

Introduction to Biosystematics

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1. Zoology

- Zoology: zôon = animal, logos = science.
- Study of animals.
- It deals with cytology, histology and anatomy.
- It includes several disciplines:
 - Ecology: relationships between living organisms and their environment.
 - Biogeography: distribution of animals in their environment.
 - Physiology: determination of the functions specific to the various organs.
 - Systematics: classification and study of the different characteristics among species.

2. Branches of Zoology

- Zoology is subdivided into:
 - Entomology: the study of insects.
 - Herpetology: the study of reptiles and amphibians.
 - Ichthyology: the study of fish.
 - Mammalogy: the study of mammals.
 - Ophiology: the study of snakes.
 - Ornithology: the study of birds.
 - Batrachology: the study of frogs/batrachians.
 - Malacology: the study of molluscs.
 - Arachnology: the study of arachnids.
 - Carcinology: the study of crustaceans.
 - Cetology: the study of cetaceans.
- Note: Fauna is the set of animals inhabiting a region; it is directly related to the existing flora.

3. Animal Taxonomy

- Animal taxonomy = the science that studies the classification of different animal species.
- The word is composed of two Greek words: Taxo = arrangement + nomos = laws or rules.
- Example: insects or Hexapoda include species that have 6 legs.
- The Swedish scientist Linnaeus (1707–1778) laid the foundations of classification in his book *Systema Naturae* with his binomial nomenclature.

4. Phylogeny / Cladistics

- Phylogeny or cladistics is based on DNA analysis.
- It recognizes one particular classification unit: the clade.

- A clade is a group of organisms forming a monophyletic group, i.e. the whole of a lineage (one common ancestor and all its descendants).
- It is based only on homologous characters; this is a stricter and more objective approach.
- It permits only monophyletic groups (descendants of a common ancestor).
- It groups all descendants of one common ancestor to form a clade.

5. Bases of Taxonomy

- Classification is the use of the rules of taxonomy and nomenclature.
- Its principle is to group organisms into categories:
 - according to their affinities and differences;
 - sharing common characters;
 - originating from the same evolutionary lineage.
- Animal species are designated by two names: genus (capitalized) and species (lowercase).
- In decreasing order of importance or rank, the most commonly used taxa are:

6. Taxonomic Ranks

- Kingdom
- Phylum
- Class
- Order
- Suborder
- Infraorder
- Superfamily
- Family
- Subfamily
- Tribe
- Genus
- Species
- Subspecies / variety or race.

7. Example of Classification

- Kingdom: Animalia
- Phylum: Arthropoda
- Subphylum: Mandibulata
- Class: Insecta
- Subclass: Pterygota
- Superorder: Neoptera
- Order: Orthoptera
- Suborder: Caelifera

- Superfamily: Acridoidea
- Family: Acrididae
- Subfamily: Caliptaminae
- Genus: Calliptamus
- Species: Calliptamus barbarus

8. The Species

- An important and fairly stable concept in classification is that of the species.
- This grouping is relatively well defined, especially for sexually reproducing species. It is the basic concept.
- A species is defined as:
 - a community of interbreeding or interfertile living organisms;
 - capable of reproducing with one another;
 - able to exchange genetic material and produce offspring that are themselves fertile.
- Note: some individuals of the same genus but belonging to different species can interbreed and produce a hybrid individual, but the latter is most often sterile.

9. Binomial Nomenclature

- Since Linnaeus (1707–1775), a species has always been designated by two Latin names for international understanding (binomial nomenclature).
- The first name is the genus name and always begins with a capital letter.
- The second name is the species name and begins with a lowercase letter.
- The two names of the species are followed by the abbreviated name of the author who first named the species and then the date of description.
- Once named and described in a scientific text, a species can no longer change its name.
- These nomenclatures do not contain accents.
- If the genus and species were given by the same author, parentheses are not placed around the author's name or the date.

10. Examples of Nomenclature

- *Felis leo* L., 1758 (the lion)
- *Rattus rattus* L., 1758 (the rat)
- *Pycnonotus barbatus* Desf., 1757 (the bulbul)
- If the genus was given by one author, parentheses are used.
 - Example: *Dilodus punctatus* (Gemelin, 1789) (the sharpsnout seabream, fish)
 - *Trigla cuculus* (Bloch, 1815) (the gurnard, fish)
- In many cases, detailed systematic study leads to the recognition of subspecies and the use of trinomial nomenclature (first used by Schlegel in 1844).
 - Example: the subspecies of goldfinch, the grey-headed goldfinch: *Carduelis carduelis caniceps*.
- Remark (1): the species name is written in italics in typed text or underlined when handwritten.

- Remark (2): if the genus is known but the species is unknown, the genus is followed by sp. (sp. = specimen) for an unidentified species.
- Example: Calliptamus sp.

11. Determination of an Animal Species

- To determine an animal species, it must be described according to:
- External morphology, observable with the naked eye or by optical or electron microscopy (protozoans), e.g. integument, wings, legs.
- Internal anatomy, requiring dissection, can provide information about the position of the nervous system or the type of circulatory system.
- Embryology, involving experiments such as cell labeling, can show the type of segmentation or gastrulation.
- These observations make it possible to determine which phylum and class it belongs to.
- More precise determination (order, family) is carried out using criteria specific to each class.
- For example, in insects, the appearance of the wings (membranous, leathery), their number and venation are studied, followed by the shape of the legs or the types of mouthparts.

