis; usually three teeth present; red blood; somites usually with five rings each. (Pratt, 319; W. and W., 656.) Order **Gnathobdellida**

PHYLUM ECHINODERMA

- 1(6) Arms present. 2
- 2(3) Arms with small branches, called pinnules; animals either sessile and attached by a stalk from the aboral surface or if free, moving about with the oral surface directed upward. (Pratt, 619.) Class Crinoidea
- 3(2) Arms without pinnules, not sessile or stalked, moving about on oral surface. 4
- 4(5) Arms not sharply marked off from the disk; oral surface of arm marked with a deep longitudinal groove. (Pratt, 623.) Class Asteroidea
- 5(4) Arms sharply marked off from the body; oral surface without a deep longitudinal groove. (Pratt, 635.) Class Ophiuroidea
- 6(1) Arms absent. 7
- 7(8) Body hard, globular, or disklike, bearing numerous spines; oral tentacles absent. (Pratt, 638.) Class Echinoidea
- 8(7) Body soft, not calcareous but with tough leathery wall; spines absent; oral tentacles present. (Pratt, 646.) Class Holothuroidea

PHYLUM MOLLUSCA

- 1(6) No distinct head present; shell never spirally coiled. 2
- 2(5) Shell when present not bivalve. 3
- 3(4) Body naked or covered on dorsal surface by shell of eight plates; marine. (Pratt, 482.) Class Amphineura
- 4(3) Shell tusklike, cylindrical; marine. (Pratt, 490.) Class Scaphopoda
- 5(2) Shell bivalve. The mussels, clams, oysters, etc. Class Pelecypoda, p. 19

- 6(1) Distinct head present; shell, if present, usually spirally coiled. 7
- 7(8) Head with one or two pairs of tentacles, eyes small if present and either sessile or stalked. Shell, if present, spirally coiled or conic. Snails, slugs, etc.
Class **Gastropoda**, p. 20
- 8(7) Head provided with eight or ten long arms bearing cuplike suckers. Shell usually apparently absent or if present coiled in flat coil and divided into chambers. Marine forms; squid, octopus, chambered nautilus. (Pratt, 605.) Class **Cephalopoda**

CLASS PELECYPODA

- 1(2) Gills absent, replaced by a horizontal septum extending from each side of the body to the mantle fold; marine. (Pratt, 601.) Order **Septibranchiata**
- 2(1) Gills present, marine or fresh water. 3
- 3(4) Gills consisting of a single pair of plumelike organs, each with two rows of flattened filaments. Two adductor muscles. Foot with a creeping surface; marine. (Pratt, 567.) Order **Protobranchiata**
- 4(3) With two pairs of flattened gills composed of numerous elongated parallel filaments, which extend ventrally from the base of each gill to its free margin, then dorsally on the opposite side. Thus each filament is more or less V-shaped and each gill is composed of two lamellae, or plates, formed respectively by the descending and ascending limbs of the filaments. 5
- 5(6, 7) Marine. Adjacent filaments not united; sometimes held together by interlocking cilia. Usually two adductor muscles. Foot usually possessing a well-developed byssus for attachment. (Pratt, 570.)
Order **Filibranchiata**

- 6(5, 7) Marine. Adjacent filaments either with interlocking cilia or with interfilamentar junctions. Foot usually only slightly developed. Usually only one adductor muscle present. The two valves of the shell often unequal. (Pratt, 573.)

Order **Pseudolamellibranchiata**

- 7(5, 6) Marine or fresh-water forms. Interfilamentar and interlamellar junctions well developed and numerous, making the gill present a continuous surface. Includes most pelecypods. (Pratt, 575; W. and W., 994; Baker, 44.)

Order **Eulamellibranchiata**

CLASS **GASTROPODA**

- 1(2) Fresh-water or terrestrial forms. Shell present, external, or internal or absent. Mantle cavity almost always modified to form a lung for breathing air; opening of the mantle cavity small. Adults without an operculum. (Pratt, 506; W. and W., 977; Baker, 138.)

Order **Pulmonata**

- 2(1) Gills present; mantle cavity not modified to form a lung; shells in fresh-water species usually closed by an operculum. 3

- 3(4) In all fresh-water forms and in many others an operculum present closing more or less completely the shell mouth when the animal is retracted. Shell almost always present. Mantle cavity situated on the anterior side of the visceral mass. Usually only one gill, which is situated anterior to the heart. (Pratt, 528; Baker, 319; W. and W., 986.)

Order **Prosobranchiata**

- 4(3) Mostly marine forms with shell spiral and external, or reduced and internal or absent. Mantle cavity absent or present; gills either a true ctenidia or in form of adaptive gills (as in sea slugs). Ctenidia when present posterior in position. Fresh-water forms few. (Pratt, 495; W. and W., 994.)

Order **Opisthobranchiata**

PHYLUM ARTHROPODA

- 1(14) With one pair of appendages in front of the mouth.
(Either chelicerae adjacent to the anterior border of the mouth or antennae some distance in front of it.)
The antennae in some larval forms are reduced to mere jointed tubercles. Body usually differentiated into head and trunk. 2
- 2(5) Without distinctly jointed appendages on the trunk, often with unjointed appendages. 3
- 3(4) Trunk distinctly segmented.
Class **Insecta** larvae, p. 37
- 4(3) Trunk not distinctly segmented. Trunk appendages stump-like and ending in two claws. (Pratt, 462.)
Class and order **Onychophora**
- 5(2) With distinctly jointed appendages, legs, on the trunk. 6
- 6(7) With more than four pairs of legs.
Class **Myriapoda**, p. 27
- 7(6) With two, three or four pairs of legs. 8
- 8(9) With one or two pairs of wings used in flight or at least capable of free movement, or with the first pair of wings in the form of thickened wing covers (elytra) meeting in a straight line down the middle of the back and sometimes fused.
Class **Insecta**, winged adults, p. 30
- 9(8) Wings absent or represented by immovable rudiments. 10
- 10(11) With three pairs, or rarely, with two pairs of legs. Head, thorax, and abdomen usually distinct. Worm-like or grub-like forms, quiescent or active or forms resembling adult insects.
Class **Insecta** (young, i.e., nymphs, larvae, pupae, and a few wingless adults).
p. 34, 37, or 42

11(10) Adults with four pairs of legs (certain young forms with three or two pairs of legs, in which case head, thorax, and abdomen are all fused), mostly terrestrial, some aquatic; respiration usually by means of tracheae or lung books or both or in the smaller aquatic forms, through the skin; by gills only in *Limulus*. 12

12(13) With four pairs of legs.

Class **Arachnida** adults, p. 25

13(12) With three or two pairs of legs. Class **Arachnida**, young and one adult gall-producing form. p. 25

14(1) With two pairs of appendages in front of the mouth. Respiration by means of gills or in some small forms through the skin. Mostly aquatic. In some sessile and parasitic forms, the appendages may become modified or disappear in the adult.

Class **Crustacea**, p. 22

CLASS CRUSTACEA

1(2, 3) Usually of a small size. Body very commonly divided into an anterior region bearing appendages and a posterior region without appendages. When appendages are present, three are always more than three pairs. Body often more or less completely covered with a carapace. (In the adult stages of some attached parasitic forms the anterior appendages are modified, reduced or absent, or all appendages are absent.)

Subclass **Entomostraca**, p. 23

2(1, 3) Usually of considerable size. Head region consisting of five segments fused together but bearing five pairs of appendages, three of which are mouth parts. Thorax of eight segments some of which are commonly fused with the head; all bear appendages. Abdomen of seven segments all more or less fused (eight in certain marine forms). All except the last bear appendages normally.

Subclass **Malacostraca**, p. 24

- 3(2, 1) Always of small size. With three pairs of jointed appendages used as swimming organs; middle pair biramous; body disk-shaped or somewhat elongated and triangular in outline in young individuals; in later stages segments are developed at the posterior end which form a narrow outgrowth that may bear small appendages.

