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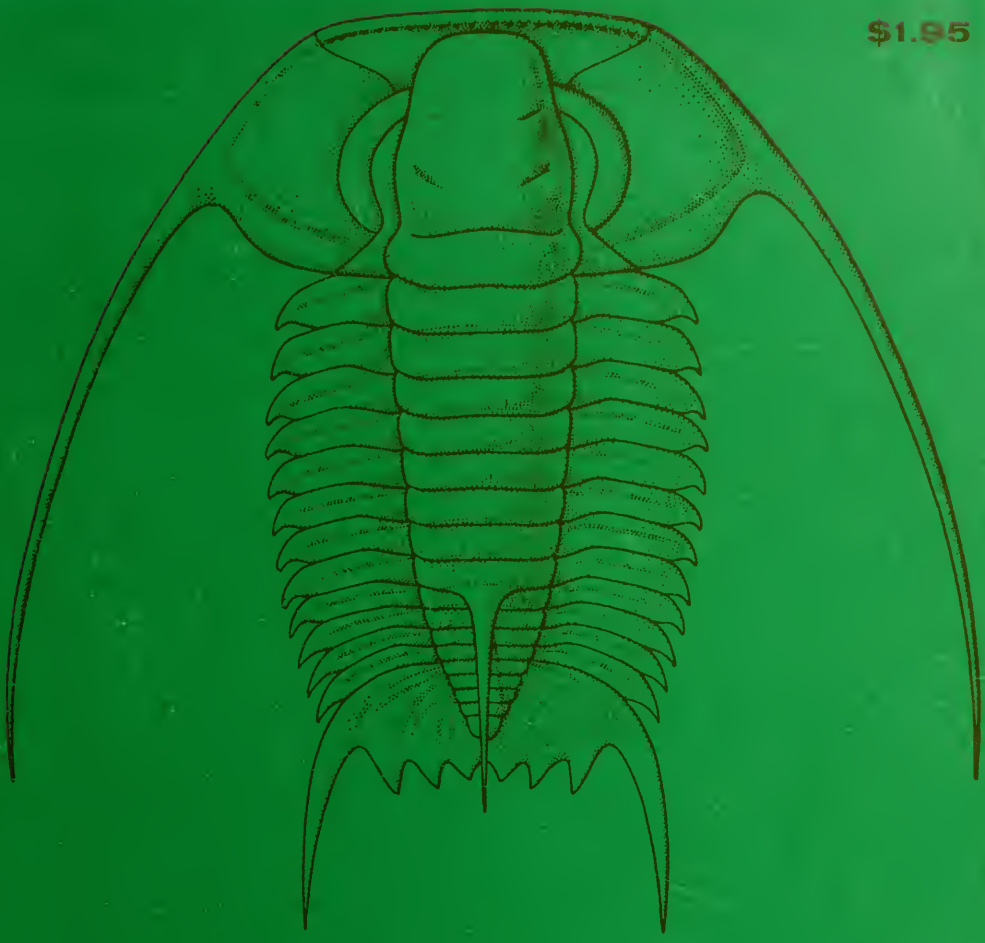

# Classification of the ANIMAL KINGDOM

Richard E. Blackwelder

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# INTRODUCTION

THE CLASSIFICATION OF ANIMALS is still very much a field in which discovery and revision are continuing, even after two hundred years of study. The importance of classification in biology increases every year, because the experimental and practical fields find increasing need for accurate identification of animals and for understanding of comparative relationships.

At least one outstanding biologist has opposed publication of this new classification on the ground that it would be accepted as final, *the* classification, and would tend to make students think that all higher classification is finished. The intention of the compiler is just the opposite. Just as this classification is different in detail from all previous ones, so will future editions be still different, as we learn more about the comparative features of animals.

It is anticipated that every new edition will spur students of the individual groups to propose improvements. It is therefore planned to issue corrected editions whenever appropriate. The very appearance of these subsequent editions will emphasize the growth of understanding of animal groups.

Only one ostensibly complete classification of animals, living and fossil, has been published in recent years. That classification, by A. S. Pearse of Duke University, is a good one, based on the views of many specialists. Certain mechanical faults make it less usable than it should be, and the need for revision gave the original impetus to preparation of the present classification. Because Pearse did not usually indicate the source of his arrangements, he is not here cited as an authority. Nevertheless, the two classifications are basically very similar. No other single classification has been found that agrees so closely with the conclusions of the present study.

It should be emphasized that, within certain limits, this classification is not a simple compilation of the views of specific workers. In nearly all details, choices have been made between conflicting schemes

of various authors, not on the basis of the reputation of those authors but on my judgment of the soundness of their supporting arguments or on my analysis of the data they present. In none of the larger groups has the work of any single author been accepted without modification.

Several considerations have influenced the decisions embodied in this classification.

*First,* a false picture is given by a simplified classification, because the existing diversity is one of the principal features of the animal kingdom. Therefore, no groups should be combined merely for the sake of simplicity.

*Second,* although the previous item would seem to require coverage of the groupings at all possible levels, to show the extreme range of division and subdivision, this is not in fact possible. Not only are there many conflicting groupings at certain levels, such as of phyla or orders, but there is no practical way to show these groupings in a general classification. It is a compromise that is believed to be effective to subdivide the phyla only into classes, subclasses, and orders. Other possible groupings, such as subphyla and superorders are referred to in the notes.

*Third,* two groups which are so distinct at any level that they cannot be described in common terms must be separated at that level. (For example, Pterobranchia and Enteropneusta; see the Notes on the Taxa.)

*Fourth,* groups which cannot be distinguished at any particular level by the type of characters used for their neighbors must be combined at that level. (For example, the sometime classes of Nematoda.)

*Fifth,* the discovery of groupings within a class, for example, does not justify the creation of new classes for each of the subgroups. The proper level for the new groups can only be determined by comparison with neighboring parts of the classification.

*Sixth,* although uniformity in the form (endings) of names at each level would unquestionably be helpful, it cannot now be attained without adding greatly to the total of name forms and synonyms. The systems so far proposed are so diverse as to introduce further confusion of their own. None of the systems has been widely enough accepted to be entitled to adoption throughout the Animal Kingdom. None has been so widely accepted on a world basis, even in one group, as to indicate

universal acceptance in the near future. Indeed, even the ordinal endings in *-iformes* adopted by American ichthyologists and ornithologists are almost entirely unused in the rest of the world. The resulting names are unnecessarily long and cumbersome. The system does not relieve anyone from learning the shorter forms also. The latter are used here, with the uniform-ending forms listed as synonyms. In other groups, usage of the source of the classification is followed as to spelling, in most cases. There are a variety of systems in use and no obvious trend toward adoption of any single system.

This classification attempts to show the various spellings as well as the various synonyms. Each zoologist will choose which one he wishes to use in each case.

*Seventh,* no single rule will suffice for choice of names where several apply to a single taxon. Reasons for each decision are given in the text in many cases, but in general it has been the goal to retain the best known names, at the most appropriate level, regardless of homonymy. Priority is considered to be of secondary importance at these levels.

*Eighth,* although considerable homonymy exists at all levels, even up to that of phylum names, there is almost no real confusion caused thereby. Until there are direct rules to govern the decisions, there seems to be nothing gained by replacing well known names, such as Decapoda (either in the Cephalopoda or in the Crustacea).

This classification is in three parts, the purposes of which are quite different. In order of preparation, these are: 1] the complete classification, including lists of the phyla and of the classes and orders, of all animals, living and fossil; 2] the justification for unusual features in this classification; and 3] a simplified classification of Recent animals for student use, with common names, again including lists of the phyla and of the classes and orders. The arrangement of these parts in the book is just the reverse of this.

In both lists, the phyla are first arranged in four subkingdoms, and one of these is divided into four series. Many other groupings of these phyla are possible, and several are shown in the footnotes of the section Complete List of Phyla. It is not here believed that these supra-phylum groupings are of much significance at this phase of the knowledge of animals.

In both lists of orders, these orders are arranged in the appropriate classes and subclasses. No other levels, such as superorder, are rec-

ognized. They may be of use in some circumstances but seem to be of little value in showing the arrangement of the orders on a practical basis.

Throughout, rejected synonyms are printed in italics, the accepted class names are in capital letters, and the subclass names and the order names are both set in capitals and lower case letters. In the footnotes, names that also appear in the classification above are printed in small capitals. The other names in the footnotes are somewhat in the nature of rejected synonyms, but as most of them are really the names of non-accepted groupings, they appear in capitals and lower case roman letters.

To the variety of spellings there is no end. No attempt is made to list *all* forms, but such spellings as would appear at a separate place in an alphabetical index are listed, along with those variations that are used for distinct levels; e.g., Echiuroidea (phylum), Echiurida (class), and Echiuroina (order).

In the Complete List of Orders the geologic range of each group is shown by symbols at the right margin. The meaning of these symbols is shown in the following table.

| | | | |
|---|---|---|---|
| REC | Recent | JUR | Jurassic |
| QUA | Quaternary | MES | Mesozoic |
| PLE | Pleistocene | PER | Permian |
| PLI | Pliocene | PEN | Pennsylvanian |
| OLI | Oligocene | MIS | Mississippian |
| MIO | Miocene | CAR | Carboniferous |
| EOC | Eocene (+ Paleocene) | DEV | Devonian |
| TER | Tertiary | SIL | Silurian |
| CEN | Cenozoic | ORD | Ordovician |
| CRE | Cretaceous | CAM | Cambrian |
| TRI | Triassic | PAL | Paleozoic |

There are a few points of discrepancy between the Simplified List and the Complete List. These are intentional, to make the simplified list more useful to students. The Complete List shows the definitive classification that is here being proposed.

The names included under the footnote heading *"Includes"* may be suborders, synonyms, rejected groups, or names of questionable application. They are all names which have at some time been used for orders or more inclusive groups and are included merely to indicate their approximate position in the scheme.

Several recent schemes of classification in particular groups are known to the compiler but are not followed herein. Some were received too late for study (e.g., part W of the Treatise of Invertebrate Paleontology). Some were not yet available in the form needed for our use and so were not considered (e.g., Echinodermata by H. B. Fell and Mollusca by Taylor and Sohl). There is no judgment of these schemes implied in this action; they will be considered for a subsequent revised edition.

It will probably be thought by some that this is an extreme classification in separating many small groups as distinct phyla. The compiler believes that it is a conservative classification even in this regard. He believes that an important basic tenet of classification, too often overlooked, is that all groups must be distinct and definable and that therefore forms are not to be forced into existing groups at any level if they do not agree with what are deemed to be the important features of that group. The important features in this case are those which caused the group to be set aside and maintained as distinct.

It is sometimes possible to enlarge slightly the scope of a group definition to admit forms previously unknown, but this does not justify including widely divergent forms that cannot be defined together effectively.

# Simplified List

Subk Series Phylum

Kingdom **ANIMALIA**[1]

EOZOA

Protozoa[2] [one-celled animals][3]

PARAZOA

Porifera sponges

AGNOTOZOA

Mesozoa

HISTOZOA (*Metazoa*)

Enterocoela

Monoblastozoa

Coelenterata (*Cnidaria*) hydroids, jellyfish, medusae, corals, sea-anemones

Ctenophora comb-jellies, sea-walnuts

Acoelomata

Platyhelminthes flatworms

Rhynchocoela (*Nemertinea*) ribbon-worms, proboscis-worms

Pseudocoelomata

Acanthocephala spiny-headed-worms

Rotifera (*Rotatoria*) rotifers, wheel-animalcules

Gastrotricha

Kinorhyncha (*Echinodera*)

Priapuloidea

Nematoda thread-worms, round-worms

Gordiacea (*Nematomorpha*) horsehair-worms, gordian-worms

Calyssozoa (*Endoprocta*)

| Subk | Series | Phylum |
|---|---|---|
| | | Coelomata |
| | | Bryozoa (*Ectoprocta*) moss-animals |
| | | Phoronida |
| | | Brachiopoda lamp-shells |
| | | Mollusca mollusks |
| | | Sipunculoidea |
| | | Echiuroidea |
| | | Myzostomida |
| | | Annelida [segmented worms] |
| | | Tardigrada bear-animalcules, water-bears |
| | | Pentastomida |
| | | Onychophora |
| | | Arthropoda crustaceans, arachnids, insects, etc. |
| | | Chaetognatha arrow-worms |
| | | Pogonophora beard-worms |
| | | Echinodermata |
| | | Pterobranchia |
| | | Enteropneusta |
| | | Planctosphaeroidea |
| | | Tunicata sea-squirts |
| | | Cephalochordata lancelets |
| | | Vertebrata vertebrates |

[1] For explanations, other synonyms, extinct groups, and other taxa above the phylum level, see the section Complete List of Phyla.

[2] The Protozoa are sometimes placed in a separate kingdom of organisms—the Protista.

[3] Non-Latin names can be made for each phylum by merely using the English form of the name, such as protozoans for Protozoa or arthropods for Arthropoda. These are listed only where they are in common use.

# Simplified List of Recent Classes and Orders

## with Common Names

**Class Subcl Order**

### PROTOZOA

FLAGELLATA (*Mastigophora*) flagellates
- Phytomastigina [plant-like flagellates]
  - Chrysomonadina silicoflagellates, etc.
  - Coccolithophorida coccolithophores, coccoliths
  - Cryptomonadina
  - Phytomonadina (*Volvocales*)
  - Euglenoidina
  - Chloromonadina
  - Dinoflagellata dinoflagellates
- Zoomastigina [animal-like flagellates]
  - Rhizomastigina
  - Protomonadina
  - Polymastigina
  - Hypermastigina

SARCODINA
- Rhizopoda rhizopods
  - Proteomyxa
  - Mycetozoa slime-molds
  - Amoebozoa
  - Testacea
  - Foraminifera foraminiferans, forams
- Actinopoda
  - Heliozoa sun-animalcules
  - Radiolaria radiolarians

SPOROZOA
- Telosporidia
  - Gregarinida
  - Coccidia
  - Haemosporidia
- Cnidosporidia
  - Myxosporidia
  - Actinomyxidia

| Class | Subcl | Order |
|---|---|---|
| | | Microsporidia microsporidians |
| | | Helicosporidia |
| | Sarcosporidia | |
| | | Sarcosporidia |
| | | Globidia |
| | Haplosporidia | |
| | | Haplosporidia |
| CILIATA ciliates | | |
| | Protociliata | |
| | | Opalinida opalinids |
| | Euciliata | |
| | | Holotricha |
| | | Spirotricha tintinnids, etc. |
| | | Chonotricha |
| | | Peritricha |
| SUCTORIA | | |
| | | Suctoria |

## PORIFERA

sponges

CALCAREA (*Calcispongea*) [calcareous sponges, chalky sponges]
- Solenida
- Lebetida
- Pharetronida
- Thalamida

HYALOSPONGEA (*Hexactinellida*) glass-sponges
- Lyssakina
- Dictyonina
- Lychniskophora
- Heteractinida

DEMOSPONGEA
- Myxospongida
- Keratosida horny-sponges
- Haplosclerida
- Poecilosclerida
- Hadromerida
- Halichondrida
- Epipolasida
- Choristida
- Carnosida
- Lithistida stone-sponges

## MESOZOA

RHOMBOZOA
- Dicyemida
- Heterocyemida

ORTHONECTIDA
- Orthonectida

## MONOBLASTOZOA

MONOBLASTOIDEA
- Monoblastidea

## COELENTERATA
(*Cnidaria*)

coelenterates, medusae

HYDROZOA
- Trachylinida
- Hydroida
- Milleporida (*Hydrocorallinae*) millepores
- Stylasterina
- Siphonophora siphonophores

SCYPHOZOA jellyfishes
- Stauromedusae
- Cubomedusae
- Coronatae
- Semaeostomeae
- Rhizostomeae

ANTHOZOA sea-anemones, corals
- Alcyonaria
  - Stolonifera
  - Telestacea
  - Alcyonacea soft-corals
  - Coenothecalia blue-corals
  - Gorgonacea sea-fans, horny-corals, gorgonians, sea-feathers
  - Pennatulacea sea-pens, sea-pansies
- Zoantharia
  - Zoanthiniaria
  - Corallimorpharia
  - Actiniaria sea-anemones
  - Scleractinia (*Madreporaria*) hexacorals, stony-corals

Class Subcl Order

Ceriantipatharia
Antipatharia black-corals, thorny-corals
Ceriantharia

## CTENOPHORA

comb-jellies, sea-walnuts

TENTACULATA
Cydippida
Lobata
Cestida
Platyctenea

NUDA
Beroida

## PLATYHELMINTHES

flatworms

TURBELLARIA planarians
Acoela
Rhabdocoela
Alloeocoela
Tricladida triclads
Polycladida polyclads

TREMATODA flukes
Monogenea
Aspidogastrea
Digenea

CESTODA tapeworms
Proteocephala
Tetraphyllidea
Disculicepitidea
Lecanicephala
Trypanorhyncha
Cyclophyllidea
Aporidea
Nippotaeniidea
Caryophyllidea
Spathebothridea
Pseudophyllidea

CESTODARIA
Amphilinidea
Gyrocotylidea
Biporophyllidea

## RHYNCHOCOELA

ribbon-worms, proboscis-worms

NEMERTINEA
- Palaeonemertea
- Heteronemertea
- Hoplonemertea
- Bdellonemertea

## ACANTHOCEPHALA

spiny-headed-worms

ACANTHOCEPHALA
- Archiacanthocephala
- Palaeacanthocephala
- Eoacanthocephala

## ROTIFERA
(*Rotatoria*)

rotifers, wheel-animalcules

SEISONIDEA
- Seisonacea

BDELLOIDEA
- Bdellacea

MONOGONONTA
- Ploima
- Flosculariacea
- Collothecacea

## GASTROTRICHA

gastrotrichs

MACRODASYOIDEA
- Macrodasyidea

CHAETONOTOIDEA
- Chaetonotidea

## KINORHYNCHA

ECHINODERA
- Echinodera

Class Subcl Order

## PRIAPULOIDEA

PRIAPULOIDEA

Priapulida

## NEMATODA

nematodes, nemas, thread-worms, round-worms

NEMATOIDEA

Enoploidea
Dorylaimoidea
Mermithoidea
Chromadoroidea
Araeolaimoidea
Monhysteroidea
Desmoscolecoidea
Rhabditoidea
Rhabdiasoidea
Oxyuroidea
Ascaroidea
Strongyloidea
Spiruroidea
Dracunculoidea
Filarioidea
Trichuroidea
Dioctophymoidea

## GORDIACEA

gordian-worms, horsehair-worms

NEMATOMORPHA

Gordioidea
Nectonematoidea

## CALYSSOZOA

endoprocts

ENDOPROCTA (*Entoprocta*)

Pedicellinida

## BRYOZOA

sea-mats, corallines, moss-animals, bryozoans, sea-mosses

PHYLACTOLAEMATA
Lophopoda
GYMNOLAEMATA
Cyclostomata
Ctenostomata
Cheilostomata

## PHORONIDA

phoronids

PHORONIDA
Phoronida

## BRACHIOPODA

lamp-shells, brachiopods

INARTICULATA
Atremata
Neotremata
ARTICULATA
Protremata
Telotremata

## MOLLUSCA

mollusks

MONOPLACOPHORA
Tryblidioidea
AMPHINEURA chitons
Neoloricata
APLACOPHORA (*Solenogastres*)
Neomeniida
Chaetodermatida
GASTROPODA snails, slugs, gastropods
Prosobranchia
Archaeogastropoda limpets, ear-shells, turbans
Caenogastropoda
Opisthobranchia
Pleurocoela sea-hares

| Class | Subcl | Order |
|---|---|---|
| | | Pteropoda butterfly-shells, pteropods |
| | | Sacoglossa |
| | | Acoela nudibranchs |
| | Pulmonata land-snails, slugs | |
| | | Basommatophora boat-shells, ramshorns |
| | | Stylommatophora slugs |
| BIVALVIA (*Pelecypoda, Lamellibranchiata*) bivalves, oysters, clams, mussels, pelecypods | | |
| | | Protobranchia |
| | | Filibranchia |
| | | Eulamellibranchia |
| | | Septibranchia |
| SCAPHOPODA tooth-shells, tusk-shells | | |
| | | Scaphopoda |
| CEPHALOPODA cephalopods | | |
| | Tetrabranchiata | |
| | | Nautiloidea pearly-nautilus |
| | Dibranchiata | |
| | | Decapoda squids, cuttle-fish |
| | | Octopoda octopuses, argonauts |
| | | Vampyromorpha |

