**Zoology**

**1-Introduction**

Zoology aims to study very diverse animals. She is interested in structures through the study of anatomy, cytology and histology. She studies the relationships between living beings and their environment (ecology). She is interested in the distribution of animals in the environment where they live (biogeography). She is interested in determining the functions specific to various organs (physiology). She is interested in studying the different characters that allow us to differentiate between species (systematics).

Fauna is a group of animals that inhabit a region, it is directly related to the existing flora.

Animal taxonomy is the science that studies the classification of different animal species.

Taxonomy consists of two Greek words, Taxo = order + nomos = laws, rule.

So it is science that is interested in the classification of animal species according to well-defined criteria.

For example, vertebrates include species that have a backbone. Invertebrates all animal species that do not have a backbone.

It was the Swedish scientist Carl Linnaeus (1707-1778) who was the first to lay the foundations of classification in his book Systema natura with its binomial nomenclature.

Classification is the use of the rules of taxonomy and nomenclature to divide beings into categories according to their affinities and differences.

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**2- Systematic hierarchy**

The main categories of systematics are as follows, in descending order of their importance or level: Kingdom, Phylum (Division), Class, Order, Family, Genus and Species.

The classification of species forms a sort of pyramid. Basically the simplest unit is the species. The genera are then grouped into families, the families into orders, the orders into classes, the classes into Phyla or Phylum (phylum) and finally the Phylums into Kingdom. There are intermediate categories, intended to multiply the levels of this hierarchy. For example, we distinguish subspecies, subfamilies or superfamilies, suborders or superorders. Other terms are sometimes used for further classification such as tribe, section, etc.

Exp: Classification of the domestic bee

Kingdom: Animalia

Phylum: Arthropoda

Subphylum: Hexapoda

Class: Insecta

Order: Hymenoptera

Family: Apidae

Genus: *Apis*

Species: *Apis melliphera*

**3- Binomial naming**

Since Linnaeus (1707-1775), the species has always been designated by two Latin names for international understanding (binomial nomenclature). The first name is that of the genus always begins with a capital letter, the second name is that of the species 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 cannot change its name. These nomenclatures do not have an accent. If the genus and species are given by the same author, do not put a parentheses on the author's name or the date.

**Exemple :**

*Felis leo* L., 1758 (The lion), *Rattus rattus* L., 1758 (The rat)

 If the genus is given by an author, a parentheses is added.

**Exemple :**

*Dilodus puntazzo* (Gemelin, 1789) ( Sar, fish)

**Note (1):** The species name is written in italics if the text is typed or underlined if the text is handwritten.

**Note (2):** If the genus is known but the species is unknown, enter the genus followed by the sp. (sp = specimen) for an unidentified species. Example: *Monomorium sp.*

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**4- endings**

Class: **EA**. EX: Zoomastigophor**ea**

Order: **IDA** or **ERA**. EX: Dinoflagell**ida**, Hymenopt**era**

Superfamily: **OIDEA**. EX: Ap**oidea**

Family: **IDAE.** EX: Halict**idae**

Subfamily: **INAE**. EX: Halict**inae**

Tribe: **INI**. EX: Halict**ini**

**5- Evolution and phylogeny**

**a- Protozoa (unicellular)**

This first unicellular stage corresponds to the appearance of unicellular organisms. These so-called primitive organisms are characterized by a microscopic size. This single independent cell has a certain number of organelles which allow the cell to perform a certain number of functions (digestion, respiration, synthesis, locomotion, support, etc.). The systematics of protozoa is essentially based on the nature of the musculoskeletal system and the characteristics of development.

Protozoa are unicellular eukaryotic living beings (which have a true nucleus), heterotrophs (incapable of synthesizing organic matter).

**b- Metazoa (multicellular)**

Metazoa constitute, in the classification of living things, all animals, eukaryotic beings, multicellular, heterotrophic and generally mobile. Opposing protozoa, they bring together 35 phyla comprising a total of more than a million species, adapted to all environments. Metazoans are extremely diverse, from sponges to elephants, including starfish, snails and humans.

Egg morula blastula gastrula (Ectoderm and endoderm separated by the mesoglea).

**Morula:** is the name given to the embryo at a very early stage of development. We speak of Morula when the embryo has 16 to 64 cells (also called blastomeres). After this stage, the blastocoele appears and there we speak of blastula which is a cavity appearing between the blastomeres (characteristic of the blastula stage. It is filled with liquid, water and salts).