Class Crustacea (Nauplius larvae)

SUBCLASS ENTOMOSTRACA

- 1(6) Free swimming or parasitic on fish. 2
- 2(5) Body usually distinctly segmented in free-living forms. 3
- 3(4) Appendages of trunk flattened, leaflike, ten or more (suborder Branchiopoda) or four to six pairs (suborder Cladocera). Carapace well developed and bivalve, or small or rarely absent. The chief organs of locomotion are either the trunk appendages (Branchiopoda) or the enlarged second antennae (Cladocera). Mostly in fresh water. (Pratt, 329; W. and W., 661 and 676.)
Order Phyllopoda
- 4(3) Appendages of body not flattened; carapace absent; thorax with four or five pairs of two-branched (biramous) appendages; abdomen without appendages. Fresh water and marine and parasitic (parasites greatly modified). (Pratt, 339; W. and W., 741.)
Order Copepoda
- 5(2) Body indistinctly segmented; free-swimming and creeping forms. Body inclosed in a carapace consisting of articulated right and left valves. Abdomen rudimentary. Five pairs of appendages from the head and two from the trunk present. Fresh water or marine. (Pratt 352; W. and W., 806.)
Order Ostracoda

- 6(1) Body of free-living animals sessile and inclosed in a calcareous shell or parasitic on decapods or molluscs; marine. (Pratt, 358.) Order **Cirripedia**

SUBCLASS **MALACOSTRACA**

- 1(2) Abdomen composed of eight segments, carapace present covering all the body save the four posterior abdominal segments; marine. (Pratt, 364.)

Division and order **Phyllocardia**

- 2(1) Abdomen consisting of seven segments or less. 3

- 3(6) Carapace rarely present; the first and, more rarely, also the second thoracic segment fused with the head; eyes sessile or sometimes with a short stalk; marine, fresh water, or terrestrial.

(Division **Arthrostraca**.) 4

- 4(5) Body usually dorsoventrally flattened; only the first thoracic segment fused with the head; carapace absent. Abdominal appendages, when present, flattened, serving as gills; marine, fresh-water, and land forms; free living or parasitic. Some of the parasitic forms have undergone great degeneration and their systemic position can be determined only by a study of development. (Pratt, 372; W. and W., 841.)

Order **Isopoda**

- 5(4) Usually laterally compressed animals; usually only the first, sometimes also the second, thoracic segment fused with the head; carapace absent; gills borne on the thoracic appendages; free living, rarely parasitic. (Pratt, 365; W. and W., 842.)

Order **Amphipoda**

- 6(3) Carapace present, covering more or less of the thorax. (Division **Thoracostraca**.) 7

- 7(12) Carapace does not cover entire thorax; almost all marine forms. 8

- 8(9) Thoracic appendages all biramous. (Pratt, 382; W. and W., 844.) Order **Schizopoda**
- 9(8) Thoracic appendages not all biramous. 10
- 10(11) Eyes stalked; abdomen large, wider than the narrow cephalothorax. The first five pairs of thoracic appendages are used for seizing and holding food. The second pair is largest. The last three pairs of thoracic appendages are small, biramous appendages; marine. (Pratt, 383.) Order **Stomatopoda**
- 11(10) Eyes sessile; abdomen narrow; carapace small leaving last five thoracic segments uncovered; marine. (Pratt, 384.) Order **Cumacea**
- 12(7) Carapace covers entire thorax, usually well developed and more or less calcified. The posterior five pairs of thoracic appendages are uniramous, although they may in part be provided with pinchers. Marine, fresh water, and terrestrial. (Pratt, 384; W. and W., 844.) Order **Decapoda**

CLASS ARACHNIDA

- 1(2) Marine arachnids of large size bearing gill books on the abdomen; with a long, spikelike tail. (Pratt, 400.) Subclass **Xiphosura**
- 2(1) Mostly terrestrial arachnids, if aquatic, small and without a long spikelike tail.
Subclass **Arachnida**, p. 25

SUBCLASS ARACHNIDA

The following key to the orders of the Arachnida is taken with some slight modification from Comstock's *Spider Book*.

- 1(14) Abdomen distinctly segmented 2
- 2(13) Animals not wormlike parasites. 3

- 3(6) Abdomen with a tail-like projection, or segmental caudal filament 4
- 4(5) Tail stout and armed with a sting at the end; first pair of legs not greatly elongated; a pair of comblike appendages on the lower side of the second abdominal segment in the adult. (Pratt, 404; Comstock, 21.)
Order **Scorpionida**
- 5(4) Tail slender, whiplash-like, without sting; first pair of legs much longer than the others; without comblike appendages on the abdomen. (Pratt, 406; Comstock, 16.)
(Family Thelyphonidae.) Order **Pedipalpi**
- 6(3) Abdomen without a tail-like projection. 7
- 7(8) Pedipalpi with pincher-like claws. (Pratt, 408; Comstock, 39.) Order **Pseudoscorpionida**
- 8(7) Pedipalpi without pincher-like claws. 9
- 9(10) Abdomen joined to the thorax by a slender stalk; front legs greatly elongated and with whiplash-like tarsi. (Pratt, 407; Comstock, 16.)
(Family Tarantulidae.) Order **Pedipalpi**
- 10(9) Abdomen broadly joined to the thorax. 11
- 11(12) Legs usually very long and slender, thorax indistinctly divided into three segments. (Pratt, 410; Comstock, 53.) Order **Phalangida**
- 12(11) Legs moderately long; head distinct from thorax; thorax distinctly divided into three segments. (Pratt, 408; Comstock, 32.) **Solpugida**
- 13(2) Animals wormlike; internal parasites in vertebrates. (Pratt, 455.) Order **Linguatulida**
- 14(1) Abdomen not segmented. 15

- 15(16, 17) Animals marine; legs long and slender. Animals not microscopic. (Pratt, 458.) Order **Pycnogonida**
- 16(15, 17) Animals marine or fresh water, always microscopic. (Pratt, 457.) Order **Tardigradi**
- 17(15, 16) Animals usually terrestrial, may be in fresh water. 18
- 18(19) Abdomen joined to the thorax by a short narrow stalk. The spiders. (Pratt, 413; Comstock, 39.) Order **Araneida**
- 19(18) Abdomen fused to the cephalothorax. The ticks and mites. (Pratt, 436; Comstock, 81.) Order **Acarina**

CLASS MYRIAPODA

- 1(2) Nearly all the visible segments of the trunk with two pairs of appendages each. Antennae usually of seven segments. The common millipeds. (Pratt, 467.) Order **Chilognatha** or **Diplopoda**
- 2(1) Not more than one pair of appendages on each visible segment. 3
- 3(6) More than twelve pairs of legs; the first pairs of trunk appendages transformed into maxillipeds and bearing poison claws. 4
- 4(5) Dorsal plates corresponding in number to the segments and pairs of legs, body elongated. Tarsi not divided into a number of small segments. The common centipedes. (Pratt, 473.) Order **Chilopoda**
- 5(4) Eight dorsal plates and fifteen pairs of very long legs. Body shorter than antennae and posterior pair of legs. Tarsi divided into a number of short segments. (Pratt, 477.) Order **Schizotarsia**
- 6(3) Not more than twelve pairs of legs. 7

- 7(8) Twelve leg-bearing segments. A number of trunk segments without legs. Maxillipeds absent. Dorsal surface of the body covered with fifteen or sixteen plates. (Pratt, 465.) Order **Symphyla**
- 8(7) Rare small forms; trunk consisting of seven to ten visible segments, with nine pairs of appendages. (Pratt, 466.) Order **Paupoda**

CLASS INSECTA

YOUNG STAGES AND WINGLESS
ADULTS

- 1(2) With two pairs of conspicuous jointed appendages (walking legs) and rudiments of a third pair on consecutive segments of the trunk; grublike. Larvae of Passalidae. (Comstock, 556; Lutz, 326.) Order **Coleoptera**
- 2(1) With three pairs of conspicuous legs; body usually divisible into head, thorax, and abdomen, antennae, present; external wings or wing rudiments present or absent; when present nearly or quite incapable of movement but never fused in the median line. 3
- 3(4) Legs not capable of being employed in locomotion¹ and rarely capable of movement; length always greater than the width of the segment bearing them. Animals usually quiescent; not feeding; abdominal wriggling the only form of locomotion; wings or wing rudiments usually present; body frequently inclosed in a cocoon or cell or in the old larval skin. Pupae of insects with complete metamorphosis. p. 42

¹ In a very few of the lower forms, the pupa becomes active and walks about for a time before the pupal skin is shed; in most forms the appendages are slightly movable just before the adult insects emerge and are used in helping to free the body from the pupal skin. The larvae and nymphs are frequently incapable of using their legs in locomotion for a period after molting. This key does not cover all these cases.