## SIPUNCULOIDEA

[sipunculid worms]

| | |
|---|---|
| SIPUNCULOIDEA | |
| | Sipunculida |

## ECHIUROIDEA

| | |
|---|---|
| ECHIURIDA | |
| | Echiuroina |
| | Xenopneusta |
| | Heteromyota |
| SACCOSOMATIDA | |
| | Saccosomatida |

## MYZOSTOMIDA

| | |
|---|---|
| MYZOSTOMIDA | |
| | Proboscidea |
| | Pharyngidea |

## ANNELIDA

[segmented worms] annelids

**Class Subcl Order**

CHAETOPODA
- Polychaeta polychaetes
  - Errantia sandworms
  - Sedentaria tubeworms
- Oligochaeta earthworms, angle-worms, night-crawlers, oligochaetes
  - Plesiothecata
  - Prosothecata
  - Prosopora
  - Opisthopora

HIRUDINEA leeches, bloodsuckers
- Rhynchobdellida
- Gnathobdellida
- Pharyngobdellida
- Acanthobdellida

ARCHIANNELIDA
- Archiannelida

## TARDIGRADA

bear-animalcules, water-bears

HETEROTARDIGRADA
- Arthrotardigrada
- Echiniscoidea

EUTARDIGRADA
- Eutardigrada

## PENTASTOMIDA

LINGUATULIDA
- Cephalobaenida
- Porocephalida

## ONYCHOPHORA

PERIPATIDEA
- Euonychophora

## ARTHROPODA

arthropods

MEROSTOMATA
- Xiphosura
  - Xiphosurida horseshoe-crabs

PYCNOGONIDA sea-spiders
- Eupantopoda

**Class Subcl Order**

ARACHNIDA arachnids
- Latigastra
  - Scorpionida scorpions
  - Pseudoscorpionida book-scorpions, false-scorpions, pseudoscorpions
  - Phalangida (*Opiliones*) harvest-men, Daddy-long-legs
  - Acarida mites, ticks, chiggers
- Caulogastra
  - Palpigradida microscorpions
  - Thelyphonida whip-scorpions
  - Schizomida
  - Phrynichida tailless-whip-scorpions
  - Araneida (*Araneae*) spiders, tarantulas, black-widows
  - Solpugida (*Solifugae*) solpugids, sun-spiders
  - Ricinuleida (*Podogonata*)

CRUSTACEA crustaceans
- Branchiopoda
  - Anostraca brine-shrimps
  - Notostraca phyllopods, fairy-shrimps
  - Conchostraca
  - Cladocera water-fleas
- Cephalocarida
  - Cephalocarida
- Ostracoda
  - Myodocopida
  - Podocopida
- Mystacocarida
  - Mystacocarida
- Copepoda (*Eucopepoda*)
  - Calanoida
  - Harpacticoida
  - Cyclopoida
  - Notodelphyoida
  - Monstrilloida
  - Caligoida
  - Lernaeopodoida
- Branchiura
  - Branchiura
- Cirripedia barnacles
  - Thoracica
  - Acrothoracica

| Class | Subcl | Order |
|---|---|---|
| | | Ascothoracica |
| | | Apoda |
| | | Rhizocephala |
| | Malacostraca | |
| | | Nebaliacea |
| | | Anaspidacea |
| | | Mysidacea opossum-shrimps |
| | | Thermosbaenacea |
| | | Spelaeogriphacea |
| | | Lophogastridea |
| | | Cumacea |
| | | Tanaidacea |
| | | Isopoda pillbugs, sowbugs |
| | | Amphipoda scuds |
| | | Euphausiacea krill |
| | | Decapoda crabs, lobsters, crayfish, shrimps, prawns |
| | | Stomatopoda mantis-shrimps |
| PAUROPODA | | |
| | | Heterognatha |
| SYMPHYLA | | |
| | Cephalostigmata | |
| DIPLOPODA millipedes | | |
| | Pselaphognatha | |
| | | Ancyrotricha |
| | | Lophotricha |
| | Chilognatha | |
| | | Limacomorpha |
| | | Oniscomorpha |
| | | Ascospermophora |
| | | Colobognatha |
| | | Nematophora |
| | | Proterospermophora |
| | | Opisthospermophora |
| CHILOPODA centipedes | | |
| | Pleurostigmophora | |
| | | Geophilomorpha |
| | | Scolopendromorpha |
| | | Lithobiomorpha |
| | | Craterostigma |
| | Notostigmophora | |
| | | Scutigeromorpha |

**Class Subcl Order**

INSECTA (*Hexapoda*) insects

Apterygota

Protura proturans

Thysanura silver-fish, bristle-tails, rock-jumpers

Entotrophi campodeids, japygids

Collembola springtails, snow-fleas

Exopterygota (*Heterometabola*)

Ephemerida mayflies

Odonata dragonflies, damselflies, mosquito-hawks, devil's-darning-needles, snake-doctors

Plecoptera stone-flies, salmonflies

Grylloblattoidea grylloblattids

Orthoptera (*Saltatoria*) grasshoppers, crickets, locusts, katydids, mole-crickets

Phasmidia walking-sticks, stick-insects, leaf-insects

Blattaria roaches, cockroaches, croton-bugs

Mantodea praying-mantis, soothsayers, mantids

Dermaptera earwigs

Embioptera embiids, webspinners

Isoptera termites, white-ants

Psocoptera (*Corrodentia*) psocids, book-lice, bark-lice, dust-lice

Zoraptera zorapterans

Mallophaga bird-lice, biting-lice

Thysanoptera thrips

Homoptera cicadas, leaf-hoppers, tree-hoppers, aphids, scale-insects, spittle-bugs, mealy-bugs, frog-spit, psyllids, lantern-flies, white-flies

Heteroptera bugs, bed-bugs

Anoplura sucking-lice, lice

Endopterygota (*Holometabola*)

Neuroptera snake-flies, serpent-flies, lace-wings, ant-lions, dobson-flies, fish-flies, orl-flies

Mecoptera scorpion-flies

Trichoptera caddis-flies, trout-flies, case-flies

Lepidoptera butterflies, moths, skippers, blues, woolly-bears, caterpillars, millers

Diptera flies, gnats, mosquitoes, midges, bots, maggots, punkies

Siphonaptera fleas, chigoes

Coleoptera beetles, weevils, fireflies, elaters, glow-worms, water-pennies, meal-worms, wire-worms, white-grubs

**Class Subcl Order**

Strepsiptera stylopids
Hymenoptera bees, wasps, ants, sawflies, hornets, wood-wasps, ichneumon-flies, gall-wasps, velvet-ants, horntails, tarantula-hawks

## CHAETOGNATHA

arrow-worms

SAGITTOIDEA
Sagittoidea

## POGONOPHORA

beard-worms

POGONOPHORA
Thecanephria
Athecanephria

## ECHINODERMATA

echinoderms

CRINOIDEA feather-stars, crinoids, sea-lilies
Articulata
Isocrinida
Cyrtocrinida
Comatulida
ASTEROIDEA starfishes, sea-stars
Phanerozonea
Spinulosa
Forcipulata
OPHIUROIDEA brittle-stars, sand-stars, basket-stars, serpent-stars
Myophiurida
Ophiocystiida
Aganasterida
Phrynophiurida
Laemophiurida
Gnathophiurida
Chilophiurida
ECHINOIDEA sea-urchins, heart-urchins, sand-dollars
Regularia
Cidaroida
Centrechinoida
Exocycloida

Class Subcl Order

Irregularia
Holectypoida
Cassiduloida
Clypeastroida cake-urchins, sand-dollars
Spantangoida heart-urchins

HOLOTHURIOIDEA sea-cucumbers
Aspidochirota
Elasipoda
Dendrochirota
Molpadonia
Apoda

## PTEROBRANCHIA

PTEROBRANCHIA
Rhabdopleurida
Cephalodiscidea

## ENTEROPNEUSTA

acorn-worms, tongue-worms

ENTEROPNEUSTA
Balanoglossida

## PLANCTOSPHAEROIDEA

PLANCTOSPHAEROIDEA
Planctosphaeroidea

## TUNICATA

tunicates

LARVACEA
Larvacea

ASCIDIACEA sea-squirts, ascidians
Stolidobranchiata
Aspiraculata
Phlebobranchiata
Aplousobranchiata
Octacnemida

THALIACEA
Pyrosomata
Pyrosomatida
Myosomata
Cyclomyaria
Hemimyaria
Desmomyaria

## CEPHALOCHORDATA

LEPTOCARDIA
Amphioxi lancelets

## VERTEBRATA

vertebrates

AGNATHA [jawless fishes]
Cephalaspidomorpha
Cyclostomata lampreys, hag-fishes, slime-eels
CHONDRICHTHYES [cartilaginous fishes]
Elasmobranchii
Selachii sharks, dogfishes, angel-fishes
Batoidea skates, rays
Holocephali rabbit-fishes
Chimaerae chimaeras, ratfishes
OSTEICHTHYES [bony fishes]
Actinopterygii [ray-finned fishes]
Chondrostei
Holostei gars
Teleostei
Choanichthyes [lobe-finned fishes]
Crossopterygii coelacanths, etc.
Dipnoi lungfishes
AMPHIBIA (*Batrachia*) amphibians, batrachians
Salientia
Anura frogs, toads
Lepospondyli
Urodela salamanders, newts
Apoda (*Gymnophiona*) caecilians
REPTILIA reptiles
Anapsida
Chelonia tortoises, turtles
Diapsida
Rhynchocephalia
Squamata lizards, snakes
Crocodilia crocodiles, gavials, alligators, caymans
AVES birds
Neornithes
Sphenisci (*Sphenisciformes*) penguins
Struthiones (*Struthioniformes*) ostriches

Class Subcl Order

Rheae (*Rheiformes*) rheas
Casuarii (*Casuariiformes*) cassowaries, emus
Apteryges (*Apterygiformes*) kiwis
Crypturi (*Crypturiformes, Tinami, Tinamiformes*) tinamous
Gaviae (*Gaviiformes*) loons
Podicipedes (*Podicipediformes, Colymbae, Colymbiformes*) grebes, divers
Procellariae (*Procellariiformes, Tubinares*) albatrosses, shearwaters, petrels, fulmars,
Steganopodes (*Pelecani, Pelecaniformes*) cormorants, pelicans, gannets, tropicbirds, boobies, snake-birds, frigate-birds
Ciconiae (*Ciconiiformes*) herons, bitterns, storks, hammerheads, spoonbills, ibises, flamingoes
Anseres (*Anseriformes*) ducks, geese, swans, screamers
Falcones (*Falconiformes*) hawks, eagles, vultures, falcons, caracaras, ospreys, harriers, secretary-birds
Galli (*Galliformes*) megapodes, pheasants, quails, grouse, turkeys, fowls, peacocks, hoatzins
Grues (*Gruiformes*) cranes, limpkins, rails, sunbitterns, bustard-quails, plainwanderers, trumpeters, coots, gallinules, kagus, sungrebes, bustards
Charadriae (*Charadriiformes*) jacanas, snipe, oyster-catchers, plovers, turnstones, surf-birds, woodcock, sandpipers, avocets, stilts, phalaropes, gulls, terns, skimmers, awks, murres
Columbae (*Columbiformes*) doves, pigeons, dodos, sandgrouse, solitaires
Psittaci (*Psittaciformes*) parrots, parakeets, lories, macaws
Cuculi (*Cuculiformes*) cuckoos, plantain-eaters, touracos, anis, roadrunners
Striges (*Strigiformes*) owls
Caprimulgi (*Caprimulgiformes*) goatsuckers, potoos, oil-birds, frogmouths
Macrochires (*Macrochiriformes, Apoda, Micropodi*) swifts, humming-birds
Colii (*Coliiformes*) mouse-birds, colies
Trogones (*Trogoniformes*) trogans
Coraciae (*Coraciiformes*) kingfishers, rollers, hoopoes, hornbills, todies, motmots, bee-eaters
Pici (*Piciformes*) woodpeckers, toucans, honey-guides, jacamars, puffbirds, barbets, piculets

**Class Subcl Order**

Passeres (*Passeriformes*) songbirds, warblers, thrushes, shrikes, creepers, nuthatches, titmice, vireos, finches, tanagers, blackbirds, starlings, orioles, crows, jays, magpies swallows, butcher-birds, wrens, thrashers, mockingbirds, kinglets, flycatchers, wrentits, dippers, honey-creepers, grosbeaks, buntings, broadbills, woodhewers, antbirds, ovenbirds, lyrebirds, bulbuls, larks, babblers, wagtails, waxwings, weaverbirds, drongos, wattlebirds, bowerbirds, birds-of-paradise, etc.

MAMMALIA mammals

Prototheria

Monotremata monotremes, platypus, echidna

Metatheria

Marsupialia marsupials, opossums, Tasmanian-wolf, bandicoots, phalangers, koalas, kangaroos

Eutheria (*Placentalia*) placentals

Insectivora insectivores, tenrecs, hedgehogs, shrews

Dermoptera colugos, flying-lemurs

Chiroptera bats, vampires

Primates lemurs, tree-shrews, aye-aye, lorises, bush-babies, tarsiers, monkeys, marmosets, macaques, baboons, guenons, langurs, apes, gibbons, lars, chimpanzees, orangutans, gorillas, men

Edentata sloths, anteaters, armadillos

Pholidota pangolins

Lagomorpha hares, rabbits, pikas

Rodentia squirrels, chipmunks, marmots, pocket-mice, pacas, kangaroo-rats, beavers, rats, mice, muskrats, lemmings, voles, dormice, porcupines, capybaras, guinea-pigs, chinchillas

Cetacea porpoises, dolphins, whales

Carnivora dogs, wolves, foxes, bears, raccoons, coatis, kinkajous, pandas, weasels, minks, otters, badgers, wolverines, skunks, civets, hyenas, cats, seals, sea-lions, walruses

Tubulidentata aardvarks

Proboscidea mastodons, mammoths, elephants

Hyracoidea hyraxes

Sirenia sea-cows

Perissodactyla horses, zebras, tapirs, rhinoceroses

Artiodactyla pigs, peccaries, hippopotamuses, camels, llamas, alpacas, guanacos, deer, giraffes, pronghorns, cattle, antelopes, sheep, gazelles, musk-oxen, goats, etc.

# Notes on the Taxa

## Subkingdoms and their subdivisions

*Animalia.* Division of the Animal Kingdom into four subkingdoms is seen in many recent classifications, although some writers prefer to list the Parazoa, Mesozoa, and Eumetazoa as branches of Metazoa in contrast to the Protozoa. The use of the additional level "branch" is difficult to justify where so few groups are involved, unless there is definite information on the phylogeny of these groups. Such knowledge of the relationships of the groups is lacking, or, at best, highly speculative. The groups are generally recognized at the phylum and subkingdom levels, and these seem to be adequate for classification except within the Metazoa proper (see below).

Inasmuch as it is often stated that animals are either one-celled or many-celled, it would seem to be necessary to accept the older subdivision of Animalia into two subkingdoms, Protozoa and Metazoa. The fact is, however, that many undoubted protozoans exist only in aggregations of many cells, often with as much division of labor between cell types as in some undoubted metazoans. Removal of the Protozoa to a separate kingdom Protista solves part of this problem, but the remaining animals still represent the three very different basic structures: 1] a vase-like cylinder open at one end and with several types of cells in the walls but with the internal cavity not serving for digestion, 2] a solid body consisting of one layer of cells around a central cell or group of cells, and 3] a multicellular body with internal cavities of which one is usually a digestive tract and with walls of one, two, or three layers of cells.

These three types of construction are so different as to require recognition as primary divisions of the kingdom. With the Protozoa (when these are treated as animals), they form the four subkingdoms employed here: Eozoa, Parazoa, Agnotozoa, and Histozoa.

*Eozoa* and *Agnotozoa.* In the choice of names for subkingdoms, it has been felt that only slight advantage results from having a single phylum known by a different name than is used for its subkingdom. However, with only four subkingdoms involved and with two of these consisting of two or more phyla, it appears to be reasonable to be uniform in this respect and use separate names for the subkingdom and phylum that include the protozoans and for the subkingdom and phylum that include the mesozoans.

*Parazoa.* The Porifera have long been recognized as constituting a group distinct from the rest of the many-celled animals. The extinct Cyathospongia, under one of the three available names, were placed with the sponges by Okulitch and others, and as a separate phylum in the Parazoa by Pearse and others.

*Histozoa.* This name is accepted here because of the great ambiguity of the more familiar name Metazoa. As explained above, the incorporation of many cells into one body is not distinctive of any major group of animals, even if single-celled adult structure is found exclusively in one group. It was the desire to retain Metazoa which has led many writers to list the Parazoa, Mesozoa, and Eumetazoa as branches of a subkingdom Metazoa. Inasmuch as Metazoa cannot be effectively defined, to the exclusion of all Protozoa, it seems to be more realistic to recognize three or four subkingdoms of animals on the basis of the general body construction. Attempts to divide it on the basis of cell number are arbitrary and misleading.

The use of any of these subkingdom groups is of questionable value; it is the phyla that are important and that are most often definable. The distinction between even Protozoa and Metazoa is so com-

pletely nebulous that it no longer serves any clear purpose. Use of the subkingdom and series names herein is simply a recognition of their use in many recent classifications.

Division of the Histozoa (Metazoa) into grades, series, or divisions has been attempted many times. Most of the groups so adopted in the past are employed in the face of obvious defects in the form of exceptions. Not all Radiata show any form of radial arrangement, and not all radially arranged animals are put in the Radiata. Bilateria included animals with quite diverse body plans, some with virtually no paired structures, no obvious "sides," no anterior and posterior, and only a remote similarity to the obviously bilateral animals. Some groups placed in the Schizocoela form their coelom in the enterocoelous manner, and at least one group placed in the Enterocoela forms its coelom by the schizocoelous method. Articulata has included animals that are *not* segmented. And so on.

It is here concluded that the histozoan (or eumetazoan) phyla cannot be grouped readily into clear-cut series. The number of these phyla is not so great as to force subdivision of the subkingdom, but custom seems to be sufficient justification for indicating some grouping of them. At this point it appears that the most useful grouping is the one based on the *type* of body cavity. Accordingly four groups are here recognized, those phyla with an enterocoel or gastrovascular cavity only, those with no cavities except a digestive tract, those with a pseudocoel, and those with a coelom. These groupings are all well known from Hyman (1940) and other works.

No satisfactory name exists for the first of these four groups. Radiata is inapplicable to many forms. Protaxonia is based on a concept of embryonic axes which would include extraneous groups. Enterozoa and Enterocoela were originally applied to much larger concepts. On the whole, Enterocoela is the most appropriate in meaning, and it is adopted here.

*Radiata* and *Bilateria.* The Histozoa or Metazoa have sometimes been divided into the Radiata (Coelenterata and Ctenophora) and the Bilateria (all others) on the basis of their general body arrangement. The distinction is here held to be a fictitious one, because Ctenophora are much less radial than some Echinodermata, and such an animal as a bryozoan is so completely different in body arrangement from an annelid worm that it is meaningless to say that they are both bilateral.

## Phyla and rejected phylum groups

*Cyathospongia.* Recent works on this extinct phylum have adopted either Pleospongia or Archaeocyatha as the phylum name. Both of these names are of later date (1937) than Cyathospongia (1935), and Archaeocyatha has been used more consistently for one of the included classes. There seems to be no firmly established usage that prevents us adopting the oldest name.

*Mesozoa.* There appears to be no reason for not adopting the name now in wide use for this phylum, especially as it is the oldest name (1877). The name has also been used at the subkingdom level, where the synonym Agnotozoa seems to be more appropriate.