**Blastula:** early stage of embryonic development, the blastula appears as a hollow sphere of the blastocoel.

**Gastrula:** this is the name given to the embryo formed by gastrulation. It is a stage of embryonic development characterized by the invagination of one of the poles of the blastula in the form of a bag with two layers (ectoderm and endoderm) or three layers (ectoderm, mesoderm and endoderm) depending on the group of the animal.

Metazoa (diploblastic) 2 sheets (sponges, cnidarians, ctenaries)

Triploblastic Metazoa (3 sheets) are classified according to the presence of the Coelom

Cœlome: from the Greek Koilos which means cavity

Metazoa (triploblastic) : Acoelomates, Pseudocoelomates, Coelomates.

1- Acœlomates (absence of the coelom): have a kind of mesenchyme which fills the space between the ectoderm and the digestive tract. Ex: Phylum Platyhelminthes (flatworms).

2- Pseudocoelomates: we detect the existence of a cavity filled with liquid, but the mesoderm only participates in its delimitation (general cavity incompletely lined by the mesoderm). Ex: Phylum Nemathelminthes (roundworms).

3- Coelomates: (the mesoderm clearly demarcates the coelomic cavities). The evolution of coelomates took place in such a way that two distinct lineages were formed: the Protostomes and the Deuterostomes.

Evolution of the blastopore :

the transition from the monoblastic state (blastula) to that of diploblastic or triploblastic (gastrula) is carried out by invagination of potentially endodermal and/or mesodermal cells, this is the phenomenon of gastrulation. This morphogenetic movement takes place in a precise location which will remain marked by a small orifice: the blastopore.

The invaginated cells form an empty pocket, the archenteron, the future digestive tract of the animal. In Protostomes, the blastopore is at the origin of the future mouth, in Deuterostomes, it gives rise to the anus, with the mouth forming secondarily.

Protostomes have a ventral nerve chain, they are Hyponeurians. Ex: annelids, molluscs, arthropods.

For the Deuterostomes, we distinguish two large groups:

a- Epineurians: have a dorsal nervous system (vertebrates: fish, reptiles, birds, man).

b- Epithelioneurians: their nervous system is very superficial. Ex: (Echinoderms, Sea urchins).

**Numerical importance of the animal kingdom:**

|  |  |
| --- | --- |
| **phylum** | **Nbr of species** |
| Arthropoda | > 1200000 |
| Mollusca | > 130000 |
| Nematoda | > 90000 |
| Chordata | > 47200 |
| Apicomplexa | > 20000 |
| Plathelminthes | > 20000 |
| Annelida | > 15000 |
| Cnidaria | > 10000 |
| Ciliophora | > 8000 |
| Echinodermata | > 7000 |
| Porifera | > 5000 |
| Sarcomastigophora  | > 4500 |

**II- Sub kingdom of the Protozoa**

**1- general information on Protozoa**

Protozoa are single-celled eukaryotic organisms.

Their morphology is extremely variable. In this group there are very simple shapes alongside highly complex shapes.

They are mostly microscopic, but their size varies from a few µm to a few mm.

The nucleus and cytoplasm are also varied. They are single or multinucleated. The central part of the cytoplasm called endoplasm is often distinguished from the peripheral part called ectoplasm.

**Functions of Protozoan Organisms :**

Given the diversity of their shape, their way of life, their habitat, their nutrition, etc., several functions are specific to the kingdom of protozoa.

**A- Locomotion :**

The locomotor organs are mainly cilia, flagella and pseudopods.

**Cilia and flagella :**

Many protozoan cells use cilia and flagella for locomotion. They are also used to create a current of water for their: nutrition, respiration, excretion and osmoregulation. All cilia and flagella have a basal corpuscle or blepharoplast at their base.

**Pseudopods :**

Pseudopods constitute the main means of locomotion of amoebae. They contain ectoplasm and endoplasm.

**B- Excretion and osmoregulation**

The excretory organelles are contractile vacuoles. These vacuoles, which fill with liquid and empty intermittently, are of variable complexity. They are often called water expulsion vesicles. They play a role in osmoregulation.

In amoebae, contractile vacuoles are formed by progressive fusion of small vacuoles, then attach to the plasma membrane to empty their contents outside.

In certain ciliates (Paramecium), the contractile vacuoles have a fixed position and contract alternately.