- 4(3) Legs capable of being employed in locomotion; active feeding forms, wing rudiments present or absent. 5
- 5(6) Wing rudiments present; nymphs and adults with rudimentary wings, in part. p. 34
- 6(5) Wing rudiments absent. 7
- 7(8) Mouth parts either combined into a movable beak or in part modified into a mask longer than the head folding on itself like a hinge. Nymphs, in part. p. 34
- 8(7) Mouth parts not of the types described in "7." 9
- 9(10) Abdomen and dorsal part of the thorax usually very weakly chitinized as compared with the rest of the body; generally soft and fleshy. Abdomen when strongly chitinized more than twice as long as the thorax and head together. Larvae of insects with a complete metamorphosis, in part. p. 37
- 10(9) Body evenly and usually strongly chitinized; abdomen less than twice as long as the head and thorax together. 11
- 11(12) Mandibles longer than the greatest dimension of the head. Larvae, in part. p. 37
- 12(11) Mandibles not longer than the greatest dimension of the head. 13
- 13(14) Terrestrial or aquatic; when aquatic gills or lateral filaments not present on the abdomen. Nymphs, in part, chiefly very young, and wingless adults. p. 34
- 14(13) Gills or lateral filaments present on the abdomen. 15
- 15(16) Paired lateral filaments which are usually respiratory in function and never leaflike or biramous, present on nearly all the abdominal segments. Nymphs, in part. p. 34
- 16(15) Gills present on the abdomen but when paired and lateral always either leaflike or biramous. Nymphs, in part. p. 34

CLASS I N S E C T A

WINGED ADULTS

Modified from Comstock's *Manual for Study of Insects*. See also key to orders of commonly observed insects; Lutz, 476.

N.B.—Elytra or wing covers of earwigs and beetles are modified wings. The last tarsal segment usually bears one or two claws which are not counted as segments.

- | | |
|---|---|
| 1(12) With one pair of wings. | 2 |
| 2(7) Wings leathery or parchment-like. | 3 |
| 3(4) Mouth parts formed for sucking. Wings leathery, shortened, or membranous at the tip. (Comstock, 121; Lutz, 80.) | Order Hemiptera |
| 4(3) Mouth parts formed for biting; jaws distinct. | 5 |
| 5(6) Wings horny without apparent veins. Hind legs not fitted for jumping. (Comstock, 494; Lutz, 280.) | Order Coleoptera |
| 6(5) Wings parchment-like with a network of veins; hind legs fitted for jumping. (Comstock, 104; Lutz, 62.) | Order Orthoptera |
| 7(2) Wings membranous. | 8 |
| 8(11) Abdomen with caudal filaments; mouth parts rudimentary. | 9 |
| 9(10) Halteres wanting. (Comstock, 86; Lutz, 40) | Order Plectoptera or Ephemerida |
| 10(9) Halteres present (males of scale insects). (Comstock, 121; Lutz, 91.) | Order Hemiptera |
| 11(8) Abdomen without caudal filaments. Halteres in place of second wings. Sucking mouth parts. (Comstock, 413; Lutz, 229.) | Order Diptera |

- 12(1) With two pairs of wings. 13
- 13(22) The two pairs of wings unlike in structure. 14
- 14(15) Front wings leathery at base and membranous at the tip, often overlapping. Mouth parts formed for sucking. (Comstock, 121; Lutz, 80.)
Order Hemiptera
- 15(14) Front wings of the same texture throughout. 16
- 16(19) Front wings horny or leathery and apparently veinless; wing covers or elytra. 17
- 17(18) Abdomen with caudal appendages in the form of movable forceps. (Comstock, 102; Lutz, 61.)
Order Euplexoptera or Dermaptera
- 18(17) Abdomen without forcep-like appendages. (Comstock, 494; Lutz, 280 and 498.) Order Coleoptera
- 19(16) Front wings leathery or parchment-like with a network of veins. 20
- 20(21) Under wings not folded, sucking mouth parts. (Comstock, 121; Lutz, 95.) Order Hemiptera
- 21(20) Under wings folded lengthwise, biting mouth parts. (Comstock, 104; Lutz, 62.) Order Orthoptera
- 22(13) The two pairs of wings similar and membranous. 23
- 23(24) Last joint of tarsi bladder-like or hooflike in form and without claws. (Comstock, 119; Lutz, 79.)
Order Physopoda or Thysanoptera
- 24(23) Last joint of tarsi not bladder-like. 25
- 25(26) Wings entirely or for the most part covered with scales. Mouth parts formed for sucking. (Comstock, 191; Lutz, 115.) Order Lepidoptera
- 26(25) Wings naked, transparent, or thinly clothed with hairs. 27

- 27(28) Mouth parts arising from the hind parts of the lower surface of the head and consisting of bristle-like organs inclosed in a jointed sheath. (Comstock, 121; Lutz, 80.)
Order **Hemiptera** (**Homoptera**)
- 28(27) Mouth parts in normal position; mandibles not bristle-like. 29
- 29(43) Wings net veined with very numerous veins and cross-veins. 30
- 30(38) Tarsi consisting of less than five segments. 31
- 31(34) Antennae inconspicuous, awl shaped and slender. 32
- 32(33) First and second pairs of wings nearly the same length; tarsi three jointed. (Comstock, 89; Lutz, 42.)
Order **Odonata**
- 33(32) Second pair of wings either small or wanting; tarsi four jointed. (Lutz, 40; Comstock, 86.)
Order **Plecoptera** or **Ephemera**
- 34(31) Antennae usually conspicuous bristle-like, threadlike, slightly or strongly club shaped or feather-like. 35
- 35(38) Tarsi two or three jointed. 36
- 36(37) Second pair of wings smaller. (Comstock, 98; Lutz, 76.)
Order **Corrodentia**
- 37(36) Second pair of wings broader or at least of the same size as the first pair. (Comstock, 93; Lutz, 50.)
Order **Plecoptera**
- 38(30) Tarsi consisting of five segments. 39
- 39(40) Abdomen with setiform, many-jointed anal filaments. (Lutz, 40; Comstock, 86.)
Order **Plecoptera** or **Ephemera** in part
- 40(39) Abdomen without many-jointed anal filaments. 41

- 41(42) Head prolonged into a trunklike beak. (Comstock, 184; Lutz, 56.) Order **Mecoptera**
- 42(41) Head not prolonged into a beak. (Comstock, 175; Lutz, 53.) Order **Neuroptera**
- 43(29) Wings with branching veins and comparatively few cross-veins or veinless. 44
- 44(47) Tarsi two or three jointed. 45
- 45(46) Posterior wings smaller than the anterior. (Lutz, 76; Comstock, 98.) Order **Corrodentia**
- 46(45) Posterior wings as large as or larger than the anterior ones. (Comstock, 93; Lutz, 40.)
Order **Plecoptera**, in part
- 47(44) Tarsi four or five jointed. 48
- 48(49) Abdomen with bristle-like, many-jointed anal filaments. (Comstock, 86; Lutz, 40.)
Order **Plecoptera** or **Ephemera**
- 49(48) Abdomen without bristle-like, many-jointed, anal filaments. 50
- 50(51) Prothorax horny; first wings larger than the second, naked or imperceptibly hairy. Second wings without, or with few, simple veins. Jaws (mandibles) well developed; palpi small. (Comstock, 599; Lutz, 406.)
Order **Hymenoptera**
- 51(50) Prothorax membranous, or at most parchment-like. Second wings as large or larger than the first, folded lengthwise, with many branching veins. First wings naked or thinly clothed with hair. Jaws (mandibles), inconspicuous; palpi long. Mothlike insects. (Comstock, 186; Lutz, 57.)
Order **Tricoptera**

CLASS I N S E C T A

NYMPHS AND WINGLESS ADULTS

Tentative key to orders of nymphs of insects with incomplete metamorphosis and to a few adults that are wingless or have rudimentary wings: modified from Comstock and from Needham.