*Monoblastozoa.* A new phylum named here for the unique metazoan *Salinella,* which has too long been left excluded from the classifications of animals. It contains only one genus and one species. The animal consists of a single layer of similar cells surrounding an internal tubular tract which has a "mouth" at one end, an "anus" at the other. The cells are thus simultaneously both "ectoderm" and "endoderm"; they are ciliated on both surfaces. Reproduction is asexual (by transverse fission), and there are indications of a sexual process in the form of fusion of two individuals. It is possible that a ciliated unicellular larva results from the sexual process.

Hyman suggested (1940) the phylum status for this peculiar animal, but she did not propose such a phylum directly and left *Salinella* unassigned to any group.

*Graptozoa.* The graptolites have had a more varied history than most other major groups. They were for years assigned to the Hydrozoa in the Coelenterata, but have more recently been transferred to the Hemichordata. In 1959 Hyman examined the arguments supporting the hemichordate assignment. After effectively disposing of all of these, she left the group without clear assignment, although she presumably retained them in the Hydrozoa, as she had doubtfully done in 1940.

Some features of the skeleton of graptolites are not duplicated in the Hydrozoa,

and the nature of the material of this exoskeleton is not known. It is not possible to say definitely that the graptolites are coelenterates, because the nature of the body cavity is not known, but there is no evidence that it is not a coelenteron. The graptolites may thus reasonably be included in the Coelenterata, even placed in the Hydrozoa because of general similarities, but information is simply lacking that would enable one to say that they did have the features of the coelenterates.

Inasmuch as there is some evidence of bilaterality, the skeletal tubes are different from those of Hydrozoa in manner of formation, and the almost universal form of the colonies is unmatched in the Hydrozoa, it is also reasonable to emphasize the differences by separating the group from the Hydrozoa as a class. Because of the lack of knowledge of all soft-part features and the possibility that some of these also are without counterpart in the Coelenterata, it is here preferred to emphasize this uncertainty by separating the group as a phylum distinct from Coelenterata.

The class Hydrozoa is already one of the most diverse in the Animal Kingdom. It seems undesirable to increase further its heterogeneity by including an additional series of different features. The distinctive features of the Coelenterata cannot be adduced to help us with the graptolites, so these fossils cannot be included in that phylum upon any firm basis.

*Conularida.* The same arguments as applied above to the Graptozoa are cogent for the separation of the Conularida as a separate phylum also. Apparently no coelenterates have a chitinophosphatic skeleton, which fact alone makes the inclusion of these animals in that phylum unsatisfactory. Of course, here also there is no direct evidence that the animals were actually coelenterate in nature.

This group has recently been assigned to the Scyphozoa, although also placed sometimes as a phylum near the Annelida or as a member of some other phylum. Although quite easily restored to look very much like elongate scyphozoans, the fossil remains of these animals show consistent differences in the steep-sided pyramidal form with four distinct sides, the closing of the aperture by lobes of the side faces, and the chitinophosphatic nature of the periderm. The arguments in the Treatise (F) for combining these with the Scyphozoa seem very weak.

*Coelenterata.* In some recent works (especially Hyman, 1940) this phylum has been called Cnidaria because Coelenterata has at other times included such groups as Ctenophora and Porifera. This reason for abandoning the universally known name Coelenterata would, if applied to other modern phylum concepts, result in changing most of the familiar names, including Porifera, Annelida, Arthropoda, Hemichordata, and Chordata. Such a change cannot, in the opinion of the writer, be justified by any benefits resulting therefrom. If it is thought to be necessary, the prior name Nematozoa would also have to be considered. (Furthermore, inclusion of the Graptozoa or Conularida (as in Hyman) would likewise necessitate a change in the phylum name, by this same argument.)

*Aschelminthes.* The proposal of this name by Hyman (1940) for all of the Pseudocoelomata except the Entoprocta has been adopted by some later works, but her alternate conclusion that the subphyla each be treated as a separate phylum has also been followed by some. It is surely premature to claim that the Aschelminthes has been conclusively accepted. Hyman (1951) removes one of the original seven groups (Acanthocephala) as a separate phylum.

The definition given for the emended phylum Aschelminthes in 1951 contains no clear-cut distinctions. Unless such exist, the supposed phylum must be concluded to be an indefinable assemblage. The fact that the included subgroups are mostly small and less well known is of no value in determining whether they are phyla, subphyla, or classes. It is here believed that they are adequately distinct by clear-cut features of fundamental nature (body plan, ciliation, "segmentation" of cuticle, presence of jaws, presence of flame bulbs or solenocytes, musculature, nature of nervous system, etc.) to be considered separate phyla.

*Nemathelminthes* and *Trochelminthes.* These two names were formerly applied to the thread-like and the ciliated animals more recently combined into the Aschelminthes. These groupings are also difficult to define. It is therefore preferred to treat their components as separate phyla. Nemathelminthes usually included the Nematoda, Gordiacea, Acanthocephala, and sometimes the Chaetognatha. The Trochelminthes included the Rotifera and Gastrotricha.

*Nematoda.* Hyman is followed here in rejecting recent proposals to change this name to Nemata.

*Gordiacea.* The best form of this name at the phylum level is a moot question. Little is gained but confusion by using Nematomorpha, whereas Gordioidea has generally been used at the class or order level. Gordiacea seems to remain as the most distinctive phylum name.

*Calyssozoa / Endoprocta.* Entoprocta is accepted by Hyman for this group, but this name (or the more distinctive spelling Endoprocta) is much more often applied at the class level. Calyssozoa was proposed originally (and followed by Kamptozoa) for the group as a phylum. Inasmuch as names are needed at both levels, Calyssozoa is accepted here for the phylum and Endoprocta for the single class. (The spellings Endoprocta and Entoprocta are both ascribed to Nitsche (1870). Both have been used extensively, but the former is more distinct from Ectoprocta and is therefore adopted here.)

*Myzostomida.* This peculiar and little-known group has previously been listed as a class of Annelida, as a subclass of Chaetopoda, or as part of the Polychaeta, but apparently never as a phylum.

These animals are disc-shaped, are non-segmented although with some paired organs, have five pairs of ventral appendages and four pairs of suckers, have ten or more pairs of marginal cirri or tentacles, lack blood-vascular and respiratory systems as well as multiple nephridia, have the central nervous system consisting of a single large ventral stellate ganglion and two nerve rings around the oesophagus and pharynx, have a complete digestive tract but with the stomach branching throughout the body, and have a trochosphere larva. These features would make the Annelida impossible to diagnose, and they result in an animal whose peculiarities are only obscured by inclusion in the Annelida.

Prenant (1960) in the Traité concludes that these animals are annelids but sufficiently distinct to be made a class. It is here believed that the features cited by Prenant make it necessary to remove the Myzostomida from the Annelida, just as the Sipunculoidea and Echiuroidea had previously been removed.

Myzostomids are reported from several geologic eras. As these are known only from scars or galls, they cannot be assigned to orders.

*Protarthropoda.* The inclusion of Tardigrada, Onychophora, and Pentastomida in the Arthropoda as a subphylum (Protarthropoda, Pararthropoda, or Oncopoda) has been done, in every case traced out, without direct consideration of whether they have the basic features of arthropods, or whether the resulting agglomeration can be defined. Apparently it cannot be defined, and these three groups individually have only a few of the basic arthropod features. Until more correlation is demonstrated, it is held that they cannot reasonably be combined with the Arthropoda.

*Tardigrada.* This group is generally placed in either the Aschelminthes or the Arthropoda. Either position is untenable if Cuenot (1949) is correct in asserting that the animals are coelomate and enterocoelous. It is distinguished from Onychophora and Pentastomida, as well as Arthropoda, by features of considerable importance. It is certainly entitled to phylum status, even if the correct position for the phylum is still unknown.

*Pentastomida.* This group is generally placed in the Arthropoda, sometimes even in the order Acarida. Some of its characters have been ascribed to parasitic degeneration. They apparently have no cilia, do have a chitinous cuticle, and do have an arthropod type of nervous system. They lack an exoskeleton, jointed appendages, Malpighian tubules or coxal glands, circulatory organs, tracheae, and nephridia, and their appendages are of the type seen in the Onychophora and the Tardigrada.

As it would be impossible to place these definitely in any class of arthropods, and since they lack many arthropod features, it seems best to emphasize their differences by treating them as a separate phylum.

*Hemichordata (Branchiotremata, Adelochorda).* Nearly all recent classifications recognize a phylum Hemichordata that includes the Enteropneusta, the Pterobranchia, and perhaps such other groups as the Graptozoa. A good example of this is Hyman (1959). It is difficult to understand this grouping when every attempt at definition consists primarily of variable or relative characters. The components are so distinct that Hyman can only discuss them separately. Almost none of her statements apply throughout the phylum.

In this situation we only obscure the

diversity and the differences by pretending that they can be included in one phylum. Besides the Enteropneusta and the Pterobranchia, there have been placed here also the Planctosphaeroidea, the Phoronida, and the Graptozoa. The latter two have already been accepted as distinct phyla in a previous part of this classification (following many other classifications). The Planctosphaeroidea, consisting of certain ciliated larvae of unknown affinities, cannot be associated with any known adults. It is therefore impossible to combine them confidently with any phylum. It seems necessary to maintain them as a distinct group at the present time.

*Chordata.* It is now more than seventy-five years since the vertebrates and some supposed relatives were first combined under this name. Nearly all subsequent classifications have accepted this arrangement, although the included groups vary somewhat. At the extreme the Chordata have included the Hemichordata, Tunicata, and Cephalochordata, as well as the Vertebrata.

The inclusion of the Hemichordata is unequivocally rejected by Hyman (1959) and others. The arguments seem to be well founded, involving the absence of any substantial similarity in major features.

The Tunicata, included in the Chordata as a matter of course in many works, are excluded here because the similarities appear to be far outweighed by the differences between tunicates and vertebrates. Even if an homologous notochord be present, even if perforations of the tracheal walls do occur, the extreme differences in arrangement of the digestive tract, the absence of paired structures in tunicates, the presence of the tunic and the substance tunicin in tunicates, the reversible blood flow in tunicates, and so on, all seem to deny a similarity so close as to justify inclusion in one phylum. With the tunicates included, the Chordata are extremely difficult to define effectively, except on the two features of notochord and pharyngotremy. With the tunicates excluded, the list of features held in common by the remaining groups is considerably increased.

The Cephalochordata can much more reasonably be united with the vertebrates. Nevertheless, the oral hood, the atrial system, the brown funnel, the multiple paired solenocytic nephridia, the single-layered epidermis, the peculiar liver-pouch, the absence of a heart, the multiple ductless gonads, and other features seem to show that the group is "more widely separated from the lowest fish than the lowest fish from a bird or mammal" (Parker & Haswell, 1897). It seems appropriate to recognize these substantial differences at the phylum level.

The use of the name Chordata for the restricted concept seems to be unnecessary as well as inappropriate. The name is younger and less well known than Vertebrata. It would seem to be an unnecessary name, based on overemphasis on a very few features held in common by the groups involved. At the most it might be considered to be a sort of "superphylum," but even thus it could reasonably include only the Cephalochordata and the Vertebrata.

## Sources of class and order arrangements

*Protozoa.* The five classes of Protozoa are almost universally agreed upon in recent works. The use of the subphyla is not so widespread. Protociliata may be considered to belong in the Plasmodroma rather than in the Ciliophora, being there treated as a separate class. Suctoria are sometimes united with Ciliata as a subclass. Telosporidia (Amoebosporidia) are sometimes separated from Sporozoa as a third subphylum.

This is the classification of Kudo (1954) except for: 1] the elevation of Haplosporidia and Sarcosporidia to subclass level, following Hyman (1940); and 2] a few cases of different choice from available synonyms.

*Porifera.* Three classes are recognized in most recent works, including the Treatise of Invertebrate Paleontology (E, 1955), but most paleontology books list also the Receptaculitida as *incertae sedis.* Inasmuch as it cannot be justified in any of the three classes, it must stand as a separate class. (The Nidulitida are now thought to be algae rather than sponges, and the Pleospongea are treated as a separate phylum).

Many works divide each of the three classes into subclasses. In some cases these subclasses are based on features now believed to be of minor importance or taxonomic value, and the view of de Laubenfels is here adopted that subclasses do not add effectively to the classification of this group. Aside from this, the arrangement here adopted is substantially that of both Hyman and the Treatise (E).

*Cyathospongia.* The status and subdivisions of this extinct phylum are taken from Okulitch in the Treatise (E, 1955). The oldest of the three names for the phylum is accepted here. (Archaeocyatha remains as a class).

*Mesozoa.* In adopting this phylum most of the views of Hyman (1940) are accepted, except that the two orders are deemed to be amply distinct in basic development and histology to be treated as classes. This is the arrangement of Lankester (1901). It is also believed that Lankester was justified in separating the Heterocyemida from the other Dicyemida, and they are accordingly given ordinal rank; for this class the name Rhombozoa is available.

*Monoblastozoa.* (See remarks under Phyla, above.)

*Graptozoa.* The orders are taken from the Treatise (V, 1955).

*Conularida.* This arrangement is taken from the Treatise (F, 1956), but the treatment as a phylum is new here (see remarks under Phyla, above).

*Coelenterata.* The classification of the classes of this phylum adopted here is the usual one except for two features: 1] two extinct classes are added, and 2] one group often listed as an order or subclass is given class rank. The first two classes are dealt with as in the Treatise (F). The third one requires discussion here.

Stromatoporoidea. This group has recently been included in the Hydrozoa. The principal arguments in favor of this seem to be that there are other Hydrozoa showing some of the same peculiar colonial features. It appears that this is an argument for re-examining these other groups (such as Spongiomorphida), because their preserved hard-parts show few features of Recent Hydrozoa. It seems best to emphasize the considerable structural differences between stromatoporoids and typical hydrozoans by not merging them in one class.

The only reasons that can be given for retaining the stromatoporoids in the Coelenterata while removing the graptolites from that phylum are that the graptolites form a somewhat more distinct group and that the recent extreme divergence in views on their position in the Animal Kingdom lend credence to their more isolated position. Retention of the stromatoporoids does not at present alter the definition of the Hydrozoa.

The orders of Stromatoporoidea are accepted from Shrock & Twenhofel (1953) after Kuhn (1939). Other recent works divide the group into families, using no orders. The orders of Hydrozoa are those of Hyman (1940) plus the extinct Spongiomorphida. The orders of Scyphozoa are those of Hyman (1940) plus the extinct Lithorhizostomeae, being thus those listed in the Treatise (F) after the removal of the Conularida. The orders of Anthozoa are those of the Treatise, and they are those of Hyman (1940) except for the Ceriantipatharia and the extinct orders.

*Ctenophora.* The classification of Hyman (1940) is accepted both as to classes and orders. Nearly all recent works agree on this arrangement.

*Platyhelminthes.* Three classes are generally recognized here, but the most recent monographic work on the tapeworms (Wardle & McLeod, 1952) seems to justify the recognition of the Cestodaria as a class distinct from the Cestoda. Hyman (1951) included these in the Cestoda as a subclass, but she found them sufficiently distinct to require separate treatment in all respects from the rest of the tapeworms (Eucestoda).

At one time the Temnocephaloidea were treated as a class intermediate between Turbellaria and Trematoda. Although it has been claimed that this arrangement is now abandoned by all workers, it does reappear in Dawes' (1946) monographic study of the Trematoda. In deference to Hyman's studies on the Turbellaria, the group is herein placed in the Turbellaria as a suborder of Rhabdocoela.

The orders of Trematoda are taken from Dawes (1946), of Cestoda and Cestodaria from Wardle & McLeod (1952), and of Turbellaria from Hyman (1951).

*Rhynchocoela.* Many recent works have divided this phylum into two classes, the Enopla and the Anopla. While accepting this subdivision, Hyman (1951) considers "the great similarity of structure throughout the phylum" as reason for not making these two groups classes. She therefore lists them as subclasses, there being no class mentioned. There is no rule preventing the subdivision of a phylum directly into subclasses, but it is unfamiliar and disconcerting.

The features cited by Hyman as distinguishing the two subclasses seem to be no more fundamental than those used for

distinguishing the orders. It is therefore here considered preferable to consider the nemertines as consisting of a single class of four orders. (The orders are those cited by Hyman, 1951.)

Inasmuch as there are two well-known names available for this one-class phylum, it seems reasonable to retain one for the phylum and the other for the class. There is little reason to choose either way, but Hyman's argument that Schultze (1850–51) was the "zoologist who first clearly understood the group" may be used as justification for adopting Schultze's name, Rhynchocoela, for the phylum.

*Acanthocephala.* This is another one-class phylum, for which no class names are available. The orders are listed as in Hyman (1951).

*Rotifera.* The decision made above, not to employ the Aschelminthes for six groups of pseudocoelomate animals, results in elevation of these six groups to phyla. This raises the question of whether the orders of the former class Rotifera should be raised to classes. This has been done by some classifiers, but there is considerable hesitation to doing so here. The Seisonidea appear from Hyman's remarks to be sufficiently distinct to be considered a separate class, but it is not so clear that Bdelloidea and Monogononta can be distinguished by equally fundamental characters. In this dilemma, the three groups are tentatively treated as classes, with the three groups within the Monogononta treated as orders.

*Gastrotricha.* The differences between the two groups of gastrotrichs, as described by Hyman, including the protonephridia, pharyngeal pores, and the body cavity subdivision, appear to justify the elevation of the two groups to the level of classes. Each then consists of a single order.

*Kinorhyncha.* Although this group is here considered to be a distinct phylum rather than a class of Aschelminthes, there seems to be no reason for not following Hyman (1951) in considering its subdivisions as of less than ordinal rank. The characters distinguishing the three subdivisions are principally matters of degree, including no fundamental clear-cut distinctions.

As the phylum must contain at least one class, there seems to be no reason for not using the name Echinodera at this level. It remains effectively a synonym of Kinorhyncha.

*Priapuloidea.* The three known species belong to two genera. There appears to be no basis for separating these at the ordinal level (Hyman, 1951), and therefore there is a single class with one order.

*Nematoda.* Although the treatment of this group as a phylum differs from Hyman's (1951) treatment of it as a class of Aschelminthes, her view is accepted that there are no subdivisions worthy of rank above the ordinal level. The single class can be distinguished from the phylum by the older but less familiar spelling Nematoidea.

*Gordiacea.* There appears to be little of basic nature in the differences between the Gordioidea and the Nectonematoidea. Hyman (1951) is therefore followed in placing these as orders, although in the status of the group as a whole a different view is adopted (see Aschelminthes, above).

*Calyssozoa / Endoprocta.* A single class and order make up this phylum, and the only questions which arise are about the names to be used. The order has been called Pedicellinida by Boettger (1952), the name Entoprocta or Endoprocta has generally been used for the class, and the first name proposed for the phylum is Calyssozoa of Clark (1921). It seems least confusing to accept these rather than duplicate one name at several levels. (The spelling Endoprocta is here preferred over Entoprocta because of its greater difference from Ectoprocta.

*Bryozoa.* Hyman's (1959) division of this phylum into two classes with six orders, following many earlier workers, is accepted here, as in most current paleontological works.

The single order of the Phylactolaemata seems to be without a name. The name first used for the group was Lophopoda, abandoned by later workers in favor of Phylactolaemata. It is here revived for the ordinal level.

The argument for replacing Bryozoa with Ectoprocta because of removal of the Endoprocta has been answered above under Coelenterata. Removal of one group is not considered justification for changing the name of a phylum (or other taxon).

*Phoronida.* The two genera seem to belong to a single order, for which there is no special name (Hyman, 1959).

*Brachiopoda.* There appears to be universal agreement as to the division of this

phylum into two classes. Six pairs of names have been proposed for these classes, of which Inarticulata and Articulata are favored in most recent works. The Inarticulata are usually divided into two orders, and the Articulata were formerly divided into two or three orders. There is no general agreement on the orders of Articulata, and the opinion of Hyman (1959) and others that there is no satisfactory classification is accepted here. However, one of the older orders is still acceptable to paleontologists, and there is no satisfactory method for combining the remaining two. The older division into three orders is therefore followed, until a clear alternative is available.

*Mollusca.* Only one recent American work is known to list seven classes of Mollusca as is done herein. There is difference of opinion among modern workers only as to the status of the groups sometimes referred to as Isopleura. Many texts have omitted the fossil Monoplacophora and treated the Solenogastres as an *incertae sedis* group. This leaves the Amphineura or Placophora as a fifth class. It also leaves the classification of the phylum incomplete and therefore unsatisfactory.