12. Biosystematic Classification Methods

- Animals are classified according to different biosystematic methods, namely:
- Unicellular / multicellular:
 - Protozoans: unicellular organisms, generally heterotrophic (they do not produce their own food).
 - Metazoans: multicellular and heterotrophic organisms.
- Nature of tissues:
 - Parazoans (sponges), comprising multicellular organisms without true tissues.
 - Eumetazoans, having true tissues.

13. Symmetry and Internal Cavity

- Symmetry pattern:
 - Radiata: animals with radial symmetry.
 - Bilateria: animals with bilateral symmetry.
- Internal cavity.
 - Bilaterians are divided into 3 groups using the presence of an internal cavity, the coelom, as a criterion.
 - We distinguish:
 - Acoelomates: without a coelom; e.g. the tapeworm of the phylum Platyhelminthes.
 - Pseudocoelomates: animals with an internal cavity that is not a true coelom; e.g. Ascaris (phylum Nematelminthes).
 - Coelomates: animals having a true coelom; e.g. earthworm (phylum Annelida).
- Origin of the mouth:
 - During embryonic development, coelomates are divided into:
 - Protostomes: the mouth derives from the blastopore (the first opening appearing at the gastrula stage).
 - Deuterostomes: the mouth derives from an opening that appears later during development.

14. Organization Plan of the Animal Kingdom

- Plan of organization of the animal kingdom.

15. Protozoans (Unicellular)

- First stage: appearance of unicellular organisms.
- Characterized by microscopic size.
- A single independent cell containing a certain number of organelles that perform all functions (digestion, respiration, synthesis, locomotion, support, etc.).
- Systematics is based on the nature of the locomotory apparatus and developmental characteristics.
- Among these phyla:
 - 1. Phylum of Flagellates = Dinoflagellata
 - 2. Phylum Rhizopoda
 - 3. Phylum Actinopoda
 - 4. Phylum Sporozoa
 - 5. Phylum Ciliates = Ciliophora
 - 6. Phylum Cnidosporidia

16. Protozoan Groups

- Flagellates
- Rhizopods
- Actinopods
- Sporozoans
- Ciliates
- Cnidosporidia

17. Metazoans (Multicellular)

- Second stage: appearance of metazoans.
- Differentiated cells grouped into false or true tissues.
- Cells constituting an animal organism can associate in two ways:
 - Loosely:
 - Cell junctions are few.
 - Metazoans without true tissues = parazoans.
 - Solidly:
 - Thanks to the presence of numerous cell junctions and the formation of a basal lamina at the base of epithelia.
 - Animals with true tissues = eumetazoans.
 - They are capable of sexual reproduction.
 - Fertilization of the ovum by a spermatozoon results in the formation of an egg or zygote.

18. Diploblasts and Triploblasts

- Eumetazoans are divided into 2 categories:
- Diploblasts = Didermic organisms:
 - development stops at the gastrula stage;
 - composed of 2 cellular layers, the ectoderm and endoderm.
- Triploblasts = Triblasts:
 - development continues after gastrulation;
 - a third cellular layer is established between the other two;
 - this is the mesoblast, which gives rise to the mesoderm in the adult.

19. Diploblasts

- Organism composed of 2 cellular layers: ectoderm (external) and endoderm (internal).
- They form the groups:
 - Sponges (Porifera)
 - Cnidarians
 - Ctenophores
- Body = a simple sac limited by these 2 layers.

20. Triploblasts

- Formation of a third intermediate layer: the mesoderm.
- Appearance of new tissues such as muscular tissue.
- The mesoderm permits the formation of true organs functioning as organ systems: reproductive, circulatory, excretory systems, etc.
- According to the mesoderm, 3 groups are distinguished:

21. Acoelomates, Pseudocoelomates and Coelomates

- Acoelomates:
 - body without a cavity between the digestive tract and the body covering;
 - compact mesoderm = filling tissue;
 - phylum Platyhelminthes (flatworms).
- Pseudocoelomates:
 - cavity present, but not entirely surrounded by mesodermal tissue;
 - phylum Nematelminthes (roundworms).
- Coelomates:
 - true coelom;
 - body cavity entirely surrounded by mesodermal tissues;
 - tissues form, on both sides of the digestive tract, pairs of symmetrical cavities;
 - according to the fate of the blastopore, two groups are distinguished:

22. Protostomes

- Proto = first, stoma = mouth = mouth formed first.
- The blastopore gives rise to the mouth of the future adult.
- Egg cleavage is of the spiral type.
- The nervous system is organized into a single ganglionic nerve chain.
- Below the digestive tube, the blastoporal or neural surface becomes ventral, hence the name Hyponeurians.
- Phyla: Annelids, Molluscs and Arthropods.

23. Deuterostomes

- Deutero = second = mouth formed second.
- The blastopore becomes the anus of the adult; the mouth forms secondarily.
- Egg cleavage is of the radial type.
- The structure of the nervous system makes it possible to distinguish:
 - Epithel neurians (nerves in the epithelium):
 - nervous system imperfectly separated from the ectoderm from which it derives;
 - it is integumentary;
 - Echinoderms and Stomochordates.
 - Epineurians (dorsal nervous system):
 - nerve centers are located above the digestive tube;
 - Prochordates and Vertebrates.

English translation prepared from the uploaded course. Terminology and organization follow the source document.