1(35) Forms not aquatic. 2

2(3, 25) Mouth parts retracted within the head so that only their apices are visible. Adults and young. (Lutz, 39; Comstock, 82.) Order **Thysanura**

3(2, 25) Mouth parts more or less prominent and fitted for biting. 4

4(5) Head prolonged into a trunklike beak; antennae borne near the eyes. Adults in part. (Comstock, 184; Lutz, 56.) Order **Mecoptera**

5(4) Head not prolonged into a trunklike beak. 6

6(9) Louselike insects of very small size. 7

7(8) Antennae not more than five segments; ectoparasitic forms, bird lice. Adults and nymphs. (Comstock, 100; Lutz, 78.) Order **Mallophaga**

8(7) Antennae with many segments. Adults in part and nymphs. (Comstock, 98; Lutz, 76.) Order **Corrodentia**

9(6) Insects of various forms but not louselike. 10

10(13) Abdomen with short, conical, compressed, many-jointed caudal appendages, or unjointed caudal appendages in the form of forceps. 11

11(12) Caudal appendages jointed. Cockroaches, adults, and nymphs. (Lutz, 62; Comstock, 104.) Order **Orthoptera**

- 12(11) Caudal appendages in the form of unjointed forceps.
(Comstock, 102; Lutz, 61.)
Euplexoptera or Dermaptera
- 13(10) Abdomen without jointed caudal appendages. 14
- 14(15) Legs fitted for jumping. Adults and nymphs in part.
(Comstock, 104; Lutz, 62.) Order Orthoptera
- 15(14) Legs fitted for running. 16
- 16(24) Abdomen broadly joined to the thorax. 17
- 17(18, 23) Body elongate, linear. Adults and nymphs in part.
(Comstock, 104; Lutz, 62.) Order Orthoptera
- 18(17, 23) Body whitish and somewhat antlike in form. Animals
living in colonies. (Lutz, 76; Comstock, 95.)
Order Isoptera 19
- 19(20) Head much elongated bearing a pair of heavy man-
dibles. Soldiers of Isoptera.
- 20(19) Head not elongated. 21
- 21(22) Animals about the size of the soldiers of Isoptera.
Workers of Isoptera.
- 22(21) Much smaller than the soldiers. Isoptera nymphs
capable of developing into many of the castes.
- 23(17, 18) Body neither linear nor antlike in form. Adults in
part. Wingless fireflies, etc. (Lutz, 280; Comstock,
494.) Order Coleoptera
- 24(16) Base of abdomen strongly constricted. Ants, *et al.*
(Lutz, 406; Comstock, 599.) Order Hymenoptera
- 25(2, 3) Mouth parts formed for sucking. 26
- 26(27, 28) Small insects of peculiar form in which the body is
either scalelike or gall-like in form, or grublike and
clothed with wax. The waxy covering may be in the

form of a powder, or of large tufts or plates, or of a continuous layer, or of a thin scale, beneath which the insect lives. Coccidae, females and nymphs in part. (Lutz, 91; Comstock, 121.) Order **Hemiptera**

27(26, 28) Body more or less covered with minute scales, or with thick long hairs; prothorax not free, i.e., closely united with the mesothorax; mouth parts usually consisting of a long "tongue" rolled under the head; adults in part. (Lutz, 115; Comstock, 191.)

Order **Lepidoptera**

28(26, 27) Body naked or with isolated or bristle-like hairs. 29

29(30) Prothorax not well developed, inconspicuous or invisible from above; tarsi five jointed; mouth parts developed into an unjointed trunk; palpi present. Adults in part. (Comstock, 413; Lutz, 229.)

Order **Diptera**

30(29) Prothorax well developed. 31

31(32) Body strongly compressed; tarsi five jointed. Adults. (Comstock, 490; Lutz, 279.) Order **Siphonaptera**

32(31) Body not compressed; tarsi one, two, or three jointed.

33

33(34) Last joint of tarsi bladder-like or hooflike in form and without claws; mouth parts forming a triangular, unjointed beak; palpi present. (Lutz, 79; Comstock, 119.) Order **Physopoda** or **Thysanoptera**

34(33) Last joint of tarsi not bladder-like and furnished with one or two claws; mouth parts forming a slender, usually jointed beak, usually directed backward between the legs, palpi apparently wanting. Nymphs in part. (Comstock, 121; Lutz, 80.)

Order **Hemiptera**

35(1) Aquatic forms.

36

- 36(41) With biting-mouth parts. 37
- 37(40) With long filamentous caudal setae; labium not longer than the head, and not folded on itself like a hinge. 38
- 38(39) Gills mainly under the thorax; tarsal claws two; caudal setae two. Stone flies. (W. and W., 883; Lutz, 50.)
Plecoptera
- 39(38) Gills mainly on the sides of the abdomen; tarsal claws single; caudal setae generally three. (May flies. (W. and W., 921; Comstock, 86; Lutz, 40.)
Order Plecoptera or Ephemera
- 40(37) Caudal setae represented by three broad, leaflike respiratory plates traversed by tracheae, or by small spinous appendages; labium when extended much longer than the head; at rest, folded like a hinge, extending between the bases of the fore legs. (Damsel flies and dragon flies. (W. and W., 928; Lutz, 42; Comstock, 89.)
Order Odonata
- 41(36) Mouth parts combined into a jointed beak, which is directed beneath the head backward between the fore legs. Bugs. (W. and W., 933; Lutz, 95; Comstock, 121.)
Order Hemiptera

CLASS INSECTA

LARVAE

Tentative key to the orders of true larvae. Wings develop internally; pass through a quiescent pupal stage. Key to land forms compiled by V. E. Shelford; aquatic forms from J. G. Needham.