In volume I of the Treatise of Invertebrate Paleontology, Yonge (1960) discusses the features of these groups and concludes that there are seven classes. This arrangement is followed also in the Traité de Zoologie and is accepted herein.

Monoplacophora. Until 1957 this class was known only as fossils. Its division into three orders is taken from the Treatise (I, 1960).

Amphineura / Polyplacophora. There are three substantially different classifications of this group among recent works. These are: 1] orders Lepidopleurida and Chitonida, by Thiele (1935), etc.; 2] orders Eoplacophora, Mesoplacophora, Isoplacophora, and Teleoplacophora, by Cotton & Godfrey (1940); and 3] orders Paleoloricata and Neoloricata, by Smith (1960). There seems to be little direct correlation between these systems.

Smith's system is ostensibly based on Pilsbry's early classification, modified by paleontological data. It is unfamiliar to neontologists, but it may be readily understood when it is seen that all living chitons are placed in the order Neoloricata (to which many fossil forms belong as well). It is adopted here as the best available classification of a neglected group.

Aplacophora. There appears to be no disagreement on the division of this class into two orders. It is sometimes treated as a subclass or even as an order, of Amphineura or Gastropoda.

Gastropoda. Nearly all recent writers agree on the division of this class into three subclasses, following Thiele (1931). The first, Prosobranchia, has been widely divided into three orders, but Cox (1960) in the Treatise (I), has combined two of these under the new name Caenogastropoda. His new arrangement is followed here, although in other respects Thiele's classification is accepted. A recent classification by Taylor & Sohl (1962) is not followed here because it is not accompanied by justification at the ordinal level.

Bivalvia / Pelecypoda. A considerable variety of classifications are in use for this class, with little obvious correlation of groupings. At the present time it appears best to present the more common arrangement of neontologists and also the customary paleontological one (in the footnotes), until a single scheme has been accepted by both groups of workers. The first of these is the scheme of Lankester (1906) and most later textbooks. The second is the scheme of Cotton & Godfrey (1938) with the orders raised to subclasses as by Cox (1960). (Cox's more numerous orders may represent a more natural arrangement, but it is not yet known whether they will be acceptable to other workers.)

Scaphopoda. Apparently no names are available for the single class and the single order. Therefore, Scaphopoda is here used for all three levels, as they are coextensive.

Cephalopoda. There is little agreement among recent workers as to the subdivision of this class, although many of the subgroups are found in all schemes. The arrangement followed here is that of Cotton & Godfrey (1940) and many of the older textbooks. The numerous nautiloid "orders" of Flower & Kümmel (1950) are based largely on relative characters and have not been clearly established as entitled to ordinal rank.

*Sipunculoidea.* The ten genera of this phylum are not separated into classes or orders. Separate names are not available for the resulting single class and order.

*Echiuroidea.* This phylum, which has often been placed in or appended to the Annelida, is divided into two classes as in Boettger (1952). The class Echiurida is divided into three orders as in Pearse (1949).

*Myzostomida.* The two orders are accepted from Prenant in the Traité de Zoologie (1959).

*Annelida.* Many recent books list the Polychaeta and Oligochaeta as separate classes. The differences between the two are largely relative, and the two together can be described in detail with few conflicts. For this reason, the two groups are here combined in the class Chaetopoda, as in many of the older works. Their differences may then be brought out at the subclass level.

No really satisfactory classification of this phylum or its classes has been found.

Polychaeta. The usual division into two orders has been followed, with the addition of one extinct order.

Oligochaeta. There being no generally accepted subdivision of this group, the one given without Latin names by Avel (1959) in the Traité (attributed by him to Michaelson, 1930) and without acceptable single names by Pearse (1949) is followed here. The names are emended to conform to custom in Latin nomenclature.

Hirudinea. Division of this class into four orders was proposed by Harant & Grassé (1959) using three orders proposed by Caballero (1952) and adding the "Acanthobdelliformes nom.nov." These names and groupings were not new there, except in ending. Rhynchobdellida dates from Blanchard (1887), Gnathobdellida from Vaillant (1890), and Pharyngobdellida from Johannson (1913). These same four orders were recognized by Lowenstein (1954), using the name Acanthobdellida and using the name Herpobdellida instead of Pharyngobdelliformes.

It is not clear whether these names were independently proposed, but there seems to be no need for the *-iformes* endings here. The four orders are accepted here, the spellings of Caballero and of Harant & Grassé are rejected, and Pharyngobdellida is accepted because of apparent priority.

Archiannelida. There is apparently general agreement that there is only one order in this class. No ordinal name is available.

*Tardigrada.* The division into three orders in two classes is taken from Pearse (1949), after Richters (1926) and Marcus (1927).

*Pentastomida.* The orders are from Boettger (1952).

*Onychophora.* Division of the phylum into two orders is accepted from Boettger (1952) and the Treatise (O, 1959), following earlier writers.

*Arthropoda.* Some recent classifications of this largest of all phyla have been complicated by attempts to include the Pentastomida, Onychophora, and even the Tardigrada. When this is done, the phylum can no longer be defined, because it would include a variety of body cavities, nervous systems, respiratory systems, excretory systems, integuments, etc. With these groups removed, the arthropods can readily be classified into eleven classes, and these can be grouped into three subphyla.

Much of the classification of the Arthropoda above the ordinal level is in an unsettled state. There seems to be no single complete classification that is adequate for both Recent and fossil groups. The one presented here is therefore made up from many sources, most of which are at least in part drawn from earlier sources. Listed below are the recent works that are accepted at each level, but they usually are not the original proposal of the arrangement.

Subphyla are accepted from Pearse (1949), classes in the Trilobitomorpha from the Treatise (O, 1959), in the Chelicerata from Pearse (1949) and Moore (1952), and in the Mandibulata from Pearse (1949) with exclusion of superclasses.

Orders in the Trilobitomorpha are from the Treatise (O, 1959), in the Merostomata from the Treatise (P, 1955), in the Pycnogonida from the Treatise (P, 1955), in the Arachnida from the Treatise (P, 1955) which is the system of Petrunkevitch, in the Crustacea from Waterman & Chace (1960), in the Pauropoda and Symphyla from Brues & Melander (1954), in the Diplopoda from Boettger (1952), in the Chilopoda from Pearse (1949), and in the Insecta from Brues & Melander (1954).

The class Eurypterida consists of a single order, for which the synonym Gigantostraca can reasonably be used.

*Chaetognatha.* This is another of the one-class one-order phyla. Boettger (1952) has used the name Sagittoidea for both class and order, but it seems to be more appropriate to restrict this name to the ordinal level and to use the phylum name also at the class level. The other two synonyms seem to be inappropriate as they were

originally employed in somewhat different context.

*Pogonophora.* This is probably the newest phylum in point of knowledge of the animals themselves, as the first species was described in 1914, and most of the present day knowledge is less than a score of years old. Only one classification has been undertaken, by Ivanov (1955), and his division into two orders is accepted here.

Inasmuch as the synonym Brachiata is not well known for these animals, it has not been used for the one class.

*Echinodermata.* No single satisfactory classification has been found for this varied phylum. The subphyla here accepted (see footnotes) are those of Shrock & Twenhofel (1953). The classes in the Pelmatozoa, Homalozoa, and Haplozoa are those of Shrock & Twenhofel (1953), being extinct except for the Crinoidea; in the Eleutherozoa the scheme of Shrock & Twenhofel is modified according to the views of Hyman (1955) to omit the Stelleroidea and treat Asteroidea and Ophiuroidea as classes. This makes it necessary also to treat as classes the extinct groups Auluroidea and Somasteroidea. This arrangement is admittedly a compromise with more familiar classifications.

This phylum contains a large number of extinct subgroups, and it is difficult to give full attention to the extinct subgroups without confusing the classification of Recent ones. The orders accepted here are as follows: In Pelmatozoa, Homalozoa, and Haplozoa, from Shrock & Twenhofel (1953); in Asteroidea, from Hyman (1955); in Ophiuroidea, from Boettger (1952) except for removal of Auluroidea; in Echinoidea, from Shrock & Twenhofel (1953) for the Regularia and from Hyman (1955) for the Irregularia (except for removal of Bothriocidaroida after Moore *et al.* (1952); and in the Holothurioidea, from Shrock & Twenhofel (1953).

*Pterobranchia.* Many writers agree on dividing the pterobranchs into two groups. The difficulties of describing *Rhabdopleura* and *Cephalodiscus* together leads to skepticism that they should be considered orders rather than classes. In deference to workers in this field, the usual division is adopted, with some misgivings (as in Hyman, 1959).

*Enteropneusta.* Only one class and one order is known in this group. It is sometimes left without a name, but Balanoglossida is available. It is here used for the order, as the phylum name is also familiar at the class level.

*Planctosphaeroidea.* This phylum consists of a single species of what appear to be larvae.

*Tunicata.* There appears to be general agreement on the assignment of the tunicates to three major classes. The subclasses and orders accepted here are those of Pearse (1949) and others, with addition to the Ascidiacea of an order Octacnemida after Harant (1948).

*Cephalochordata.* This group, which is usually included in the Chordata, has at least four available names. Those adopted are the ones most often used at the respective levels.

*Vertebrata.* The restriction of this phylum to the craniates is explained in a previous section. The classes of Vertebrata are taken from Romer (1945) and Colbert (1955). The orders of these classes are taken from these same works, except that Romer is generally followed where he treats as orders the groups which Colbert lists as subclasses or superorders.

# Complete List

| Subk | Series | Phylum | |
|---|---|---|---|
| | | **ANIMALIA** (Zoa) | |
| | | EOZOA (*Plastidozoa*) | |
| | | Protozoa | CAM-REC |
| | | PARAZOA | |
| | | Porifera (*Spongiaria, Spongeae*) | CAM-REC |
| | | Cyathospongia (*Pleospongia, Archaeocyatha*) | CAM |
| | | AGNOTOZOA | |
| | | Mesozoa (*Planuloidea, Mionelminthes, Moruloidea* | REC |
| | | HISTOZOA (*Metazoa, Eumetazoa*) | |
| | | Enterocoela (*Enterozoa, Protaxonia*) | |
| | | Monoblastozoa | REC |
| | | Graptozoa | CAM-MIS |
| | | Conularida | CAM-TRI |
| | | Coelenterata (*Cnidaria, Nematozoa, Nematophora*) | CAM-REC |
| | | Ctenophora (*Acnidaria, Collaria, Ctenarea, Ctenophoraria*) | REC |
| | | Acoelomata | |
| | | Platyhelminthes (*Platodes*) | REC |
| | | Rhynchocoela (*Nemertinea, Aplocoela, Miocoela*) | REC |
| | | Pseudocoelomata (*Pseudocoelia, Autoscolecida, Protonephridozoa*) | |
| | | Acanthocephala | REC |
| | | Rotifera (*Rotatoria*) | REC |
| | | Gastrotricha | REC |
| | | Kinorhyncha (*Echinodera*) | REC |
| | | Priapuloidea | REC |
| | | Nematoda (*Nemata*) | REC |
| | | Gordiacea (*Gordioidea, Nematomorpha*) | CAR-REC |
| | | Calyssozoa (*Entoprocta, Endoprocta, Kamptozoa*) | REC |

# of Phyla[1]

| Subk | Series | Phylum | |
|---|---|---|---|
| | | Coelomata (*Eucoelomata*) | |
| | | Bryozoa (*Polyzoa, Ectoprocta*) | ORD-REC |
| | | Phoronida | REC |
| | | Brachiopoda (*Spirobranchia, Palliobranchiopoda*) | CAM-REC |
| | | Mollusca (*Palliata, Malacozoa, Saccata, Heterogangliata, Otocardia*) | CAM-REC |
| | | Sipunculoidea | REC |
| | | Echiuroidea | REC |
| | | Myzostomida | JUR-REC |
| | | Annelida (*Annulata, Coelhelminthes*) | CAM-REC |
| | | Tardigrada | REC |
| | | Pentastomida (*Linguatulida*) | REC |
| | | Onychophora (*Polypoda, Protracheata, Ceratophora, Malacopoda*) | CAM-REC |
| | | Arthropoda (*Euarthropoda*) | CAM-REC |
| | | Chaetognatha (*Homalopterygia, Oesthelminthes*) | CAM-REC |
| | | Pogonophora (*Brachiata*) | REC |
| | | Echinodermata | CAM-REC |
| | | Pterobranchia | ORD-REC |
| | | Enteropneusta (*Helminthomorpha*) | REC |
| | | Planctosphaeroidea | REC |
| | | Tunicata (*Urochordata*) | REC |
| | | Cephalochordata (*Acrania, Cirrhostomi, Entomocrania, Haplocyemata, Homomeria, Myelozoa, Pharyngobranchii*) | REC |
| | | Vertebrata (*Euchorda, Craniata*) | ORD-REC |

[1] For explanations, see preceding section.

# Complete List of Classes and Orders

## with Synonyms, Subgroups, and Geologic Range

| Class | Subcl | Order | |
|---|---|---|---|
| **PROTOZOA**[1] | | | |
| FLAGELLATA[2] (*Mastigophora*) | | | SIL-REC |
| | Phytomastigina[3] (*Phytomastigophorea*) | | SIL-REC |
| | | Chrysomonadina (*Silicoflagellata, Chrysomonadaceae*) | CRE-REC |
| | | Coccolithophorida | SIL-REC |
| | | Cryptomonadina (*Cryptomonadaceae*) | REC |
| | | Phytomonadina (*Volvocales, Volvocina, Volvocaceae*) | EOC-REC |
| | | Euglenoidina (*Euglenida, Euglenaceae*) | EOC-REC |
| | | Chloromonadina (*Chloromonadaceae*) | REC |
| | | Dinoflagellata[4] (*Cilioflagellata, Catenata*) | JUR-REC |
| | Zoomastigina[5] (*Zoomastigophorea*) | | REC |
| | | Rhizomastigina (*Pantostomatida, Rhizomastigaceae Rhizoflagellata*) | REC |
| | | Protomonadina (*Protomastigida, Protomastigaceae*) | REC |
| | | Polymastigina | REC |
| | | Hypermastigina (*Holomastigina*) | REC |
| SARCODINA | | | CAM-REC |
| | Rhizopoda[6] | | ORD-REC |
| | | Proteomyxa | REC |

[1] *Synonyms:* Eozoa, Plastidozoa. *Subphyla:* Plasmodroma (Homokaryota, Gymnomyxa, Cytomorpha) = FLAGELLATA + SARCODINA + SPOROZOA. Ciliophora (Infusoria, Heterokaryota, Cytoidea) = CILIATA + SUCTORIA. *Includes:* Corticata (FLAGELLATA + SPOROZOA + CILIOPHORA).

[2] *Includes:* Lissoflagellata, Monadidea, Heteromastigina, Chromomonadina, Choanoflagellata, Craspedomonadina, Phalansteriina, Phytoflagellata, Chlamydomonadina, Euflagellata.

[3] *Includes:* Heterochlorida.

[4] *Includes:* Prorocentraceae, Adinida, Peridiniaceae, Gymnodiniaceae, Diniferidea, Cystoflagellata, Rhynchoflagellata.

[5] *Includes:* Trichomonadida.

[6] *Includes:* Labyrinthulidea, Lobosa, Filosa.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Mycetozoa [7] (*Myxomycetes, Myxogasteres*) | REC |
| | | Amoebozoa (*Amoebina, Amoebaea, Nuda, Gymnamoebaea*) | REC |
| | | Testacea (*Thecamoebae*) | EOC-REC |
| | | Foraminifera [8] (*Reticularia, Polythalamia, Thalamophora*) | ORD-REC |
| | Actinopoda | | CAM-REC |
| | | Heliozoa [9] | PLE-REC |
| | | Radiolaria [10] (*Polycystina, Cytophora, Echinocystida*) | CAM-REC |
| SPOROZOA [11] (*Gregarina*) | | | REC |
| | Telosporidia [12] (*Cytosporidia, Ectospora, Amoebosporidea*) | | REC |
| | | Gregarinida [13] | REC |
| | | Coccidia [14] (*Coccidiomorpha*) | REC |
| | | Haemosporidia [15] (*Haemocytozoa, Acystosporidia, Gymnosporidia*) | REC |
| | Cnidosporidia | | REC |
| | | Myxosporidia (*Amoebogeniae*) | REC |
| | | Actinomyxidia | REC |
| | | Microsporidia | REC |
| | | Helicosporidia | REC |
| | Sarcosporidia (*Sarcocystidea*) | | REC |
| | | Sarcosporidia | REC |
| | | Globidia | REC |
| | Haplosporidia (*Aplosporidia*) | | REC |
| | | Haplosporidia | REC |

[7] *Includes:* Euplasmodida, Eumycetozoa, Sorophora, Acrasiae, Amaurochaetaceae, Amaurochaetineae, Amaurosporales, Anemineae, Arcyriaceae, Calcarineae, Calonemineae, Ceratiomyxaceae, Dictyosteliaceae, Didymiaceae, Endosporeae, Exosporae, Guttulinaceae, Heterodermaceae, Lamprosporales, Liceaceae, Lygogalaceae, Margaritaceae, Physaraceae, Reticulariaceae, Stemonitaceae, Trichiaceae, Tubulinaceae.

[8] *Includes:* Allogromidiaceae, Astrorhizidea, Cheilostomellaceae, Chilostomellidea, Globigerinidea, Gromiidea, Lagenidea, Lituolidea, Miliolidia, Nummulitidea, Rotalidea, Textularidea, Xenophyophoridea.

[9] *Includes:* Actinophrydea, Aphrothoraca, Centrohelidia, Chalarothoraca, Chlamydophora, Desmothoraca, Helioflagellida.

[10] *Includes:* Acantharia, Acanthometrida, Acanthophractida, Actipylaea, Cyrtellaria, Botryoidea, Cyrtoidea, Spyroidea, Monopylaria, Nasselaria, Osculosida, Merotrypasta, Peripylaria, Spumellaria, Collodaria, Sphaerellaria, Sphaerozoa, Plectellaria, Plectoidea, Stephoidea, Porulosida, Holotrypasta, Tripylaria, Phaeodaria, Phaeoconchia, Phaeocystina, Tripylaea, Phaeogromia, Phaeosphaeria).

[11] Neosporidea (Histosporidia, Endospora) = CNIDOSPORIDIA + SARCOSPORIDIA + HAPLOSPORIDIA. Acnidosporidia = SARCOSPORIDIA + HAPLOSPORIDIA.

| Class | Subcl | Order | |
|---|---|---|---|
| CILIATA | | | JUR-REC |
| | Protociliata (*Ciliatoidea*) | | REC |
| | | Opalinida | REC |
| | Euciliata | | JUR-REC |
| | | Holotricha [16] (*Aspirigera, Aspirotricha*) | REC |
| | | Spirotricha [17] (*Spirigera*) | JUR-REC |
| | | Chonotricha | REC |
| | | Peritricha | REC |
| SUCTORIA (*Acineta, Acinetaria, Tentaculifera*) | | | REC |
| | | Suctoria | REC |

## PORIFERA [18]

| | | |
|---|---|---|
| CALCAREA [19] (*Calcispongea*) | | CAM-REC |
| | Solenida (*Asconosa*) | CAM-REC |
| | Lebetida (*Syconosa*) | JUR-REC |
| | Pharetronida | PER-REC |
| | Thalamida (*Sphinctozoa*) | PEN-CRE |
| HYALOSPONGEA [20] (*Hexactinellida, Triaxonida*) | | CAM-REC |
| | Lyssakina (*Lyssacina*) | CAM-REC |
| | Dictyonina (*Dictyida, Inermia*) | ORD-REC |
| | Lychniskophora (*Lychniskida*) | JUR-REC |
| | Heteractinida | CAM-CAR |
| DEMOSPONGEA [21] (*Desmospongea*) | | CAM-REC |
| | Myxospongida | REC |
| | Keratosida [22] (*Ceratospongida, Ceratosa, Ceratosida, Euceratosa*) | CAR-REC |

[12] *Includes:* Rhabdogeniae, Serosporidia, Exosporidia, Piroplasmidea.

[13] *Includes:* Eugregarinida, Schizogregarinida.

[14] *Includes:* Adeleida, Eimeriida.

[15] *Includes:* Babesiida, Plasmodiida.

[16] *Includes:* Apostomina, Aspirotrichaceae, Astomata, Astomina, Gymnostomata, Hymenostomata, Thigmotrichina, Trichostomata.

[17] *Includes:* Ctenostomina, Entodiniomorphina, Heterotricha, Hypotricha, Oligotrichina, Polytricha, Tintinnina.

[18] *Synonyms:* Spongiaria, Spongeae. *Includes:* Octactinellida, Heteractinellida. Silicospongiae (Non-calcarea) = HEXACTINELLIDA + DEMOSPONGEA. Nidulitida, sometimes included here, is probably a calcareous alga.

[19] Asconosa, Syconosa, Leuconosa are structural types, not groups. *Includes:* Sycones, Dialytina, Lithonina, Homocoelida, Heterocoelida.

[20] *Includes:* Hexasterophora, Amphidiscophora, Uncinataria.

[21] *Includes:* Tetractinellida, Tetraxonida, Desmophora, Monaxonida, Sigmatomonaxonellida, Monactinellida.

[22] Considered by some to belong to Hadromerida. Sometimes placed with some others of Demospongea as Cornacuspongia (with orders Protorhabdina, Poikilorhabdina, Phthinorhabdina, Aporhabdina). *Includes:* Dictyoceratina, Monoceratina, Dendroceratina, Hexaceratina.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Haplosclerida | CAM-REC |
| | | Poecilosclerida | CAM-REC |
| | | Hadromerida (*Astromonaxonellida*) | CAM-REC |
| | | Halichondrida | REC |
| | | Epipolasida | CAM-REC |
| | | Choristida (*Astrophora, Sigmatophora*) | CAR-REC |
| | | Carnosida (*Homosclerophora, Microsclerophora*) | CAR-REC |
| | | Lithistida | CAM-REC |
| | | RECEPTACULITIDA [23] | ORD-DEV |
| | | Receptaculitida | ORD-DEV |

## CYATHOSPONGIA [24]

| | | | |
|---|---|---|---|
| | | MONOCYATHA | CAM |
| | | Monocyathida | CAM |
| | | Archaeophyllida | CAM |
| | | ARCHAEOCYATHA | CAM |
| | | Ajacicyathida | CAM |
| | | Metacyathida | CAM |
| | | Acanthinocyathida | CAM |
| | | Hetairacyathida | CAM |
| | | Syringocnemida | CAM |
| | | ANTHOCYATHA | CAM |
| | | Anthomorphida | CAM |
| | | Somphocyathida | CAM |

## MESOZOA [25]

| | | | |
|---|---|---|---|
| | | RHOMBOZOA | REC |
| | | Dicyemida | REC |
| | | Heterocyemida | REC |
| | | ORTHONECTIDA | REC |
| | | Orthonectida | REC |

## MONOBLASTOZOA

| | | | |
|---|---|---|---|
| | | MONOBLASTOIDEA | REC |
| | | Monoblastidea | REC |

[23] *Affinities unknown; may not belong to Porifera.*

[24] *Includes:* Acanthocyatha, Uranocyatha, Exocyatha. *Synonyms:* Pleospongia.

[25] *Synonyms:* Planuloidea, Mionelminthes, Moruloidea. Catenata are now considered to be parasitic dinoflagellates (Protozoa).

[26] *Includes:* Rhabdophora, Retioloidea. Acanthaspida, Acanthistida, Graptoblasti, Graptovermida are groups of uncertain status.

## GRAPTOZOA[26]

| | |
|---|---|
| GRAPTOLITHIDA | CAM-MIS |
| Dendroidea | CAM-MIS |
| Graptoloidea | ORD-SIL |
| Tuboidea | ORD-SIL |
| Camaroidea | ORD |
| Stolonoidea | ORD |

## CONULARIDA

| | |
|---|---|
| CONULATA | CAM-TRI |
| Conulariida | CAM-TRI |

## COELENTERATA[27]

| | |
|---|---|
| PROTOMEDUSAE | CAM-ORD |
| Brooksellida | CAM-ORD |
| DIPLEUROZOA | CAM |
| Dickinsoniida | CAM |
| STROMATOPOROIDEA | CAM-CRE |
| Stromatoporidea | CAM-CRE |
| Labechioidea | ORD-CRE |
| Sphaeractinoidea | JUR-CRE |
| HYDROZOA[28] (*Anoecia, Ectocarpen, Aphacellae, Hydrozoaria*) | CAM-REC |
| Trachylinida[29] | JUR-REC |
| Hydroida[30] (*Nudibrachiata, Polypiaria, Hydrida, Hydrariae, Diplomorpha*) | CAM-REC |
| Spongiomorphida | TRI-JUR |
| Milleporida (*Hydrocorallinae*) | CRE-REC |
| Stylasterina | CRE-REC |
| Siphonophora[31] | ORD-REC |

[27] *Synonyms:* Cnidaria, Nematozoa, Nematophora.
[28] *Includes:* Eleutheroblastea, Hydromedusae.
[29] *Includes:* Trachymedusae, Trachomedusae, Narcomedusae.
[30] *Includes:* Anthomedusae, Athecata, Gymnoblastea, Leptomedusae, Thecata, Thecaphora, Calyptoblastea, Leptolinae, Sertularina, Campanulariae, Tubulariae.
[31] *Includes:* Calycophora, Physophora, Chondrophora.

| Class | Subcl | Order | |
|---|---|---|---|
| SCYPHOZOA [32] (*Scyphomedusae, Acalephae, Neoscyphozoa, Acraspeda*) | | | JUR-REC |
| | | Stauromedusae (*Lucernaria, Lucernariidea, Cyclicozoa, Calycozoa*) | REC |
| | | Cubomedusae (*Carybdeida, Charybdeida, Marsupialia*) | JUR-REC |
| | | Coronatae (*Peromedusae, Corona, Coronatida*) | JUR-REC |
| | | Semaeostomeae (*Semostomeae, Semaeostomatida*) | JUR-REC |
| | | Lithorhizostomeae (*Lithorhizostomatida*) | JUR |
| | | Rhizostomeae (Rhizostomatida) | JUR-REC |
| ANTHOZOA (*Endoaria, Actinozoa, Actinoidea, Oecioa, Polycyclia, Corallaria, Monocyclica, Coralligena, Coralla, Scyphopolypi, Anthozoariae*) | | | CAM-REC |
| | Alcyonaria [33] (*Octocorallia, Octactinia, Zoophytaria*) | | PER-REC |
| | | Stolonifera | CRE-REC |
| | | Telestacea | REC |
| | | Alcyonacea | JUR-REC |
| | | Trachypsammiacea | PER |
| | | Coenothecalia | CRE-REC |
| | | Gorgonacea | CRE-REC |
| | | Pennatulacea | CRE-REC |
| | Zoantharia [34] (*Hexacorallia, Helianthoida, Zoanthactiniaria, Actinanthida, Dodecacorallia, Zoantha*) | | CAM-REC |
| | | Zoanthiniaria (*Zoanthidea*) | REC |
| | | Corallimorpharia (*Stichodactylina, Asclerocorallia*) | REC |
| | | Actiniaria (*Actiniidea, Malacactiniae, Edwardsiidea*) | CAM-REC |
| | | Rugosa (*Stauracea, Pterocorallia, Tetraseptata, Tetracoelia, Tetracorallia*) | ORD-PER |
| | | Heterocorallia (*Dicoelia*) | CAR |
| | | Scleractinia (*Madreporaria, Polyactinia, Cyclocorallia*) | TRI-REC |
| | | Tabulata (*Aseptata, Trichocorallia, Tubulosa, Tetradida, Schizocoralla, Heliolitida, Multisolenida, Thallocoralla, Chaetetida*) | ORD-PER |

[32] Discomedusae (Discophora) = CORONATAE + SEMAEOSTOMEAE + RHIZOSTOMEAE.

[33] *Includes:* Pseudaxonia, Axifera, Stelechotokea, Protalcyonacea, Synalcyonacea.

[34] *Includes:* Paramera, Cryptoparamera, Ptychodactiaria, Proactiniae.

[35] *Synonyms:* Acnidaria, Collaria, Ctenophoraria, Ctenarea.

[36] *Synonyms:* Platodes, Platyelmia, Plathelminthes, Platyhelmia. Cestoidea = CESTODA + CESTODARIA.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Ceriantipatharia | MIO-REC |
| | | Antipatharia (*Hexactinia, Anticorallia, Antipathidea*) | MIO-REC |
| | | Ceriantharia (*Paranemata, Tetractiniae, Heterocoralla, Cerianthiae, Cerianthidea*) | REC |

## CTENOPHORA[35]

| | |
|---|---|
| TENTACULATA (*Micropharyngea*) | REC |
| Cydippida (*Saccata*) | REC |
| Lobata (*Bolinopsidea*) | REC |
| Cestida (*Cestoidea*) | REC |
| Platyctenea (*Tjalfiellidea, Ctenoplanidea*) | REC |
| NUDA (*Macropharyngea, Atentaculata*) | REC |
| Beroida | REC |

## PLATYHELMINTHES[36]

| | |
|---|---|
| TURBELLARIA (*Planaria*) | REC |
| Acoela | REC |
| Rhabdocoela[37] | REC |
| Alloeocoela (*Alloiocoela*) | REC |
| Tricladida | REC |
| Polycladida (*Cryptocoela*) | REC |
| TREMATODA | REC |
| Monogenea[38] (*Monogenetica, Heterocotylea, Heterocotylea, Herocotylida, Polystomea, Pectobothrii, Cryptocoela, Ectoparasitica*) | REC |
| Aspidogastrea (*Aspidobothria, Aspidocotylea*) | REC |
| Digenea[39] (*Digenetica, Malacocotylea, Distomea, Malacobothrii, Strigeata*) | REC |
| CESTODA[40] (*Eucestoda, Cestoidea, Merozoa, Polyzoa, Tomiosoma*) | REC |
| Proteocephala (*Proteocephaloidea*) | REC |
| Tetraphyllidea (*Phyllobothrioidea*) | REC |
| Disculicepitidea | REC |
| Lecanicephala (*Lecanicephaloidea, Diphyllidea*) | REC |

[37] *Includes:* Temnocephaloidea, Dactylifera, Catenulida, Macrostomida.

[38] *Includes:* Monopisthocotylea, Polyopisthocotylea.

[39] *Includes:* Gasterostoma, Prosostomata.

[40] *Includes:* Aphylles, Monophyllidea, Heterophyllidea, Cystica, Caryophyllacea.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Trypanorhyncha (*Tetrarhyncha, Tetrarhynchoidea, Phyllorhyncha*) | REC |
| | | Cyclophyllidea (*Taenioidea, Tetracotylea, Tetrabothridiata*) | REC |
| | | Aporidea | REC |
| | | Nippotaeniidea | REC |
| | | Caryophyllidea | REC |
| | | Spathebothridea | REC |
| | | Pseudophyllidea (*Bothriocephaloidea, Dicestoda, Dibothridiata*) | REC |
| CESTODARIA (*Monozoa, Atomiosoma*) | | | REC |
| | | Amphilinidea | REC |
| | | Gyrocotylidea | REC |
| | | Biporophyllidea | REC |

## RHYNCHOCOELA[41]

| | | | |
|---|---|---|---|
| NEMERTINEA[42] (*Nemertea*) | | | REC |
| | | Palaeonemertea (*Paleonemertea, Palaeonemertini*) | REC |
| | | Heteronemertea (*Schizonemertini, Trimyaria, Eupolida*) | REC |
| | | Hoplonemertea (*Metanemertini*) | REC |
| | | Bdellonemertea (*Bdellomorpha*) | REC |

## ACANTHOCEPHALA

| | | | |
|---|---|---|---|
| ACANTHOCEPHALA[43] | | | REC |
| | | Archiacanthocephala | REC |
| | | Palaeacanthocephala | REC |
| | | Eoacanthocephala[44] | REC |

## ROTIFERA[45]

| | | | |
|---|---|---|---|
| SEISONIDEA | | | REC |
| | | Seisonacea | REC |
| BDELLOIDEA | | | REC |
| | | Bdellacea (*Bdelloidaceae*) | REC |

[41] *Synonyms:* Aplocoela, Miocoela.
[42] *Includes:* Dimyaria, Protonemertini, Mesonemertini, Anopla, Enopla.
[43] Metacanthocephala = ARCHIACANTHOCEPHALA + PALAEACANTHOCEPHALA
[44] *Includes:* Gyracanthocephala, Neoacanthocephala.
[45] *Synonyms:* Rotatoria. Digononta = SEISONIDEA + BDELLOIDEA.
[46] *Includes:* Rhizota.

| Class | Subcl | Order | |
|---|---|---|---|
| MONOGONONTA [46] | | | REC |
| | | Ploima [47] (*Ploimoidaceae*) | REC |
| | | Floscullariacea [48] | REC |
| | | Collothecacea | REC |

## GASTROTRICHA

| | | | |
|---|---|---|---|
| MACRODASYOIDEA | | | REC |
| | | Macrodasyidea | REC |
| CHAETONOTOIDEA | | | REC |
| | | Chaetonotidea | REC |

## KINORHYNCHA

| | | | |
|---|---|---|---|
| ECHINODERA | | | REC |
| | | Echinodera [49] | REC |

## PRIAPULOIDEA

| | | | |
|---|---|---|---|
| PRIAPULOIDEA | | | REC |
| | | Priapulida | REC |

## NEMATODA [50]

| | | | |
|---|---|---|---|
| NEMATOIDEA | | | REC |
| | | Enoploidea (*Enoplata*) | REC |
| | | Dorylaimoidea | REC |
| | | Mermithoidea | REC |
| | | Chromadoroidea [51] | REC |
| | | Araeolaimoidea | REC |
| | | Monhysteroidea | REC |
| | | Desmoscolecoidea | REC |
| | | Rhabditoidea (*Anguilluloidea*) | REC |
| | | Rhabdiasoidea | REC |

[47] *Includes:* Notommatoidea, Brachionoidea, Asplanchnaceae, Loricata, Illoricata.

[48] *Includes:* Scirtopoda, Trochosphaerida, Melicertida.

[49] *Includes:* Cyclorhaga, Conchorhaga, Homalorhaga, as suborders.

[50] *Synonym:* Nemata. *Includes:* Hologonia, Telogonia, Phasmidia, Aphasmidia.

[51] *Includes:* Chaetosomatida.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Oxyuroidea | REC |
| | | Ascaroidea | REC |
| | | Strongyloidea | REC |
| | | Spiruroidea (*Camallanta*) | REC |
| | | Dracunculoidea | REC |
| | | Filarioidea | REC |
| | | Trichuroidea (*Trichinelloidea*) | REC |
| | | Dioctophymoidea | REC |

## GORDIACEA

| | | | |
|---|---|---|---|
| | | NEMATOMORPHA | CAR-REC |
| | | Gordioidea (*Gordididea*) | CAR-REC |
| | | Nectonematoidea | REC |

## CALYSSOZOA[52]

| | | | |
|---|---|---|---|
| | | ENDOPROCTA (*Entoprocta*) | REC |
| | | Pedicellinida | REC |

## BRYOZOA[53]

| | | | |
|---|---|---|---|
| | | PHYLACTOLAEMATA (*Hippocrepia*) | CRE-REC |
| | | Lophopoda | CRE-REC |
| | | GYMNOLAEMATA[54] (*Stelmatopoda*) | ORD-REC |
| | | Trepostomata (*Tripostomata, Monticuliporoidea*) | ORD-PER |
| | | Cryptostomata | ORD-PER |
| | | Cyclostomata (*Stenostomata*) | ORD-REC |
| | | Ctenostomata | ORD-REC |
| | | Cheilostomata (*Chilostomata*) | CRE-REC |

## PHORONIDA

| | | | |
|---|---|---|---|
| | | PHORONIDA | REC |
| | | Phoronida | REC |

[52] *Synonyms:* Kamptozoa (see also class names).

[53] *Synonyms:* Polyzoa, Ectoprocta. Formerly included also Endoprocta; together called also Holobranchia.

[54] Stenolaemata = TREPOSTOMATA + CYCLOSTOMATA. Cheiloctenostoma (Eurystomata) = CTENOSTOMATA + CHEILOSTOMATA.

[55] *Synonyms:* Spirobranchiopoda, Palliobranchiopoda, Branchiopoda, Brachionopoda, Brachionocephala, Branchionobranchia, Spirobranchia.

[56] *Includes:* Orthida, Strophomenida.

[57] *Includes:* Pentamerida, Rhynchonellida, Spiriferida, Terebratulida, Triplesiida.

[58] *Synonyms:* Palliata, Malacozoa, Heterogangliata, Otocardia, Saccata. Glossophora (Cephalophora) = AMPHINEURA + GASTROPODA + CEPHALOPODA + SCA-

## BRACHIOPODA [55]

| | |
|---|---|
| INARTICULATA (*Ecardines, Lyopomata, Pleuropygia, Gastrocaulia, Tretenterata, Sarcobranchiata*) | CAM-REC |
| Atremata | CAM-REC |
| Neotremata | CAM-REC |
| ARTICULATA (*Testicardines, Arthropomata, Apygia, Pygocaulia, Clistenterata*) | CAM-REC |
| Palaeotremata (*Paleotremata*) | CAM |
| Protremata [56] | CAM-REC |
| Telotremata [57] | CAM-REC |

## MOLLUSCA [58]

| | |
|---|---|
| MONOPLACOPHORA [59] (*Protogastropoda, Amphigastropoda*) | CAM-REC |
| Tryblidioidea (*Tryblidiacea*) | CAM-REC |
| Archinacelloidea | CAM-SIL |
| Cambridioidea | CAM |
| AMPHINEURA [60] (*Aculifera, Polyplacophora, Loricata, Crepipoda, Polyplakiphora, Polyplaxiphora, Placophora, Polybranchiata, Lamellata, Lepidoglossa*) | CAM-REC |
| Paleoloricata | CAM-CRE |
| Neoloricata | CAR-REC |
| APLACOPHORA (*Solenogastres, Telobranchia, Scolecomorpha*) | REC |
| Neomeniida (*Neomeniomorpha*) | REC |
| Chaetodermatida (*Chaetodermomorpha*) | REC |
| GASTROPODA [61] (*Anisopleura, Paracephalophora, Pselaphocephala*) | CAM-REC |
| Prosobranchia (*Streptoneura, Cochlides*) | CAM-REC |
| Archaeogastropoda [62] | CAM-REC |

PHOPODA. Stenolaemata = AMPHINEURA + GASTROPODA + BIVALVIA + SCAPHOPODA. Prorhipidoglossomorpha = GASTROPODA + BIVALVIA + SCAPHOPODA. Isopleura = MONOPLACOPHORA + AMPHINEURA + APLACOPHORA.

[59] *Includes:* Cynostraca, Cochliostraca.

[60] *Includes:* Lepidopleurida, Chitonida, Eoplacophora, Isoplacophora, Mesoplacophora, Teleoplacophora.

[61] *Also spelled:* Gasteropoda, Gastraeopoda, Gasteropodophora, Gasterozoa. *Includes:* Spironotia. Euthyneura (Androgyna, Platymalakia) = OPISTHOBRANCHIA + PULMONATA.