- 1(29) With jointed thoracic legs. 2
- 2(11) Aquatic forms, i.e., forms capable of living beneath the water. 3

- 3(4) With slender, decurved piercing mouth parts, half as long as the body; small larvae living on fresh-water sponges. (Family Hemerobiidae, W. and W., 934.) (Lutz, 53; Comstock, 175.) Order **Neuroptera**
- 4(3) With biting-mouth parts. **5**
- 5(8) With a pair of prolegs on the last segment (except in *Sialis*, which has a single long median tail-like process at the end of the abdomen); these are directed backward and armed each with two or three hooks or claws. **6**
- 6(7) Abdominal segments each with a pair of long lateral filaments. (Family Sialididae, W. and W., 953.) (Lutz, 53; Comstock 175.) Order **Neuroptera**
- 7(6) Abdominal segments without long, muscular, lateral, filaments; often with minute gill filaments; cylindrical larvae, generally living in portable cases. (W. and W., 936; Comstock, 186; Lutz, 57.) Order **Trichoptera**
- 8(5) Prolegs when present on more than one abdominal segment, if present on the last segment, then not armed with single or double claws; often entirely wanting. **9**
- 9(10) With five pairs of prolegs, and with no spiracles at the apex of the abdomen. (W. and W., 903; Comstock, 191; Lutz, 115.) Order **Lepidoptera**
- 10(9) Generally without prolegs; never with five pairs of them; usually with terminal spiracles; long lateral filaments often present on the abdominal segments. (W. and W., 937, adults, 943 for larvae.) (Comstock, 494; Lutz, 280.) Order **Coleoptera**
- 11(2) Non-aquatic forms (i.e., not capable of living beneath the water.) **12**

- 12(13) Mandibles long and slender, always as long as the greatest dimension of the head, and frequently nearly twice as long, crescent-shaped or sharply curved toward each other at the tips, or straight slender rods; body widest just behind the posterior pairs of legs. (Comstock, 175; Lutz, 53.) Order **Neuroptera**
- 13(12) Mandibles heavy, rarely longer than the greatest dimension of the head; never twice as long. 14
- 14(17) Without abdominal prolegs. 15
- 15(16) Living in the egg sacs of spiders. (Lutz, 54; Comstock, 179.) Order **Neuroptera** (Mantispa)
- 16(15) Free living forms. (Comstock, 494; Lutz, 280.) Order **Coleoptera**, in part
- 17(14) With abdominal prolegs. 18
- 18(19) Prolegs present on the first eight abdominal segments. (Lutz, 56; Comstock, 184.) Order **Mecoptera**
- 19(18) Prolegs absent from at least the first abdominal segment, more frequently from the first two and in this case also from the following one, two, or three segments; always present on the sixth segment. 20
- 20(23) Prolegs absent from the first abdominal segment, present on the second and from four to six consecutive segments behind it. 21
- 21(22) Body with very numerous long hairs or bristles and numerous shorter tubercles. (Comstock, 218; Lutz, 201.) Order **Lepidoptera** (Megalopygidae)
- 22(21) Hairs and tubercles very rarely present; when present short and scattered. (Comstock, 610; Lutz, 408.) Order **Hymenoptera** (Terebrantia)
- 23(20) Prolegs absent from at least the first two abdominal segments. 24

- 24(28) Prolegs absent from one or two segments immediately in front of the last segment. 25
- 25(26, 27) Five pairs of prolegs present. (Comstock, 191; in part, Lutz, 115 and 485.) Order Lepidoptera
- 26(25, 27) Two, three, or four pairs of prolegs present; absent from more than two of the anterior abdominal segments; animal advances by a looping movement. Almost entirely Geometridae. (Lutz, 192; Comstock, 287.) Order Lepidoptera
- 27(25, 26) Four pairs of prolegs present; absent from the last segment. Chiefly Tineoidea. (Comstock, 246; Lutz, 198.) Order Lepidoptera
- 28(24) Prolegs present on the last segment only, or when present on more than one segment, the additional ones on consecutive segments immediately in front of the last, never with five pairs. (Lutz, 280; Comstock, 494.) Order Coleoptera, in part
- 29(1) Without jointed thoracic legs. 30
- 30(32) Aquatic forms (i.e., capable of living beneath the water). 31
- 31 With abdominal prolegs, or entirely legless; in the more degenerate forms, the head is reduced and retracted within the pointed apex of the thorax; no appendages of the imago are visible, and the pupa is formed within the contracted and hardened larval skin. (W. and W., 943.) Order Diptera, in part
- 32(30) Non-aquatic (i.e., not capable of living under water). 33
- 33(40) With conspicuous head and mandibles, unjointed rudiments of the thoracic legs frequently present, body usually not tapering at the anterior end. 34

- 34(35) With fleshy protuberances on the ventral side of the abdominal segments and a single spine at the posterior end. First thoracic segments apparently longer than the second and third together. (Comstock, 614; Lutz, 411.) Order **Hymenoptera** (horntails)
- 35(34) Without fleshy protuberances on the abdomen. 36
- 36(37) Forms of considerable size in later stages, boring in various plant structures or in decaying wood. (Lutz, 280; Comstock, 494.) Order **Coleoptera**, in part
- 37(36) Forms of very small size even in later stages. 38
- 38(39) Segmental setae short. Feeding in stems of grains. (Lutz, 414; Comstock, 629.) Order **Hymenoptera**, in part (joint worms)
- 39(38) Segmental setae long, body very slender. Living in refuse; very minute. (Lutz, 279; Comstock, 490.) Order **Siphonaptera**
- 40(33) Head inconspicuous, frequently retractile inside the thoracic segments; body tapering at the anterior end, without rudiments of thoracic legs. 41
- 41(42) Larvae free living. (Comstock, 413; Lutz, 229.) Order **Diptera**, in part
- 42(41) Parasitic or living in cells or in nest prepared by the adults. 43
- 43(44, 45) Parasitic on other arthropods or on plants. Gall formers. (Lutz, 406; Comstock, 601.) Order **Hymenoptera**, in part or (Lutz, 229; Comstock, 444.) Order **Diptera**, in part
- 44(43, 45) Parasitic on mammals beneath the skin, in the nose or stomach. (Lutz, 229.) Order **Diptera**, in part

- 45(43, 44) In some sort of cell or nest constructed by the adults which are usually near at hand: food, supplied by the adult, consisting of the bodies of other insects, pollen or honey, sometimes fed as needed but more frequently stored. The cell is constructed of wax or plant material, in earth or decaying wood or on the stems of plants. (Lutz, 406; Comstock, 599.)

Order **Hymenoptera**, in part

CLASS I N S E C T A

PUPAE

Tentative key to the orders of pupae of the Chicago area.
Compiled by V. E. Shelford.

- 1(12, 19) Without wings or wing rudiments. 2

- 2(3) Head prolonged into an immovable beak (antennae borne near the eyes). (Comstock, 184; Lutz, 56.)

Order **Mecoptera**, in part

- 3(2) Head not prolonged into a beak. 4

- 4(7) Prothorax distinct, i.e., not standing out as a distinct segment. 5

- 5(6) Body compressed laterally; inclosed in a cocoon; mouth parts formed for sucking; very minute. (Comstock, 490; Lutz, 279.)

Order **Siphonaptera**

- 6(5) Body not compressed laterally, not inclosed in a cocoon; of considerable size; mouth parts formed for biting. (Comstock, 494; Lutz, 280.)

Order **Coleoptera**, in part

- 7(4) Prothorax not distinct; posterior boundary sometimes indicated by a very slight groove on the dorsal surface. 8

- 8(9) Mouth parts formed for biting; body sharply constricted between the thorax and abdomen. (Lutz, 415; Comstock, 633.)

Order **Hymenoptera** (ants)

- 9(8) Mouth parts not formed for biting. 10
- 10(11) Body inclosed in the old body skin (puparium) and always associated with birds, mammals, or honey bees. (Lutz, 229; Comstock, 413.)
Order **Diptera**, in part
- 11(10) Body not inclosed in the old body skin; appendages fused to the integument of the rounded body. (Lutz, 115; Comstock, 181.) Order **Lepidoptera**, in part
- 12(1, 19) With one pair of wings or wing rudiments. 13
- 13(14) Mouth parts absent; fore legs extending forward beneath the head; body covered with waxy scale or inclosed in the old skin of previous molts or both. (Lutz, 91; Comstock, 164.)
Order **Hemiptera**, males of the Coccidae
- 14(13) Mouth parts present; fore legs not extending forward under the head. 15
- 15(16) Head prolonged into an immovable beak bearing the antennae at the sides. (Lutz, 393; Comstock, 590.)
Order **Coleoptera**, Rhyncophora in part
- 16(15) Head not prolonged into an immovable beak. 17
- 17(18) Prothorax distinct, mouth parts formed for biting. (Comstock, 494; Lutz, 280.)
Order **Coleoptera**, in part
- 18(17) Prothorax not distinct, its posterior boundary never more than a slight groove on the dorsal surface; mouth parts not formed for biting (appendages may be fused to the integument of the body, or the pupa may be inclosed in the old larval skin (puparium). (Comstock, 413; Lutz, 229.)
Order **Diptera**, in part
- 19(1,12) With two pairs of wings or wing rudiments which when fused to the body are distinguishable by slight projections where they join the body. 20