[62] *Includes:* Scutibranchia, Aspidobranchiata, Diotocardia, Bellerophontacea, Cyclobranchia, Zygobranchia, Docoglossa, Rhipidoglossa.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Caenogastropoda [63] | ORD-REC |
| | Opisthobranchia [64] | | MIS-REC |
| | | Pleurocoela [65] (*Tectibranchiata, Tectobranchia, Aplysiacea, Steganobranchia*) | MIS-REC |
| | | Pteropoda | CRE-REC |
| | | Sacoglossa | REC |
| | | Acoela [66] | EOC-REC |
| | Pulmonata | | PEN-REC |
| | | Basommatophora | PEN-REC |
| | | Stylommatophora | PEN-REC |
| BIVALVIA [67] (*Pelecypoda, Lamellibranchiata, Aglossa, Lipocephala, Conchifera, Conchophora, Acephala*) | | | ORD-REC |
| | | Protobranchia [68] | ORD-REC |
| | | Filibranchia [69] | ORD-REC |
| | | Eulamellibranchia [70] | SIL-REC |
| | | Septibranchia | JUR-REC |
| SCAPHOPODA (*Cirrhobranchiata, Solenoconchia, Prosopocephala, Lateribranchiata*) | | | DEV-REC |
| | | Scaphopoda | DEV-REC |
| CEPHALOPODA (*Siphonopoda*) | | | CAM-REC |
| | Tetrabranchiata (*Schizosiphona, Tentaculifera*) | | CAM-REC |
| | | Nautiloidea [71] | CAM-REC |
| | | Ammonitoidea [72] | ORD-CRE |
| | Dibranchiata (*Coleoidea, Acetabulifera, Holosiphona*) | | MIS-REC |
| | | Decapoda [73] (*Decembrachiata, Decabrachia*) | JUR-REC |

[63] *Includes:* Siphonobranchia, Pectinibranchia, Ctenobranchiata, Hemipomatostoma, Apomatostoma, Monotocardia, Azygobranchia, Mesogastropoda, Stenoglossa, Neogastropoda, Rachiglossa, Toxoglossa, Heteropoda, Taenioglossa, Platypoda, Rhachiglossa.

[64] *Includes:* Gymnosomata, Oncidiacea, Acochlidiacea, Vaginulacea, Anaspidea.

[65] *Includes:* Cephalaspidea, Thecosomata, Bullomorpha, Gyrosomata.

[66] *Includes:* Notaspidea, Pleurobranchomorpha, Nudibranchiata.

[67] *Includes:* Anisomyaria, Anatinacea, Cladocopa, Ambonodonta. Groups sometimes recognized include: Siphonida, Asiphonida, Homomyaria, Macrociliobranchia, Microciliobranchia, Pteriomorpha, Colloconchida, Eutaxodonta, Isofilibranchia, Pteroconchida, Rostroconchida, Heteroconchia, Eudesmodontida, Naiadida, Pachyodontida, Pantodontida, Asthenodontida, Schizodontida, Heterodontida, Septibranchida. Also used as orders: Autobranchiata, Dimyaria, Eleutherorhabda, Hemibranchia, Heteromya, Heteromyaria, Isedrolotila, Isomya, Laternulacea, Macrotrachia, Monomyaria, Monomya, Neotaxodonta, Palaeobranchia, Palaeolamellibranchia, Parafilibranchia, Pholadacea, Pleuroconcha, Pleurodonta, Praeheterodonta, Synaptorhabda, Veneracea.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Octopoda (*Octobrachiata, Octopoida*) | CRE-REC |
| | | Vampyromorpha | REC |
| | | Belemnoida [74] (*Phragmophora*) | MIS-EOC |

## SIPUNCULOIDEA

| | | | |
|---|---|---|---|
| SIPUNCULOIDEA | | | REC |
| | | Sipunculida | REC |

## ECHIUROIDEA

| | | | |
|---|---|---|---|
| ECHIURIDA | | | REC |
| | | Echiuroina | REC |
| | | Xenopneusta | REC |
| | | Heteromyota | REC |
| SACCOSOMATIDA | | | REC |
| | | Saccosomatida | REC |

## MYZOSTOMIDA [75]

| | | | |
|---|---|---|---|
| MYZOSTOMIDA | | | PAL-REC |
| | | Proboscidea | REC |
| | | Pharyngidea | REC |

Arrangement preferred by paleontologists:
Subclass Prionodesmacea (orders Paleoconcha, Taxodonta, Schizodonta, Isodonta, Dysodonta).
Subclass Anomalodesmacea (orders Septibranchia, Anomalobranchia).
Subclass Teleodesmacea (orders Pantodonta, Diogenodonta, Cyclodonta, Teleodonta, Asthenodonta, Heterodonta, Pachyodonta, Desmodonta)

[68] Sometimes a subclass with orders Cryptodonta, Lipodonta, Palaeotaxodonta.

[69] *Includes:* Pseudolamellibranchia.

[70] *Includes:* Schizodonta, Heterodonta, Adapedonta, Anomalodesmata, Sinupalliata, Integripalliata.

[71] Sometimes ranked as a separate subclass with orders Mixochoanites, Schistochoanites, Orthochoanites, Cyrtochoanites; or with orders Ellesmeroceroida, Michelinoceroida, Ascoceroida, Oncoceroida, Endoceroida, Actinoceroida, Discosoroida, Nautilida; or with orders Basslerocerati da, Barrandeoceratida, Centroceratida, Rutoceratida, Solenochilida, Tarphyceratida.

[72] Sometimes ranked as a separate subclass with order Ammonitida; or with orders Intrasiphonata, Extrasiphonata.

[73] *Includes:* Teuthoidea, Sepioidea, Loliginacea, Architeuthacea.

[74] Sometimes used as subclass in place of Dibranchiata.

[75] *Synonyms:* Myzostomaria, Myzostoma.

Class Subcl Order

## ANNELIDA[76]

| | |
|---|---|
| CHAETOPODA[77] | CAM-REC |
| Polychaeta[78] | CAM-REC |
| Errantia (*Phanerocephala*) | CEN-REC |
| Sedentaria (*Cryptocephala, Tubicola*) | ORD-REC |
| Miskoa | CAM |
| Oligochaeta[79] | ORD-REC |
| Plesiothecata | ?-REC |
| Prosothecata | ?-REC |
| Prosopora | ?-REC |
| Opisthopora | ?-REC |
| HIRUDINEA | REC |
| Rhynchobdellida (*Rhynchobdelliformes*) | REC |
| Gnathobdellida (*Gnathobdelliformes*) | REC |
| Pharyngobdellida (*Herpobdellida, Erpobdellida, Pharyngobdelliformes*) | REC |
| Acanthobdellida (*Acanthobdelliformes*) | REC |
| ARCHIANNELIDA[80] | REC |
| Archiannelida | REC |

## TARDIGRADA

| | |
|---|---|
| HETEROTARDIGRADA | REC |
| Arthrotardigrada (*Prototardigrada*) | REC |
| Echiniscoidea | REC |
| EUTARDIGRADA | REC |
| Eutardigrada | REC |

[76] *Synonyms:* Annulata, Coelhelminthes. Clitellata = OLIGOCHAETA + HIRUDINEA.

[77] *Includes:* Haplodrili, Saccocirrida.

[78] *Includes:* Nereidiformia, Capitelliformia, Spioniformia, Terebelliformia, Scoleciformia, Archichaetopoda, Poecobioidea.

[79] *Includes:* Aphaneura, Limicolae, Moniligastres, Terricolae, Naidomorpha, Lumbricimorpha. Plesiothecata and Prosothecata have previously been cited as Plesiopora plesiotheca and Plesiopora prosotheca.

[80] *Includes:* Dinophilea.

[81] *Synonyms:* Polypoda, Protracheata, Ceratophora, Malacopoda.

[82] *Synonyms:* Euarthropoda. *Subphyla:* Trilobitomorpha (Anomomeristica) = TRILOBITOIDEA + TRILOBITA; Chelicerata (Nomomeristica) = MEROSTOMATA + PYCNOGONIDA + ARACHNIDA; Mandibulata = CRUSTACEA + PAUROPODA + SYM-

| Class | Subcl | Order | |
|---|---|---|---|
| | | **PENTASTOMIDA** | |
| | | LINGUATULIDA | REC |
| | | Cephalobaenida | REC |
| | | Porocephalida (*Linguatulodea*) | REC |
| | | **ONYCHOPHORA**[81] | |
| | | PERIPATIDEA | CAM-REC |
| | | Protonychophora | CAM |
| | | Euonychophora | REC |
| | | **ARTHROPODA**[82] | |
| | | TRILOBITOIDEA[83] | CAM-PEN |
| | | Merostomoidea (*Xenopoda*) | CAM |
| | | Limulavida (*Prochelicerata, Limulava*) | CAM |
| | | Emeraldellida | CAM |
| | | Nectaspida | CAM |
| | | Leanchoiliida (*Pseudanostraca*) | CAM |
| | | Pseudonotostraca (*Pseudocrustacea*) | CAM |
| | | Burgessiida | CAM |
| | | Waptiida | CAM |
| | | Marrellomorpha[84] (*Marellomorpha*) | CAM |
| | | Marrellida | CAM |
| | | Hymenocarina | CAM |
| | | Hymenocarina | CAM |
| | | Arthropleurida | PEN |
| | | Arthropleurida | PEN |
| | | Cheloniellida | DEV |
| | | Cheloniellida | DEV |
| | | Opabiniida | CAM |
| | | Palaeanostraca | CAM |

PHYLA + DIPLOPODA + CHILOPODA + INSECTA. Hyparthropoda was proposed for hypothetical ancestral forms. A separate class Arthrocephala is listed by Boettger in the Chelicerata, but no other reference to such an extinct group has been found. Diantennata = TRILOBITOMORPHA + CRUSTACEA. Branchiata = TRILOBITOMORPHA + CHELICERATA + MANDIBULATA. Acerata = MEROSTOMATA + ARACHNIDA. Arachnomorpha = TRILOBITOMORPHA + CRUSTACEA. Myriapoda = PAUROPODA + SYMPHYLA + DIPLOPODA + CHILOPODA. Progoneata = SYMPHYLA + DIPLOPODA + PAUROPODA. Antennata = PAUROPODA + SYMPHYLA + DIPLOPODA + CHILOPODA + INSECTA. Opisthogoneata = CHILOPODA + INSECTA. *Includes:* Marriocarida, of unknown position.

[83] Homopoda = MARRELLINA + PSEUDANOSTRACA + PSEUDONOTOSTRACA + HYMENOCARINA.

[84] *Includes:* Mimetasterida, Pygaspida, Proarthropoda.

| Class | Subcl | Order | |
|---|---|---|---|
| TRILOBITA [85] | | | CAM-PER |
| | | Agnostida (*Isopygia, Miomera*) | CAM-ORD |
| | | Redlichiida (*Micropygia, Mesonacida*) | CAM |
| | | Corynexochida (*Bathyuriscidea, Zacanthoidacea*) | CAM |
| | | Ptychopariida (*Conocoryphida, Trinucleida*) | CAM-PER |
| | | Phacopida (*Proparia*) | ORD-DEV |
| | | Lichida (*Lichacea*) | ORD-DEV |
| | | Odontopleurida | CAM-DEV |
| MEROSTOMATA [86] (*Palaeostraca*) | | | CAM-REC |
| | Xiphosura (*Gnathopoda, Poecilopoda*) | | CAM-REC |
| | | Aglaspida | CAM-ORD |
| | | Xiphosurida [87] | SIL-REC |
| | Eurypterida | | ORD-PER |
| | | Gigantostraca | ORD-PER |
| PYCNOGONIDA (*Pantopoda*) | | | DEV-REC |
| | | Eupantopoda [88] | REC |
| | | Palaeopantopoda | DEV |
| ARACHNIDA [89] (*Embolobranchiata, Aeropneusta, Eu-arachnida*) | | | SIL-REC |
| | Latigastra | | SIL-REC |
| | | Scorpionida (*Scorpiones, Pectinifera*) | SIL-REC |
| | | Pseudoscorpionida (*Chelonethida, Chernetes, Chernetidea*) | OLI-REC |
| | | Phalangida (*Opiliones, Opilionidea*) | PEN-REC |
| | | Architarbida (*Architarbi, Phalangiotarbi*) | CAR |
| | | Acarida [90] (*Acari, Acarina, Rhynchostomi, Monomerostomata*) | DEV-REC |
| | Stethostomata | | CAR |
| | | Haptopodida (*Haptopoda*) | CAR |
| | | Anthracomartida (*Anthracomarti*) | CAR |
| | Soluta | | DEV-CAR |
| | | Trigonotarbida (*Trigonotarbi*) | DEV-CAR |
| | Caulogastra [91, 92] | | CAR-REC |

[85] *Includes:* Opisthoparia, Hypoparia, Integricephalida, Oligomeria, Pliomeria, Protoparia, Epiparia, Polymera, Eodiscida, Olenellida.

[86] Delobranchia (Hydropneustea) = MEROSTOMATA (sometimes + TRILOBITOMORPHA).

[87] *Includes:* Synxiphosurida, Bunodomorpha, Limulida, Euxiphosura.

[88] *Includes:* Colossendeomorpha, Nymphonomorpha, Ascorhynchomorpha, Pycnogonomorpha.

[89] Epectinata = all ARACHNIDA except SCORPIONIDA. Arachnoidea = class ARACHNIDA or ARACHNIDA + MEROSTOMATA.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Palpigradida (*Microthelyphonida, Latisterna, Palpigradi*) | JUR-REC |
| | | Thelyphonida (*Uropygi, Holopeltidia*) | CAR-REC |
| | | Schizomida (*Tartarides, Schizopeltidia, Colopyga, Schizonotida*) | PLI-REC |
| | | Kustarachnida (*Kustarachne*) | PEN |
| | | Phrynichida (*Amblypygi, Phryneides*) | CAR-REC |
| | | Araneida (*Araneae*) | CAR-REC |
| | | Solpugida (*Solifugae, Galeodea, Rostrata, Mycetophorae*) | CAR-REC |
| | | Ricinuleida (*Rhinogastra, Meridogastra, Podogonata, Cucullifera, Rhignogastra*) | CAR-REC |
| CRUSTACEA [93] (*Eucrustacea*) | | | CAM-REC |
| | Branchiopoda [94] | | CAM-REC |
| | | Anostraca (*Euanostraca*) | EOC-REC |
| | | Lipostraca | DEV |
| | | Notostraca | PER-REC |
| | | Conchostraca | DEV-REC |
| | | Cladocera | REC |
| | Cephalocarida | | REC |
| | | Cephalocarida | REC |
| | Ostracoda (*Ostracopa, Ostrapoda*) | | CAM-REC |
| | | Archaeocopida [95] (*Archaeostraca*) | CAM-TRI |
| | | Leperditicopida (*Leperditiida*) | ORD-DEV |
| | | Myodocopida (*Myodocopa, Cladocopa*) | ORD-REC |
| | | Podocopida (*Podocopa, Platycopa*) | ORD-REC |
| | | Palaeocopida (*Paleocopa, Beyrichiida*) | ORD-PER |
| | Mystacocarida | | REC |
| | | Mystacocarida | REC |
| | Copepoda (*Eucopepoda*) | | REC |
| | | Calanoida | REC |
| | | Harpacticoida | REC |
| | | Cyclopoida | REC |

[90] *Includes:* Notostigmata, Cryptostigmata, Prostigmata, Stomatostigmata, Heterostigmata, Parastigmata, Mesostigmata, Metastigmata.

[91] Camarostomata = SCHIZOMIDA + THELYPHONIDA + KUSTARACHNIDA. Labellata = PHRYNICHIDA + ARANEIDA.

[92] Pedipalpida (scorpion-spiders) = SCHIZOMIDA + THELYPHONIDA + PHRYNICHIDA.

[93] Entomostraca = BRANCHIOPODA + OSTRACODA + COPEPODA + CIRRIPEDIA.

[94] Diplostraca = CONCHOSTRACA + CLADOCERA. Phyllopoda (Euphyllopoda, Onychura) = ANOSTRACA + NOTOSTRACA + CONCHOSTRACA.

[95] *Includes:* Bradorina, Discinocarina.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Notodelphyoida | REC |
| | | Monstrilloida | REC |
| | | Caligoida | REC |
| | | Lernaeopodoida | REC |
| | Branchiura | | REC |
| | | Branchiura | REC |
| | Cirripedia (*Thyrostraca, Eucirripedia*) | | SIL-REC |
| | | Thoracica | SIL-REC |
| | | Acrothoracica | REC |
| | | Ascothoracica | REC |
| | | Apoda | REC |
| | | Rhizocephala | REC |
| | Malacostraca [96] | | PER-REC |
| | | Nebaliacea | REC |
| | | Rhinocarina | DEV-PEN |
| | | Ceratiocarina (*Ceratocarina*) | CAM-PEN |
| | | Nahecarida | DEV |
| | | Anaspidacea (*Anomostraca, Syncarida*) | PEN-REC |
| | | Mysidacea [97] | MIS-REC |
| | | Thermosbaenacea | REC |
| | | Spelaeogriphacea | REC |
| | | Lophogastridea | REC |
| | | Cumacea (*Sympoda*) | REC |
| | | Tanaidacea (*Chelifera, Anisopoda*) | REC |
| | | Isopoda | DEV-REC |
| | | Amphipoda (*Laemodipoda*) | TER-REC |
| | | Euphausiacea | REC |
| | | Pygocephalomorpha | PAL |
| | | Decapoda [98] | TRI-REC |
| | | Stomatopoda (*Hoplocarida*) | MIS-REC |
| PAUROPODA | | | REC |
| | | Heterognatha | REC |

[96] Phyllocarida (Leptostraca) = NEBALIACEA + RHINOCARINA + CERATIOCARINA + HYMENOCARINA. Eumalacostraca = ANASPIDACEA + MYSIDACEA + THERMOSBAENACEA + CUMACEA + TANAIDACEA + ISOPODA + AMPHIPODA + EUPHAUSIACEA + DECAPODA + STOMATOPODA. Peracarida (Podophthalma, Thoracostraca, Schizopoda, Anaspides) = MYSIDACEA + THERMOSBAENACEA + LOPHOGASTRIDEA + CUMACEA + TANAIDACEA + ISOPODA + AMPHIPODA. Edriophthalma (Arthrostraca, Tetradecapoda) = ISOPODA + AMPHIPODA. Eucarida = EUPHAUSIACEA + DECAPODA + STOMATOPODA.

[97] Lophogastridea has sometimes been included here.

[98] *Includes:* Macrura, Anomura, Brachyura.

| Class | Subcl | Order | |
|---|---|---|---|
| SYMPHYLA | | | REC |
| | | Cephalostigmata | REC |
| DIPLOPODA [99] | | | PEN-REC |
| | Pselaphognatha (*Penicillata*) | | REC |
| | | Ancyrotricha | REC |
| | | Lophotricha | REC |
| | Chilognatha [100] | | TER-REC |
| | | Limacomorpha | REC |
| | | Oniscomorpha (*Armadillomorpha*) | TER-REC |
| | | Ascospermophora | REC |
| | | Colobognatha (*Platydesmiformia*) | TER-REC |
| | | Nematophora (*Merochaeta*) | TER-REC |
| | | Proterospermophora | REC |
| | | Opisthospermophora | REC |
| | Protosyngnatha | | PEN |
| | | Protosyngnatha | PEN |
| | Archipolypoda | | DEV-CAR |
| | | Palaeocoxopleura (*Macrosterni*) | DEV-CAR |
| CHILOPODA (*Syngnatha*) | | | TER-REC |
| | Pleurostigmophora [101] (*Pleurostigma*) | | TER-REC |
| | | Geophilomorpha (*Geophylomorpha*) | TER-REC |
| | | Scolopendromorpha | TER-REC |
| | | Lithobiomorpha | TER-REC |
| | | Craterostigma | REC |
| | Notostigmophora (*Notostigma*) | | TER-REC |
| | | Scutigeromorpha | TER-REC |
| INSECTA [102] (*Hexapoda*) | | | DEV-REC |
| | Apterygota (*Synaptera, Apterygogenea, Aptera*) | | DEV-REC |
| | | Protura (*Myrientomata, Mirientomata, Prothysanura, Panprotura, Ellipura, Anamerentoma*) | REC |
| | | Thysanura (*Ectotrophi, Ectognatha*) | TRI-REC |
| | | Entotrophi (*Entognatha, Diplura, Campodeoidea, Holomerentoma, Panthysanura, Dicellura*) | MIO-REC |

[99] *Includes:* Eurysterna, Paleomorpha.

[100] *Includes:* Opisthandria, Proterandria, Eugnatha, Polydesmoidea, Juliformia.

[101] Anamorpha = CRATEROSTIGMA + LITHOBIOMORPHA. Epimorpha = GEOPHILOMORPHA + SCOLOPENDROMORPHA.