- 20(23) Aquatic forms, usually inclosed in some sort of a case. 21
- 21(22) Case (a silken cocoon) filled with air and connected with the internal atmosphere of an aquatic plant. Chrysomellidae, in part. (Lutz, 362; Comstock, 574.)
Order **Coleoptera**
- 22(21) Case (usually made from pebbles, sand, or plant material cemented together with silk) not filled with air. (Lutz, 57; Comstock, 186.)
Order **Trichoptera**
- 23(20) Pupae not aquatic. 24
- 24(27) Head prolonged into immovable beak. 25
- 25(26) Antennae long enough to reach beyond the middle of the body; borne on the front of the head between the eyes nearly in line with their lower margins. (Lutz, 56; Comstock, 184.)
Order **Mecoptera**, in part
- 26(25) Antennae not long enough to reach beyond the middle of the body; borne on the sides of the head or beak in front of the eyes. Rhyncophora, in part. (Comstock, 590; Lutz, 393.)
Order **Coleoptera**
- 27(24) Head not prolonged into an immovable beak. 28
- 28(31) Prothorax distinct (i.e., standing out as a distinct segment); mouth parts formed for biting. 29
- 29(30) Appendages and wings folded tightly against the body; antennae either lamellate or passing around the sides of the head and backward between the body and the dorsal angle of the folded legs; cells or cocoons when present, always elongated. (Lutz, 280; Comstock, 494.)
Order **Coleoptera**, in part

- 30(29) Appendages and wings almost always standing out loosely from the body, when tightly folded; antennae never in the position described under 29. Cells or cocoons nearly spherical or hemispherical. (Lutz, 53; Comstock, 175.)

Order **Neuroptera**, with few exceptions

- 31(28) Prothorax not distinct, its posterior boundary not indicated at all or only by a slight groove on the dorsal surface; mouth parts formed for biting or sucking, sometimes not in evidence. **32**

- 32(35) All appendages wholly or partially fused to the integument of the body; wings large, covering at least one-third of the anterior half of the body; antennae almost always passing backward parallel with the anterior edge of the forewing. **33**

- 33(34) Attached at the posterior end only, or in addition by a single thread of silk passing around the body; never with cocoon. (Papilionidae, Lutz, 134; Comstock, 375.)

Order **Lepidoptera**

- 34(33) With a cocoon or entirely without attachments. (Heterocera and Hesperiiidae, Lutz, 142, 146.)

Order **Lepidoptera**

- 35(32) Appendages not fused to the integument of the body; wings covering much less than one-third of the anterior half of the body; antennae passing downward across the front of the face and past the mouth parallel with the mouth parts (except in females of some horn tails and sawflies which can be recognized by an ovipositor made up of two small saws or three horny projections at the posterior end of the abdomen). When the antennae are long, the ends rest against the ventral surface of the thorax between the legs. Body usually strongly constricted between the thorax and abdomen. (Comstock, 599; Lutz, 406.)

Order **Hymenoptera**, in part

ADDITIONAL REFERENCES TO KEYS TO SUB-ORDERS,
FAMILIES, ETC., OF ADULT AND YOUNG INSECTS

- Ephemera:** *Bull. New York State Mus.* 86, pp. 22-28, Nymphs and adults; Ward and Whipple, p. 918, adults; p. 921, nymphs.
- Odonata:** *Bull. New York State Mus.* 47, pp. 429, 430, 452 ff., Nymphs and adults; Williamson, "Dragonflies of Indiana," *Rep. State Geol. of Ind.*, 1899; Ward and Whipple, p. 922, adults; p. 928, nymphs.
- Neuroptera:** *Bull. New York State Mus.* 47, pp. 540-42, Nymphs and adults; Ward and Whipple, p. 934, adults; p. 935, larvae.
- Tricoptera:** *Bull. New York State Mus.* 47, p. 563, Larvae; Lloyd, *Bulletin of the Lloyd Library* 21; Ward and Whipple, p. 936, adults.
- Lepidoptera:** *Insects of New Jersey*, New Jersey State Board of Agric., 1899, pp. 369-500, larvae.
- Diptera:** *Bull. New York State Mus.* 68, p. 289, larvae and pupae in part. Ward and Whipple, p. 943, aquatic dipterous larvae; Williston, *Diptera*.
- Coleoptera:** Blatchley, *Coleoptera of Indiana*, adults; *Bull. New York State Mus.* 68, p. 289, larvae; Ward and Whipple, p. 937, aquatic adults; p. 943, aquatic larvae.
- Hymenoptera:** *Insects of New Jersey*, as above, pp. 500-600, larvae and adults.
- Galls:** "Gall Insects of Vicinity of New York City," *Guide Leaflet No. 16, Am. Mus. Nat. Hist.*
"Galls of Indiana," *Ann. Rep. Ind. Dept. Geol.*, 1904, pp. 800-867.

PHYLUM C H O R D A T A

- 1(2) Body (in American species) long and wormlike, marine.
(Pratt, 652.)

Subphylum Hemichordata (Enteropneusta)

- 2(1) Body not wormlike. 3
- 3(4, 5) Body more or less sac shaped and inclosed in a gelatinous or tough tunic; solitary or colonial; sessile or free swimming. (May be minute tadpole-like forms with a long tail which contains a notochord.) Always with two external openings for intake and outflow of water; marine. (Pratt, 555.)
Subphylum **Urochordata** (Tunicata)
- 4(3, 5) Body lanceolate; marine. (Pratt, 671.)
Subphylum **Cephalochordata** (Leptocardia)
- 5(3, 4) Body shape various, typically with a vertebral column of either cartilage or bone. Marine, fresh water or terrestrial.
Subphylum **Vertebrata** (Craniata), p. 47

SUBPHYLUM V E R T E B R A T A

- 1(6) Fishlike animals living in water and breathing by means of internal gills; lungs and appendages other than fins, absent; partially developed legs may be present in tadpoles. 2
- 2(5) Paired fins lacking. 3
- 3(4) Jaws lacking; mouth round and closed only by the end of the "tongue"; internal gills; eel-like.
Class **Cyclostomata**, p. 48
- 4(3) Horny jaws present except in very young tadpoles when the mouth has not yet broken through in which case the animal has plumelike external gills; external gills may be absent and partially developed legs may be present in older forms.
Tadpole larvae of Class **Amphibia**
- 5(2) Paired fins usually present but even if lacking the mouth has true jaws. Class **Pisces**, p. 48

- 6(1) Adults not fishlike; always with lungs though sometimes with gills in addition. Larvae may be fishlike tadpoles. 7
- 7(8) Skin naked and slimy, no scales, feathers or hairs.
Class **Amphibia**, p. 49
- 8(7) Skin covered by outgrowth consisting of scales, feathers, or hairs or combinations. 9
- 9(10, 11) Skin covered with scales, never with hair or feathers.
Class **Reptilia**, p. 49
- 10(9, 11) Skin covered by feathers and scales; birds (see Reed, *Bird Guide* or Chapman, *Birds of N.E. United States*).
Class **Aves**
- 11(9, 10) Skin covered in part by hairs which may be apparently absent at times; scales may be present; young born alive and suckled with milk from mammary glands. (except Australian species).
Class **Mammalia**, p. 50

CLASS CYCLOSTOMATA

- 1(2) Buccal tentacles present, eyes degenerate; intestine without spiral valve; marine.
Subclass **Myxinoidea**
- 2(1) No buccal tentacles; eyes well developed; intestine with a rudimentary spiral valve. (Forbes and Richardson, 5.)
Subclass **Petromyzontia**