[102] Includes extinct orders: Sypharopteroidea, Archodonata, Perielytrodea, Protephemerida, Eubleptidodea, Syntonopteroidea, Permoneurodia. Pterygota (Pterygogenea) = EXOPTERYGOTA + ENDOPTERYGOTA. Palaeoptera = PALAEODICTYOPTERA + MEGASECOPTERA + PROTOHEMIPTERA + PROTODONATA + ODONATA + EPHEMERIDA. Neoptera = EXOPTERYGOTA (except PALAEOPTERA) + ENDOPTERYGOTA. Euentomata = DIPLURA + ECTOTROPHI + PTERYGOTA.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Collembola (*Oligoentomata*) | DEV-REC |
| | Exopterygota [103] | (*Heterometabola*) | DEV-REC |
| | | Palaeodictyoptera [104] (*Eopaleodictyoptera*) | PEN-PER |
| | | Megasecoptera [105] (*Megasecopterida*) | PEN-PER |
| | | Protephemerida (*Protephemeroidea*) | PEN |
| | | Ephemerida [106] (*Ephemeroptera, Ephemeroidea, Plectoptera*) | PER-REC |
| | | Protodonata (*Meganisoptera*) | PEN-PER |
| | | Odonata [107] | PER-REC |
| | | Protohemiptera (*Pseudohemiptera*) | PEN-PER |
| | | Protoperlaria [108] | PER |
| | | Plecoptera (*Perlarides, Perloidea, Perlaria, Nemuraedes*) | PER-REC |
| | | Protorthoptera | PEN-PER |
| | | Caloneurodea | PEN-PER |
| | | Diploglossata (*Hemimeroidea, Dermodermaptera*) | PAL |
| | | Grylloblattoidea (*Notoptera*) | REC |
| | | Orthoptera (*Saltatoria, Aeroplanoptera*) | PEN-REC |
| | | Phasmidia (*Phasmoidea, Ambulatoria, Gressoria, Cheleutoptera*) | TRI-REC |
| | | Blattaria (*Blattaeformia, Oothecaria, Cursoria, Dictyoptera, Neoblattariae*) | PEN-REC |
| | | Mantodea (*Deratoptera, Dacnostomata, Phylloptera, Exopterygoptera, Pandictyoptera*) | PAL-REC |
| | | Glosselytrodea | PER-JUR |
| | | Protelytroptera (*Protocoleoptera*) | PER |
| | | Dermaptera (*Labidura, Euplexoptera*) | JUR-REC |
| | | Embioptera (*Embiidina, Embioidea, Adenopoda, Oligoneura, Aetioptera*) | OLI-REC |
| | | Isoptera | EOC-REC |

[103] Coleopteroidea = PROTOCOLEOPTERA + COLEOPTERA + STREPSIPTERA. Phthiraptera (Ellipoptera) = MALLOPHAGA + ANOPLURA. Hemiptera (Rhynchota) = HETEROPTERA + HOMOPTERA + PROTOHEMIPTERA + PALAEOHEMIPTERA. Blattoidea = PROTOBLATTOIDEA + BLATTARIA + MANTODEA + ISOPTERA + ZORAPTERA + PSOCOPTERA + MALLOPHAGA + ANOPLURA.

[104] *Includes:* Hemiodonata, Anisaxia, Permodictyoptera, Breyeridea, Archaehymenoptera.

[105] *Includes:* Protohymenoptera, Diaphanopteroidea, Palaeohymenoptera.

[106] *Includes:* Aphelophlebia, Agnatha, Odontota, Anisoptera, Archipterygota.

[107] *Includes:* Paraneuroptera, Permodonata, Cryptodonata, Cryptodontia, Libellulides, Libelluloidea.

[108] *Includes:* Protoblattoidea, Pruvostitoptera, Mixotermitoidea, Synarmogoi-

| Class | Subcl | Order | |
|---|---|---|---|
| | | Psocoptera (*Corrodentia, Copeognatha*) | PER-REC |
| | | Zoraptera (*Panisoptera*) | REC |
| | | Mallophaga (*Lipoptera*) | REC |
| | | Thysanoptera (*Physopoda, Physapida, Thripoides, Thripsites*) | PER-REC |
| | | Homoptera | PAL-REC |
| | | Heteroptera [109] | MES-REC |
| | | Anoplura [110] (*Siphunculata, Parasita, Pseudorhynchota*) | PLE-REC |
| | Endopterygota [111] | (*Holometabola*) | PER-REC |
| | | Neuroptera [112] | PER-REC |
| | | Mecoptera (*Panorpatae, Panorpina, Mecaptera, Petanoptera, Paramecoptera, Protomecoptera, Protodiptera*) | PER-REC |
| | | Trichoptera (*Phryganoidea, Placipennes, Paratrichoptera, Agnathes*) | JUR-REC |
| | | Lepidoptera (*Glossata*) | EOC-REC |
| | | Diptera (*Antliata, Halterata, Halteriptera, Haustellata*) | JUR-REC |
| | | Siphonaptera (*Suctoria, Aphaniptera, Rophoteira, Medamoptera, Pulicina*) | OLI-REC |
| | | Coleoptera [113] (*Eleutherata, Elytroptera*) | PER-REC |
| | | Strepsiptera [114] (*Rhipiptera, Rhipidoptera, Strepsata, Stylopida*) | OLI-REC |
| | | Hymenoptera | JUR-REC |

## CHAETOGNATHA [115]

| | | |
|---|---|---|
| CHAETOGNATHA | | CAM-REC |
| | Sagittoidea | CAM-REC |

dea, Hapalopteroidea, Hadentomoidea, Reculoidea, Cnemidolestoidea, Paraplecoptera, Miomoptera, Protocicadida, Protofulgorida.

[109] *Includes:* Palaeohemiptera, Hemipsocoptera.

[110] *Includes:* Pediculidea, Polyptera.

[111] Hymenopteroidea = ARCHAEOHYMENOPTERA + PALAEOHYMENOPTERA + PROTOHYMENOPTERA + HYMENOPTERA. Panorpoidea = TRICHOPTERA + LEPIDOPTERA + DIPTERA + SIPHONAPTERA + MEGASECOPTERA + PANORPATAE.

[112] *Includes:* Megaloptera, Raphidioidea, Emmenognatha, Leptophya. (Planipennia sometimes used for all these.)

[113] *Includes:* Paracoleoptera.

[114] Sometimes placed in Coleoptera as family Stylopidae.

[115] *Synonyms:* Homalopterygia, Oesthelminthes.

[116] *Synonyms:* Brachiata, Pogonofora.

Class Subcl Order

## POGONOPHORA [116]

| | |
|---|---|
| POGONOPHORA | REC |
| Thecanephria | REC |
| Athecanephria | REC |

## ECHINODERMATA [117]

| | |
|---|---|
| CYSTOIDEA | ORD-PER |
| Hydrophoridea [118] (*Cystidea*) | ORD-DEV |
| Rhombifera | ORD-DEV |
| Diploporita | ORD-DEV |
| Blastoidea [119] | ORD-PER |
| Eublastoidea | SIL-PER |
| Coronata | ORD-SIL |
| Parablastoidea | ORD |
| CRINOIDEA [120] (*Brachiata, Actinoidea, Eucrinoidea*) | ORD-REC |
| Inadunata [121] | ORD-TRI |
| Disparida (*Disparata*) | ORD-PER |
| Hybocrinida | ORD-SIL |
| Cladida (*Cladoidea*) | ORD-TRI |
| Flexibilia (*Ichthyocrinacea*) | ORD-PER |
| Taxocrinida (*Taxocrinoidea*) | ORD-PER |
| Sagenocrinida (*Sagenocrinoidea*) | SIL-PER |
| Camerata (*Sphaeroidocrinacea, Adunata*) | ORD-PER |
| Diplobathrida (*Diplobathra*) | ORD-MIS |
| Monobathrida (*Monobathra*) | ORD-PER |
| Articulata [122] | TRI-REC |
| Isocrinida | TRI-REC |
| Millericrinida | TRI-EOC |
| Cyrtocrinida | JUR-REC |
| Uintacrinida | CRE |
| Roveacrinida | TRI-CRE |

[117] *Subphyla:* Pelmatozoa = CYSTOIDEA + BLASTOIDEA + CRINOIDEA + EOCRINOIDEA + PARACRINOIDEA + EDRIOASTEROIDEA. Homalozoa = CARPOIDEA + MACHAERIDIA. Haplozoa = single class HAPLOZOA. Eleutherozoa = SOMASTEROIDEA + ASTEROIDEA + OPHIUROIDEA + ECHINOIDEA + BOTHROCIDAROIDEA + OPHIOCYSTOIDEA + HOLOTHURIOIDEA. *Includes:* Heterostelea (CARPOIDEA + Amphoridea), Asterozoa, Stelleroidea, Stelliformia, Hypostoma, Echinozoa, Cystocidaroidea, Aporita.

[118] *Includes:* Eucystoidea, Cystechinoidea, Dichoporita, Cystocrinoidea.

[119] Sometimes separated into orders Regulares and Irregulares, or orders Eublastoidea and Protoblastoidea. Sometimes as a separate class.

[120] *Includes:* Palaeocrinoidea, Inarticulata, Coadunata, Costata, Testacea, Mo-

| Class | Subcl | Order | |
|---|---|---|---|
| | | Comatulida | JUR-REC |
| EOCRINOIDEA [123] | | | CAM-ORD |
| | | Eocrinoidea | CAM-ORD |
| PARACRINOIDEA | | | ORD |
| | | Paracrinoidea | ORD |
| EDRIOASTEROIDEA (*Thecoidea, Cystasteroidea, Thyroidea, Agelacrinoidea*) | | | CAM-PEN |
| | | Edrioasteroidea | CAM-PEN |
| CARPOIDEA | | | CAM-DEV |
| | | Carpoidea | CAM-DEV |
| MACHAERIDIA [124] | | | ORD-DEV |
| | | Machaeridia | ORD-DEV |
| HAPLOZOA [124] | | | CAM |
| | | Cyamoidea | CAM |
| | | Cycloidea | CAM |
| SOMASTEROIDEA | | | ORD |
| | | Goniactinida | ORD |
| ASTEROIDEA [125] (*Cirrigrada*) | | | ORD-REC |
| | | Hemizonida | ORD-CAR |
| | | Platyasterida | ORD-DEV |
| | | Phanerozonea | ORD-REC |
| | | Spinulosa [126] | REC |
| | | Forcipulata [126] | REC |
| AULUROIDEA | | | ORD-MIS |
| | | Lysophiuroida (*Lysophiurae, Aegophiurida*) | ORD-MIS |
| | | Streptophiuroida (*Streptophiurae*) | ORD-MIS |
| OPHIUROIDEA [127] (*Spinigrada*) | | | ORD-REC |
| | Myophiurida | | ORD-DEV |
| | | Ophiocystiida | ORD-DEV |
| | | Aganasterida | ?-REC |
| | | Phrynophiurida | ?-REC |
| | | Laemophiurida | ?-REC |
| | | Gnathophiurida | ?-REC |

nocyclica, Dicyclica, Irregularia, Regularia, Larvata, Tesselata, Canaliculata, Semi-articulata.

[121] Sometimes divided into Larviformia (Haplocrinacea) and Fistulata (Cyathocrinacea).

[122] *Includes:* Pentacrinoidea, Pentacrinacea, Stomatocrinoidea, Neocrinoidea.

[123] Perhaps not a natural group.

[124] Groups of doubtful relationships,—possibly not even Echinodermata.

[125] *Includes:* Encrinasteriae, Euasteriae, Cryptozonia.

[126] Sometimes united as Cryptozonia.

[127] *Includes:* Ophiureae, Ophiurida, Euryalae, Euryalida, Cladophiurae, Zygophiurae. Also sometimes divided into orders Stenurida and Ophiurida.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Chilophiurida | ?-REC |
| ECHINOIDEA [128] | | | ORD-REC |
| | Regularia [129] (*Endocyclica*) | | ORD-REC |
| | | Lepidocentroida | ORD-PER |
| | | Cidaroida | MIS-REC |
| | | Centrechinoida (*Diadematoida, Diademoida*) | CRE-REC |
| | | Exocycloida (*Exocyclica*) | JUR-REC |
| | | Plesiocidaroida | TRI |
| | | Echinocystoida | SIL |
| | | Perischoechinoida | SIL-PER |
| | Irregularia [130] | | JUR-REC |
| | | Holectypoida | JUR-REC |
| | | Cassiduloida | JUR-REC |
| | | Conoclypina | CEN |
| | | Clypeastroida | CRE-REC |
| | | Spatangoida | CRE-REC |
| BOTHRIOCIDAROIDEA (*Pseudechinoidea*) | | | ORD |
| | | Bothriocidaroida | ORD |
| OPHIOCYSTIOIDEA (*Ophiocistioidea*) | | | ORD-DEV |
| | | Ophiocystia | ORD-DEV |
| HOLOTHURIOIDEA [131] (*Holothuroidea, Fistulides, Scytodermata, Ascidiastella, Scytactinata*) | | | ORD-REC |
| | | Aspidochirota [132] (*Aspidochirotida*) | JUR-REC |
| | | Elasipoda (*Elasipodida*) | REC |
| | | Dendrochirota (*Cucumariida, Dendrochirotida*) | REC |
| | | Molpadonia (*Molpadida*) | REC |
| | | Apoda (*Synaptida, Paractinopoda*) | PER-REC |
| | | Megalopoda | ORD |

## PTEROBRANCHIA

| | | | |
|---|---|---|---|
| PTEROBRANCHIA | | | ORD-REC |
| | | Rhabdopleurida | CRE-REC |
| | | Cephalodiscidea | ORD-REC |

[128] *Includes:* Palaeo-echinoidea, Paleo-echinoidea, Palechinoidea, Euechinoidea.

[129] *Includes:* Melonechinoida, Melonitoida, Stirodonta, Aulodonta, Camarodonta, Endobranchiata, Ectobranchiata.

[130] *Includes:* Gnathostomata, Atelostomata.

[131] *Includes:* Pedata. Subclasses sometimes accepted: Actinopoda, Apoda, Megalopoda.

Class Subcl Order

## ENTEROPNEUSTA[133]

ENTEROPNEUSTA REC
Balanoglossida REC

## PLANCTOSPHAEROIDEA

PLANCTOSPHAEROIDEA REC
Planctosphaeroidea REC

## TUNICATA[134]

LARVACEA (*Copelata, Appendicularia, Atremata, Perennichordata*) REC
Larvacea REC
ASCIDIACEA[135] (*Tethyodeae*) REC
Stolidobranchiata (*Ptychobranchia*) REC
Aspiraculata REC
Phlebobranchiata (*Diktyobranchia, Dictyobranchia*) REC
Aplousobranchiata (*Krikobranchia*) REC
Octacnemida REC
THALIACEA REC
Pyrosomata REC
Pyrosomatida (*Luciae, Lucida*) REC
Myosomata REC
Cyclomyaria (*Doliolida*) REC
Hemimyaria (*Salpida*) REC
Desmomyaria REC

## CEPHALOCHORDATA[136]

LEPTOCARDIA REC
Amphioxi (*Branchiostomoidea*) REC

[132] *Includes:* Pelagothurida.
[133] *Synonyms:* Helminthomorpha.
[134] *Synonyms:* Urochordata. *Subphyla:* Copelata = LARVACEA; Acopa (Caducichordata) = ASCIDIACEA + THALIACEA.
[135] *Includes:* Enterogona, Pleurogona.
[136] *Synonyms:* Cirrhostomi, Entomocrania, Haplocyemata, Homomeria, Myelozoa, Pharyngobranchii, Acrania.

Class Subcl Order

## VERTEBRATA[137]

AGNATHA[138] (*Monorhyncha, Monorhina*) ORD-REC
Cephalaspidomorpha SIL-REC
Cyclostomata[139] (*Marsipobranchii, Petromyzonoidea*) REC
Cephalaspida[140] (*Osteostraci, Aspidocephali, Osteostracoidea, Cephalaspidiformes*) SIL-DEV
Anaspida[141] (*Anaspidoidea*) SIL-DEV
Pteraspidomorpha[142] (*Pteraspides*) ORD-DEV
Pteraspida (*Heterostraci, Pteraspidiformes* ORD-DEV
Coelolepida (*Coelolepidoidea, Coelolepiformes*) SIL-DEV
PLACODERMI[143] (*Aphetohyoidea*) SIL-PER
Acanthodii[144] (*Acanthoglossa, Acanthodioidea*) SIL-PER
Arthrodira[145] (*Euarthrodira, Arthrodiroidea, Phyllolepida, Ptyctodontida*) SIL-DEV
Macropetalichthyida[146] (*Anarthrodira*) DEV
Antiarchi[147] (*Antiarchoidea, Pterichthyes, Pterichthyomorpha*) DEV

[137] *Synonyms:* Euchorda, Craniata. Superclass Gnathostomata (Amphirhyncha, Amphirhina) = PLACODERMI + all "higher" vertebrates. Ichthyopterygii = PLACODERMI + ELASMOBRANCHII + HOLOCEPHALI + OSTEICHTHYES. Pisces (Ichthya, Eotetrapoda) = AGNATHA + PLACODERMI + CHONDRICHTHYES + OSTEICHTHYES. Haemacryma = PISCES + AMPHIBIA + REPTILIA. Haematherma = AVES + MAMMALIA. Anamnia (Ichthyopsida) = PISCES + AMPHIBIA. Amniota = REPTILIA + AVES + MAMMALIA. Tetrapoda (Cheiropterygia) = AMPHIBIA + REPTILIA + AVES + MAMMALIA. Sauropsida = REPTILIA + AVES. *Includes:* Protichthyes, Ichthyodorulites.

[138] Ostracodermi (Ostracophori) = CEPHALASPIDA + ANASPIDA + PTERASPIDA + COELOLEPIDA. *Includes:* Euphaneroidea.

[139] *Includes:* Myxinoidea, Hyperotreti, Myxini, Myxiniformes, Petromyzontia, Petromyzontiformes, Hyperoarti.

[140] *Includes:* Trematapidiformes, Lasaniiformes, Oligocnemata, Endeiolepiformes.

[141] *Includes:* Birkeniiformes, Phlebolepiformes.

[142] *Includes:* Astraspiformes, Psammosteiformes, Cyathaspiformes, Amphiaspiformes, Thelodonti.

[143] Coccostei (Coccosteomorphi) = EUARTHRODIRA + PHYLLOLEPIDA + MACROPETALICHTHYES.

[144] *Includes:* Climatiiformes, Mesacanthiformes, Ischnacanthiformes, Gyracanthiformes, Cheiracanthiformes, Acanthodiformes, Acanthoessi, Acanthoessiformes. Conodontophorida (Conodonta) may belong here (Ord-Tri).

[145] *Includes:* Acanthothoraci, Arctolepiformes, Acanthaspidomorphi, Acanthaspida, Coccosteiformes, Brachythoraci, Mylostomatiformes, Ptyctodontiformes, Phyllolepiformes.

[146] *Includes:* Gemuendiniformes, Rhenanida, Petalichthyida.

[147] *Includes:* Remigolepiformes, Asterolepiformes.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Stegoselachii (*Stensiöelliformes, Jagoriniformes, Stensiöellida*) | SIL-MIS |
| | | Palaeospondyloidea (*Palaeospondyliformes*) | DEV |
| CHONDRICHTHYES | | | DEV-REC |
| | Elasmobranchii [148] | | DEV-REC |
| | | Cladoselachii [149] (*Pleuropterygii*) | DEV-PER |
| | | Pleuracanthodii (*Ichthyotomi, Proselachii*) | DEV-TRI |
| | | Selachii [150] (*Euselachii, Plagiostomi, Chondropterygii, Placoidei*) | DEV-REC |
| | | Batoidea [151] (*Hypotremata, Platosomia*) | JUR-REC |
| | Holocephali [152] | | DEV-REC |
| | | Bradyodonti [153] (*Bradyodontoidea*) | DEV-PER |
| | | Chimaerae [154] (*Chimaeroidea*) | JUR-REC |
| OSTEICHTHYES (*Teleostomi*) | | | DEV-REC |
| | Actinopterygii [155] | | DEV-REC |
| | | Chondrostei [156] (*Chondrosteoidea, Palaeopterygii*) | DEV-REC |
| | | Holostei [157] | PER-REC |
| | | Teleostei [158] | JUR-REC |

[148] *Includes:* Diplodonti, Diplodontiformes, Xenanthi, Xenacanthi, Xenacanthoidea.

[149] *Includes:* Cladodontiformes, Cladoselachoidea, Cladoselachiformes.

[150] Includes: Pleurostomata, Pleurotremata, Selachoidea, Heterodontiformes, Heterodontoidea, Hexanchoidea, Hexanchiformes, Notidanoidea, Lamnoidea, Lamniformes, Isuriformes, Galeoidei, Squaloidea, Squaliformes, Tectospondyli, Edestidi.

[151] *Includes:* Narcaciontiformes, Torpediniformes, Rajiformes.

[152] *Includes:* Petalodontes, Petalodontiformes.

[153] *Includes:* Eubradyodonti, Chondrenchelyes, Chondrenchelyiformes.

[154] *Includes:* Chimaeriformes.

[155] Sometimes divided into superorders: CHONDROSTEI, HOLOSTEI, TELEOSTEI. Sometimes divided into infraclasses: Polypterei, CHONDROSTEI, HOLOSTEI, TELEOSTEI. Ganoidi = CHONDROSTEI + HOLOSTEI. Neopterygii = HOLOSTEI + TELEOSTEI.

[156] *Includes:* Tarrasiiformes, Gymnonisciformes, Luganoidiiformes, Phanerorhynchiformes, Dorypteriformes, Cephaloxeniformes, Bobasatraniiformes, Redfieldiiformes, Calopteriformes, Perleidiformes, Platysiagiformes, Ospiiformes, Aetheodontiformes, Pholidopleuriformes, Saurichthyiformes, Palaeoniscoidea, Heterocerci, Palaeonisciformes, Polypterini, Brachyopterygii, Polypteriformes, Cladistia, Cladistioidea, Acipenseroidea, Acipenseriformes, Subholostei, Subholosteoidea.

[157] *Includes:* Semionotoidea, Lepidostei, Lepisostei, Lepidosteoidea, Lepisosteiformes, Ginglymodi, Rhomboganoidei, Pycnodontoidea, Pycnodontiformes, Aspidorhynchoidea, Aspidorhynchiformes, Amioidea, Amiiformes, Pholidophoroidea, Pholidophoriformes, Pachycormoidea, Pachycormiformes, Protospondyli.

[158] *See* p. 66 for footnote 158.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Choanichthyes (*Amphibioidea*) | DEV-REC |
| | | Crossopterygii [159] (*Crossopterygioidea*) | DEV-REC |
| | | Dipnoi [160] | DEV-REC |
| AMPHIBIA [161] (*Batrachia*) | | | DEV-REC |
| | | Labyrinthodontia [162] (*Stegocephalia*) | DEV-TRI |
| | | Ichthyostegalia | DEV-PEN |
| | | Rhachitomi | MIS-TRI |
| | | Embolomeri | MIS-PER |
| | | Trematosauria | MES |
| | | Stereospondyli | TRI |
| | | Salientia [163] | PEN-REC |
| | | Eoanura | PEN |
| | | Proanura | TRI |
| | | Anura [164] (*Euanura, Ecaudata*) | JUR-REC |
| | | Lepospondyli (*Urodeloidei, Pseudocentrophori*) | MIS-REC |
| | | Aistopoda | PEN |
| | | Nectridia | PEN-PER |
| | | Microsauria (*Adelospondyli, Micramphibia*) | MIS-PER |
| | | Urodela (*Caudata, Gradientia, Saurabatrachia*) | CRE-REC |
| | | Apoda (*Gymnophiona, Peromela, Caecilia*) | REC |

[158] *Includes:* Isospondyli, Isospondyloidea, Malacopterygii, Thrissomorphi, Ostariophysi, Ostariophysoidea, Apodes, Heteromi, Heteromoidea, Mesichthyes, Cyprinodontiformes, Acanthopterygii, Symbranchiformes, Physostomi, Physoclysti, Discocephalioidea, Echiniiformes, Echeniiformes, Plectognathoidea, Hypostomosoidea, Cephalacanthoidea, Scleropareioidea, Percomorphoidea, Allotrioghathoidea, Anacanthoidea, Apodoidea, Batrachoidea, Batrachoidiformes, Haplodoci, Gobiesociformes, Xenopterygii, Lampridiformes, Lophiiformes, Lyomeroidea, Pediculati, Pediculatiformes, Pegasiformes, Salmopercoidea, Solenichthyoidea, Synentognathoidea, Tetradontiformes, Tetrodontiformes, Thoracostoidea, Thunniformes, Icosteioidea, Icosteiformes, Malacichthyes, Chaudhurioidea, Chaudhuriiformes, Mastacembelioidea, Mastacembeliformes, Opisthomi, Synbranchioidea, Perciformes, Dactylopteriformes, Pleuronectoidea, Pleuronectiformes, Heterosomata, Beryciformes, Berycomorphoidea, Zeiformes, Zeomorphoidea, Mugiliformes, Polynemiformes, Ophiocephaliformes, Clupeiformes, Bathyclupeoidea, Bathyclupeiformes, Galaxiiformes, Cypriniformes, Anguilliformes, Halosauriformes, Notacanthiformes, Beloniformes, Myctophiformes, Iniomi, Scopeliformes, Ateleopiformes, Ateleopoidea, Giganturoidea, Giganturiformes, Saccopharyngiformes, Mormyroidea, Mormyriformes, Gadiformes, Macruriformes, Gasterosteiformes, Syngnathiformes, Cyprinodontoidea, Microcyprini, Phallostethiformes, Percopseiformes, Stephanoberyciformes.

[159] *Includes:* Porolepiformes, Osteolepiformes, Osteolepides, Osteolepidoti, Holoptychiformes, Megalichthyiformes, Rhipidistia, Actinistia, Coelacanthini, Coelacanthiformes.

[160] *Includes:* Dipteri, Dipteriformes, Dipneumona, Dipneusti, Phaneropleuri-

| Class | Subcl | Order | |
|---|---|---|---|
| REPTILIA | | | PEN-REC |
| | Anapsida [165] (*Pararеptilia, Reptiliomorphoidea*) | | PEN-REC |
| | | Seymouriamorpha | PEN-PER |
| | | Cotylosauria | PEN-TRI |
| | | Chelonia (*Testudinata, Testudines*) | PER-REC |
| | Parapsida (*Ichthyopterygia, Metapsida*) | | TRI-CRE |
| | | Ichthyosauria | TRI-CRE |
| | Euryapsida (*Synaptosauria*) | | PER-CRE |
| | | Protorosauria [166] (*Araeoscelida*) | PER-TRI |
| | | Sauropterygia [167] | TRI-CRE |
| | Diapsida [168] | | PER-REC |
| | | Eosuchia [169] (*Prolacertiformes*) | PER-EOC |
| | | Rhynchocephalia [170] | TRI-REC |
| | | Squamata [171] (*Plagiotremata*) | JUR-REC |
| | | Thecodontia [172] | TRI |
| | | Crocodilia [173] (*Loricata, Emydosauria, Hydrosauria*) | TRI-REC |
| | | Pterosauria (*Pterodactyli, Ornithosauria*) | JUR-CRE |

formes, Uronemiformes, Ctenodontiformes, Ceratodontiformes, Lepidosireniformes, Rhynchodipteriformes, Monopneumona, Ctenodipterini, Ceratodonti, Sirenoidei.

[161] *Includes:* Pholidota, Monopnoa, Dipnoa, Nuda. Aspidospondyli (Apsidospondyli, Batrachosauria) = LABYRINTHODONTIA + SALIENTIA. Euamphibia = SALIENTIA + LEPOSPONDYLI.

[162] Sometimes treated as the only superorder in subclass Aspidospondyli. *Includes:* Temnospondyli, Anthracomorphoidea, Anthracosauroidea, Anthracosauria, Phyllospondyli. Seymouriamorpha removed to Reptilia.

[163] Sometimes listed as a superorder of Aspidospondyli.

[164] *Includes:* Amphicoela, Angusticoela, Opisthocoela, Anomocoela, Procoela, Diplasiocoela.

[165] *Includes:* Eunotosauria, Diadecta, Diadectomorpha, Procolophonia, Pareiasauria.

[166] *Includes:* Weigeltisauria, Trachelosauria, Tanysitrachelia.

[167] *Includes:* Nothosauria, Placodontia, Plesiosauria.

[168] Lepidosauria (Archosauromorpha) = EOSUCHIA + SQUAMATA + RHYNCHOCEPHALIA. Archosauria = THECODONTIA + CROCODILIA + PTEROSAURIA + SAURISCHIA + ORNITHISCHIA. *Includes*: Katapsida, Kathapsida, Neosauromorpha. Dinosauria (Ornithoscelida, Pachypodes) = SAURISCHIA + ORNITHISCHIA.

[169] *Includes:* Thalattosauria, Pleurosauria, Acrosauria.

[170] Sometimes placed in Archosauria.

[171] *Includes:* Sauria, Lacertilia, Serpentes, Ophidia, Pythonomorpha, Mosasauria, Rhiptoglossa, Streptostylica.

[172] *Includes:* Pseudosuchia, Phytosauria, Parasuchia.

[173] *Includes:* Protosuchia, Sebecosuchia, Mesosuchia, Thalattosuchia, Eusuchia.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Saurischia [174] (*Theropoda, Sauropoda, Compsognatha*) | TRI-CRE |
| | | Ornithischia (*Orthopoda, Ornithopoda, Predentata Stegosauria*) | TRI-CRE |
| | Synapsida [175] | | PEN-JUR |
| | | Pelycosauria | PEN-TRI |
| | | Therapsida [176] | PER-TRI |
| | | Ictidosauria | TRI-JUR |
| | | Mesosauria (*Proganosauria*) | PER |
| AVES | | | JUR-REC |
| | Archaeornithes (*Saururae*) | | JUR |
| | | Archaeopteryges (*Archaeopterygiformes*) | JUR |
| | Neornithes [177] (*Ornithae, Ornithurae*) | | CRE-REC |
| | | Hesperornithes (*Odontolcae, Hesperornithiformes*) | CRE-EOC |
| | | Ichthyornithes (*Odontormae, Ichthyornes, Ichthyornithiformes, Ichthyorniformes*) | CRE |
| | | Sphenisci (*Sphenisciformes, Impennes*) | OLI-REC |
| | | Caenagnathae (*Caenagnathiformes*) | CRE |
| | | Struthiones (*Struthioniformes*) | PLI-REC |
| | | Rheae (*Rheiformes*) | PLI-REC |
| | | Casuarii (*Casuariiformes*) | PLE-REC |
| | | Dinornithes (*Dinornithiformes*) | PLE |
| | | Aepyornithes (*Aepyornithiformes*) | EOC-PLE |
| | | Apteryges (*Apterygiformes*) | PLE-REC |
| | | Crypturi (*Tinami, Tinamiformes, Crypturiformes*) | PLI-REC |
| | | Gaviae (*Gaviiformes*) | EOC-REC |
| | | Podicipedes (*Podicipediformes, Podicipiformes, Colymbae, Colymbiformes, Pygopodes*) | OLI-REC |
| | | Procellariae (*Procellariiformes, Cecomorphae, Turbinares, Tubinares*) | EOC-REC |

[174] *Includes:* Hallopoda.

[175] *Includes:* Promammalia (Protodonta), at one time placed in subclass Prototheria, of Mammalia.

[176] *Includes:* Dromosauria, Deinocephalia, Dicynodontia, Theriodontia, Anomodontia, Theromorpha.

[177] *Includes:* Dromeognathae, Megistanes, Gastornithes, Stereornithes, Carinatae, Colymbomorphae, Pelargomorphae, Alectoromorphae, Coraciomorphae, Limicolae, Pterocletes, Picariae, Musophagi. Neognathae (Euornithes) = all except HESPERORNITHES + ICHTHYORNITHES + IMPENNES. Superorder Odontognathae = HESPERORNITHES (+ ICHTHYORNITHES). Superorder Palaeognathae = CAENAGNATHAE + STRUTHIONES + RHEAE + CASUARII + DINORNITHES + AEPYORNITHES + APTERYGES. Ratitae included STRUTHIONES, RHEAE, CASUARII, DINOR-

| Class | Subcl | Order | |
|---|---|---|---|
| | | Steganopodes (*Pelecani, Pelecaniformes, Pelicaniformes*) | CRE-REC |
| | | Ciconiae [178] (*Ciconiiformes, Gressores, Herodiones Herodii*) | CRE-REC |
| | | Anseres (*Anseriformes, Chenomorphae*) | CRE-REC |
| | | Falcones [179] (*Falconiformes, Accipitres, Accipitriformes*) | EOC-REC |
| | | Galli [180] (*Galliformes, Gallinae*) | EOC-REC |
| | | Grues [181] (*Gruiformes*) | EOC-REC |
| | | Diatrymae (*Diatrymiformes*) | EOC |
| | | Charadriae [182] (*Charadriiformes, Laro-limicolae*) | EOC-REC |
| | | Columbae (*Columbiformes*) | MIO-REC |
| | | Psittaci (*Psittaciformes*) | MIO-REC |
| | | Cuculi (*Coccyges, Cuculiformes*) | OLI-REC |
| | | Striges (*Strigiformes*) | EOC-REC |
| | | Caprimulgi (*Caprimulgiformes*) | PLI-REC |
| | | Macrochires (*Macrochiriformes, Apoda, Apodiformes, Micropodi, Micropodiformes*) | OLI-REC |
| | | Colii (*Colliformes*) | REC |
| | | Trogones (*Trogoniformes*) | OLI-REC |
| | | Coraciae [183] (*Coraciiformes*) | EOC-REC |
| | | Pici (*Piciformes*) | EOC-REC |
| | | Passeres [184] (*Passeriformes*) | EOC-REC |
| MAMMALIA [185] (*Mammifera*) | | | JUR-REC |
| | Prototheria | | PLE-REC |
| | | Monotremata (*Ornithodelphia*) | PLE-REC |
| | Allotheria [186] | | JUR-EOC |
| | | Multituberculata | JUR-EOC |
| | | Triconodonta | JUR |

NITHES, AEPYORNITHES, APTERYGES, CURSORES, PROCERES, BREVIPENNES, CRYPTURI.

[178] *Includes:* Phoenicopteri, Phoenicopteriformes, Amphimorphae, Pelargiformes.

[179] *Includes:* Cathartidiformes.

[180] *Includes:* Opisthocomi, Opisthocomiformes, Heteromorphae, Grallae.

[181] *Includes:* Ralliformes, Heliornithiformes, Hemipodii, Telmatomorphormes.

[182] *Includes:* Alciformes, Lariformes.

[183] *Includes:* Alcedines, Bucerotes.

[184] *Includes:* Eurylaemi, Menurae. Scansores = PICI + PSITTACI in part.

[185] Eplacentalia = PROTOTHERIA + ALLOTHERIA + PANTOTHERIA. Theria = PANTOTHERIA + METATHERIA + EUTHERIA. Promammalia transferred to Reptilia (Synaptida).

[186] *Includes:* Plagiaulacoidea, Tritylodontoidea.

| Class | Subcl | Order | |
|---|---|---|---|
| | | Pantotheria | JUR |
| | | Trituberculata | JUR |
| | | Symmetrodonta | JUR |
| | | Metatheria [187] | CRE-REC |
| | | Marsupialia (*Didelphia*) | CRE-REC |
| | | Eutheria [188] (*Monodelphia, Placentalia, Placentaria*) | CRE-REC |
| | | Insectivora | CRE-REC |
| | | Dermoptera | EOC-REC |
| | | Chiroptera | EOC-REC |
| | | Primates [189] | EOC-REC |
| | | Tillodontia | EOC |
| | | Taeniodonta (*Ganodonta, Stylinodontia*) | EOC |
| | | Edentata (*Xenarthra, Paratheria, Bruta*) | EOC-REC |
| | | Pholidota (*Squamata, Nomarthra*) | OLI-REC |
| | | Lagomorpha (*Duplicidentata*) | EOC-REC |
| | | Rodentia[190] | EOC-REC |
| | | Cetacea [191] (*Mutica, Cete*) | EOC-REC |
| | | Carnivora [192] | EOC-REC |
| | | Condylarthra | EOC |
| | | Litopterna | EOC-PLE |

[187] *Includes:* Polyprotodontia, Caenolestoidea, Diprotodontia, Paucituberculata.

[188] *Includes:* Ancylopoda, Chalicotheria, Taxeopoda, Quadrumana, Daubentomioidea, Subungulata, Pithecoidea, Platyrhina, Simiae, Toxodontia, Barytheria, Carnivores, Edentates, Ungulates, Bunotheria. Unguiculata = INSECTIVORA + DERMOPTERA + CHIROPTERA + PRIMATES + TILLODONTIA + TAENIODONTA + EDENTATA + PHOLIDOTA. Ungulata = Protungulata (CONDYLARTHRA + LITOPTERNA + NOTOUNGULATA + ASTRAPOTHERIA + TUBULIDENTATA) + Paenungulata (PANTODONTA + DINOCERATA + XENUNGULATA + PYROTHERIA + PROBOSCIDEA + EMBRITHOPODA + HYRACOIDEA + DESMOSTYLIFORMES + SIRENIA + PERISSODACTYLA + ARTIODACTYLA). Glires = LAGOMORPHA + RODENTIA. Mutilata = CETACEA + SIRENIA. Protungulata = CONDYLARTHRA + LITOPTERA + NOTOUNGULATA + ASTRAPOTHERIA + TUBULIDENTATA. Therictoidea = INSECTIVORA + Ferae. Archonta = Menotyphla + DERMOPTERA + CHIROPTERA + PRIMATES. Paenungulata = PANTODONTA + DINOCERATA + PYROTHERIA + PROBOSCIDEA + EMBRITHOPODA + HYRACOIDEA + SIRENIA. Diplarthra = PERISSODACTYLA + ARTIODACTYLA.

[189] *Includes:* Anthropoidea, Lemuroidea, Prosimii.

[190] *Includes:* Simplicidentata.

[191] *Includes:* Zeuglodontia, Archaeoceti, Odontoceti, Mystacoceti.

[192] *Includes:* Fissipedia, Creodonta, Pinnipedia, Ferungulata, Ferae.

[193] *Includes:* Taxodontia.

[194] *Includes:* Amblydactyla, Taligrada, Coryphodontia.

[195] *Includes:* Myohyracoidea.

| | |
|---|---|
| Notoungulata [193] | EOC-PLE |
| Astrapotheria | EOC-MIO |
| Tubulidentata | EOC-REC |
| Pantodonta [194] (*Amblypoda*) | EOC-OLI |
| Dinocerata (*Uintatheria*) | EOC |
| Pyrotheria | EOC-OLI |
| Proboscidea | EOC-REC |
| Embrithopoda (*Barypoda*) | OLI |
| Hyracoidea [195] (*Hyraces*) | OLI-REC |
| Sirenia | EOC-REC |
| Perissodactyla (*Mesaxonia*) | EOC-REC |
| Artiodactyla (*Paraxonia*) | EOC-REC |

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MANY BOOKS, pamphlets, and articles have been consulted in the preparation of this classification. A listing of all of these appears to serve no essential purpose here. The list given below therefore contains principally recent works in which a formal classification is presented for the entire animal kingdom or a major part of it. The list is intended merely as background for the present classification. It does not contain references to all authors and works cited in the text.


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# INDEX TO COMMON NAMES

# INDEX TO LATIN NAMES

# Classification of the ANIMAL KINGDOM

BY *Richard E. Blackwelder*

The classification of animals is still very much a field in which discovery and revision are continuing, even after two hundred years of study. Yet, the importance of classification in biology increases every year because the experimental and practical fields find increasing need for accurate identification of animals and for understanding of comparative relationships.

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RICHARD E. BLACKWELDER is an Associate Professor of Zoology at Southern Illinois University. He formerly was Associate Curator at the American Museum of Natural History, New York, and at the National Museum, Washington, D C. In 1961 he was President of the Society of Systematic Zoology. He is the author of more than one hundred monographs and articles and compiler, with Ruth M. Blackwelder, of *Directory of Zoological Taxonomists of the World.*

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