CLASS PISCES

- 1(2) Fishes with a cartilaginous skeleton and exposed gill slits; marine forms. (Jordan, 14.)
Subclass **Elasmobranchii**
- 2(1) Fishes with a skeleton more or less bony; gill slits concealed under an operculum; marine and fresh water.
Subclass **Teleostomi**, p. 49

SUBCLASS **TELEOSTOMI**

- 1(4) Tail heterocercal; fins without spines; rudimentary spiral valve in intestine; heart with a conus arteriosus.
- 2(3) Skeleton chiefly cartilaginous. (Forbes and Richardson, 21.) ²
Order **Chondrostei**
- 3(2) Skeleton bony. (Forbes and Richardson, 30 and 37.)
Order **Holostei**
- 4(1) Tail homocercal; fins frequently with spines; spiral valve and conus arteriosus lacking. (Forbes and Richardson, 1.)
Order **Teleostei**

CLASS **A M P H I B I A**

- 1(2) Adults with tails; body elongated; legs of approximately equal size; salamanders, newts, and mud-puppies. (Jordan, 186.)
Order **Urodela**
- 2(1) Adults lacking tails; body short and stout; hind legs much longer than fore legs. (Dickerson, 43.)
Order **Anura** (Salentia)

CLASS **R E P T I L I A**

- 1(2, 3) Short compact body inclosed in a hard case or shell from which only head, tail and legs protrude; cloacal opening oval; turtles and tortoises. (Ditmars, 3.)
Order **Chelonia**
- 2(1, 3) Body elongated; legs present or absent; cloacal opening transverse; body covered with scales somewhat as in fishes; snakes and lizards. (Ditmars, 95 and 207.)
Order **Squamata**
- 3(1, 2) Lizard-like in shape but may attain a size of ten feet or more; cloacal opening, oval; scales and bony plates in the skin; jaws extend to form a long snout; tail flattened laterally. (Ditmars, 83.)
Order **Crocodylia**

CLASS M A M M A L I A

- 1(2) Young born in very immature state and carried by the mother in an external pouch formed by a fold of skin on the abdominal surface of the body; placenta absent or rudimentary. Subclass **Marsupalia** (Didelphia)

One order, **Polyprodonta**, including opossums occurs in this region. (Cory, 49.)

- 2(1) Young born in relatively mature condition; never carried in an abdominal pouch; placenta present and well developed.

Subclass **Placentalia** (Monodelphia) 3

- 3(4, 5, 6) Animals with claws. Section **Unguiculata**, p. 50

- 4(3, 5, 6) Animals with finger and toe nails.
Section and order **Primates**

- 5(3, 4, 6) Animals with hoofs (some more or less whalelike aquatic animals excepted). Section **Ungulata**, p. 51

- 6(3, 4, 5) Fishlike animals without posterior appendages and with fore legs modified to form flippers.
Section **Cetacea**

SECTION UNGUICULATA

- 1(2, 3, 4) Small animals with (usually) a proboscis-like tactile snout and sharp pointed teeth. Dental formulas from $\frac{2143}{0143}$ in moles to $\frac{2113}{2013}$ in shrews. (Cory, 405.)

Order **Insectivora**

- 2(1, 3, 4) True flying mammals with fingers of fore limbs greatly elongated to support a skin fold which extends also to hind limbs and tail; dental formula often $\frac{2133}{3133}$; the bats. Order **Chiroptera**

- 3(1, 2, 4) Feet with well-developed claws in land forms; canine teeth specialized and prominent; molars fitted for cutting; animals chiefly of carnivorous habit; cats, dogs, seals, etc. (Cory, 273.) Order **Carnivora**
- 4(1, 2, 3) Canine teeth absent; a wide gap between cheek teeth and front teeth (incisors) which are large and chisel shaped; never more than two incisors in the lower jaw.
 Formula varies between $\frac{2033}{1023}$ and $\frac{1002}{1002}$. Rabbits, squirrels, etc. (Cory, 97.) Order **Rodentia**

SECTION **UNGULATA**

- 1(2) With two or four toes bearing hoofs; swine, deer, cattle. (Cory, 58.) Order **Artiodactylia**
- 2(1) In our species with only one hoof for each foot; horses. Order **Perissodactylia**

A GLOSSARY OF TECHNICAL TERMS USED IN THE SYNOPTIC KEY

(In part after Shull)

- Aboral:** The region or side of an animal away from the mouth.
- Adductor muscle:** The muscle of a bivalve mollusc which serves to close the shell.
- Adoral:** The region around the mouth.
- Alimentary canal:** The digestive tract of an animal.
- Ameboid:** Having the power of changing shape by sending out finger-like processes called pseudopodia.
- Antennae:** Jointed appendages which project from the head of an insect or crustacean.
- Anus:** The posterior opening of the alimentary tract.
- Ascon type:** A type of sponge structure in which the collar cells are located on the wall of the single central cavity.
- Axial filaments:** A supporting element running along the axis of a given structure.
- Bilateral symmetry:** An arrangement of the parts of an animal such that the opposite sides are mirror images of each other.
- Biramous appendage:** An appendage with a basal portion from which two extensions arise. The inner is called the endopod and the outer, the exopod.
- Buccal:** Pertaining to the mouth.
- Byssus:** A threadlike structure, which is found as an organ of attachment in certain bivalve molluscs and as a sensory organ in certain of their larvae.

- Calcareous:** Containing calcium carbonate which may be determined by touching with hydrochloric acid. If the material is calcareous it will effervesce.
- Carapace:** The chitinous or calcareous covering of the cephalothorax of a crustacean such as the crayfish or lobster. Also the bony dorsal covering of a turtle.
- Caudal filaments:** Threadlike outgrowths from the posterior end of the body of an animal.
- Cephalothorax:** The fused head and thorax of such an animal as the crayfish.
- Chelicerae:** Appendages of the spider group found immediately in front of the mouth.
- Chitin:** A horny substance forming the outside covering of crustacea, insects, and many other animals.
- Chitinized:** Impregnated with chitin.
- Cilia (sing. Cilium):** Minute hairlike structures occurring on the surface of certain cells as in *Paramecium*.
- Cloaca:** A common passage through which the intestines, kidneys, and sexual organs discharge their products in some fishes, amphibia, reptiles, birds, and lower mammals.
- Cocoon:** A case in which eggs are laid and in which the larvae are developed; also a silky covering around a pupa.
- Colony:** Two meanings: (1) animals organically connected as *Plumatella*; (2) animals not organically but socially connected as a colony of bees.
- Complete metamorphosis:** A term applied to the life-history of certain animals, especially insects, in which the adult is wholly unlike the grublike larvae in appearance.
- Conus arteriosus:** A bulblike structure at the base of the aorta which contains a number of valves.

Ctenidia: Gills.

Cuticula: A definite covering over the outside of a cell or body.

Dental formula: A device for showing the number of incisor, canine, premolar, and molar teeth on one side of each jaw. The numbers above the line represent the teeth of the upper jaw.

Dorsal: Pertaining to the back, usually the upper surface of an animal.

Dorsoventrally: Pertaining to the relation between the back and belly. An animal flattened dorsoventrally has its dorsoventral axis shortened and extends laterally as a ribbon.

Ectoparasitic: Parasites attached to the outside of the animal which serves as their host.

Ectoplasm: The outer layer of protoplasm in a cell in which the outer and inner parts of the cell differ markedly in structure (*See* Endoplasm.)

Elytra: The thickened wing covers of beetles.

Endoparasitic: Parasites living on the inside of the animal which serves as their host.

Endoplasm: The inner part of the protoplasm of a cell in which the outer and inner portions differ markedly in structure. The endoplasm surrounds the nucleus. *See* Ectoplasm.

Exumbrella: The outer, convex, aboral surface of a medusa as opposed to the subumbrella which is the concave surface around the manubrium.

Filiform: Slender cylindrical form pointed at both ends.

Flagella: Long whiplike projections from cells, capable of movement.

Free living: Animals which are not parasitic.

- Gastric ridges:** Ridges extending out into the digestive cavity of certain coelenterate larvae.
- Gemmation:** The process of forming small aggregates of protoplasm or of cells which are called gemmules.
- Gill books:** Respiratory apparatus similar to lung books except that water rather than air is introduced between the "pages."
- Gill slits:** Openings from the pharynx to the exterior which are typically used in gill breathing as in fish.
- Gizzard:** A thick-walled portion of the alimentary tract used in mixing or grinding food.
- Gonads:** Sex organs.
- Halteres:** Knobbed filaments which take the place of a second pair of wings as in flies.
- Heterocercal:** A type of fish tail in which the dorsal lobe is larger than the ventral and contains the continuation of the vertebral column.
- Homocercal:** A type of fish tail in which the two lobes appear symmetrical as in most fishes.
- Hyaline:** With glasslike transparency.
- Hydroid:** Resembling the simple hydra, generally used to designate a colonial coelenterate the individuals of which resemble hydra in some respects.
- Incomplete metamorphosis:** A term applied to the life-history of certain animals, particularly insects, in which the young stages bear some resemblance to the adult animals.
- Integument:** Outer covering, skin.
- Intracellular:** Lying within a cell.

Labium: The "lower lip" of an insect, which may be greatly modified in different forms but is typically developed in the grasshopper.

Lamellate: Leaflike.

Labrum: The "upper lip" of an insect which is typically developed in the grasshopper.

Lanceolate: Lance-shaped, i.e., long, narrow, and pointed.

Larvae: A young stage in the life-history of an animal which does not closely resemble the adult; here used in the case of insects to designate the wormlike young of forms having a complete metamorphosis.

Lithocyst: A small globular structure containing one or more solid particles, frequently supposed to be concerned with equilibrium.

Lophophore: The horseshoe-shaped set of tentacles of a bryozoan.

Lorica: The outer shell around some rotifers and protozoa.

Lung books: A method of respiration in spiders by which the air is introduced between the "pages" of a booklike structure.

Mandibles: Chewing organs, jaws, sometimes modified into piercing organs.

Manubrium: A projection from the underside of a medusa, which bears the mouth.

Marine: Living in the sea.

Maxillae: Accessory jaws lying near the mandibles, typically developed in the crayfish and grasshopper.

Maxillipeds: Anterior thoracic appendages of crustaceans which have been developed as accessory mouth parts.

Medusae: Jellyfish.

Membranellae: Membrane-like structures formed by the fusion of cilia.

Mesothorax: The median part of the thorax of insects, typically bearing the median legs and the anterior pair of wings.

- Metamorphosis:** A change in body form as when the grub changes into a butterfly.
- Metathorax:** The posterior part of the thorax of insects, typically bearing the posterior legs and the posterior pair of wings.
- Metazoa:** Animals composed of many cells: animals in which one or more tissues are present.
- Mouth parts:** The different appendages grouped closely about the mouth of arthropods which are used in capturing or chewing food.
- Multinucleate:** Having many nuclei within one cell wall.
- Nematocysts:** The stinging bodies of Hydra and other coelenterates.
- Notochord:** A cylindrical rod of cells beneath the nervous system. It is the first stage in the development of the vertebral column (backbone) of vertebrates; usually present only in embryos.
- Nymphs:** Frequently used as synonymous with larvae, here used to designate the young of insects with an incomplete metamorphosis.
- Operculum:** In snails, a chitinous structure borne on the foot which closes the mouth of the shell when the foot is withdrawn; in fishes, the covering of the gills.
- Ovaries:** The female reproductive organs which originate the eggs or ova. They can frequently be distinguished under the microscope by the fact that they contain large egg cells.
- Palpi:** Segmented antennal-like processes attached to the mouth parts of some arthropods; also a shortening of pedipalpi, the second pair of appendages in arachnids.
- Parapodia:** Fleshy outgrowths from the body wall of some annelids which bear setae.
- Parasite:** An animal which lives in or on some other animal from which it obtains its food.
- Parenchymatous:** A loose spongy tissue like the pith of plants.

Pedipalpi. *See* Palpi.

Peduncle: A stalk by which a sessile animal or organ is attached.

Pharynx: The section of the alimentary canal just back of the mouth.

Photoreceptors: Light percipient organs.

Placenta: A vascular tissue found in mammals dovetailing into the wall of the uterus on the one side and connected with the embryo on the other thus serving to connect the developing embryo with its mother.

Polar: Lying at one side of the cell as the North Polar ice field lies on one side of the earth.

Polyps: One of the feeding individuals of a hydroid or coral colony or a similar form.

Proboscis: A fleshy structure which extends or is capable of being projected from the body (elephant's proboscis).

Prolegs: Fleshy appendages found on the abdominal segments of certain larvae particularly those of butterflies and moths.

Prothorax: The anterior part of the thorax of insects typically bearing the anterior pair of legs.

Protoplasm: The living matter of which animals and plants are essentially composed.

Pseudopodia: Irregular projections from cells which may be withdrawn.

Pupa: A quiescent stage in the life-history of an insect just before the adult condition is reached.

Radial symmetry: An arrangement of parts such that they radiate around a central axis as in the starfish.

Rudimentary: Reduced in size from that found in normal development.

- Segment:** A part of the body of an animal shown either by constrictions on the surface, by appendages, or by internal structure.
- Segmental appendages:** Outgrowths from the body such as legs of the centipede which are regularly arranged on different body segments.
- Septum:** A partition or dividing membrane.
- Sessile:** Attached animals as distinguished from free living. Hydra is a sessile form. Also used in the case of organs to signify the absence of a stalk, as: *the eyes are sessile, not stalked.*
- Setae:** Bristles such as project from the body of the earthworm.
- Silicious:** Composed of silicon and therefore glasslike.
- Solitary:** Animals living alone; used both to distinguish animals not organically connected with each other from those that are organically connected and also to distinguish hermit-like species from those that live in colonies.
- Somites:** Segments, or divisions of the body shown either by constrictions on the surface, by appendages, or by internal structure.
- Spicules:** Bodies of various shapes, sometimes needle-like, again three, four, or six pointed, which form part of the skeleton of sponges.
- Spiracle:** One of a number of openings along either side of the body through which air is introduced into trachea. Best developed in insects.
- Spiral valve:** A spiral fold which occupies the interior of the intestine of some fishes.
- Spongins:** The silklike fibers that make up the skeleton of the bath sponge.

- Spores:** Small particles of protoplasm which become surrounded with a resistant covering and so are able to withstand extreme conditions.
- Statoblast:** A gemmule-like body by means of which many Bryozoa reproduce asexually.
- Sycon type:** A type of sponge structure in which the central cavity is free from collar cells which are located in side branches from this cavity.
- Symmetrical:** Of a form that may be divided by a line or plane into two parts that are mirror images of each other.
- Tarsus:** The distal part of the foot of an insect; it is normally composed of more than one segment.
- Tentacle:** An elongated tactile organ.
- Terrestrial:** Pertaining to land; animals that live on land.
- Thorax:** A middle portion of the body of many animals, between the head and abdomen.
- Trachea:** An air tube, normally stiffened by rings of supporting tissue.
- Tracheal gills:** Arrangements whereby the tracheal vessels are brought near the water for purposes of respiration (in aquatic insects).
- Tubercle:** A rounded swelling.
- Umbrella:** The jelly-like body of the medusa resembles an umbrella with the manubrium in the place of a broken handle.
- Velum:** A shelf of muscular material placed near the edge of the bell of a jellyfish much as a running track is placed around a gymnasium.
- Ventral:** Literally, pertaining to the belly, hence usually the lower part of an animal.
- Zoecium:** The body wall of a bryozoan.

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