**C-Nutrition**

Protozoa can be classified into two groups: autotrophs and heterotrophs. Autotrophs feed through photosynthetic activity.

Among heterotrophs, we distinguish phagotrophs (feed by phagocytosis), and osmotrophs (feed by pinocytosis or diffusion).

**D- Reproduction**

One of the main characteristics of protozoa is their great capacity for multiplication. There are two modes of reproduction

**Asexual reproduction :**

she can be

* **A binary fission**, during which the individual separates laterally in two to produce two identical individuals of the same size, resulting from a simple mitosis. It is longitudinal in flagellates and transverse in ciliates.
* **A budding** during which an extension of the organism separates and produces a new individual.
* **Multiple fission** or schizogony where the multinucleated parent divides into several cells of similar size (division of the cytoplasm preceded by one or more nuclear divisions).

**Sexual reproduction**

It can be sexual by syngamy (union of a male and female gamete to form an egg) or by conjugation in ciliates, a special mechanism of exchange of genetic material which does not involve gametes.

**E- Defenses**

Amoebae that live in soil produce cysts when conditions become harsh. These cysts are resistant to desiccation and freezing.

Many ciliates have trichocysts that look like small harpoons and are often coated with paralyzing substances. These trichocysts are used to immobilize prey and are released when a predator touches the ciliate.

The flagellate responsible for sleeping sickness (Trypanosoma) protects itself from attacks by the immune system by continually modifying their cytoplasmic membrane (glycocalyx) in such a way as to render the antibodies ineffective.

**Lifestyle**

The majority of protozoa are free aquatic heterotrophs. Various lifestyles are represented: free, parasitic, commensal, symbiont, aquatic or terrestrial. Some are colonial.

**2- Classification**

The systematics of protozoa is based on the means of locomotion. Among the main phyla belonging to the protozoa.

**2-1- Phylum of Sarcomastigophora or Rhizoflagellates**

This phylum includes amoebae and flagellates

**A- Sub phylum of Mastigophora**

Mastigophores have flagella. They bring together two classes

**Class Phytomastigophorea**

They are free organisms. They have one or two flagella. They have an affinity with the plant kingdom. They have chloroplasts or other pigmented forms. They are autotrophic. Ex: Euglena

**Class Zoomastigophorea**

They have affinities only with the animal kingdom. They have one or more flagella and they are heterotrophic. This class includes free forms such as choanoflagellates, parasitic forms such as Trypanosoma gambiense (agent of sleeping sickness in humans) transmitted to humans by the bite of the tsetse fly (Glossina palpalis) and symbiotic forms such as Trichonympha which lives in the intestine of termites.

**B- Sub Phylum Sarcodina**

They move in pseudopodia. They bring together the super class Rhizopoda which includes:

* Naked amoebae such as Entamoeba histolytica which parasitize the human intestine and cause amoebic dysentery.
* Amoebae surrounded by a secreted capsule or composed of exogenous debris such as Difflugia.

**2-2- phylum of Ciliophora or Ciliata**

Ciliates are the most specialized protozoa and those with the greatest structural complexity. They are characterized by the presence of numerous vibratile cilia during at least part of their biological cycle.

The cilia can clump together and form either cirri, more specifically locomotor organelles, or membranes with a nutritional role.

Ciliates have a dual nuclear apparatus, a macronucleus (n) which controls cellular function and one or more micronuclei (2n) which are involved in sexual reproduction. They present various lifestyles: free in an aquatic environment, fixed pedunculated, commensal, symbiotic or parasitic. Among the classes belonging to this phylum.

**A- Class Spirotrichea**

They are very evolved, characterized by the presence of a fringe of powerful adoral membranes which surround the peristome. Example: Stentors, very large (from 500 microns to 1 millimeter). They are shaped like a trumpet, completely covered in eyelashes. They can attach themselves by the pointed rear end or swim freely.

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**B- Class Oligohymenophorea**

Constitute an important class of ciliates. They are aquatic in most species, the body cilia are uniform and often dense, while the oral cilia are simple and sometimes reduced (or vice versa). The cytostome is ventral or close to the anterior end. Among the subclasses belonging to this group :

**Subclass Peritrichia**

The temporary somatic ciliature is reduced to a posterior circle of locomotor cilia. Species in this subclass are generally stalked and sedentary. Ex: Vorticella

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**Subclass Hymenostomatia**

The somatic ciliature is uniform, abundant, the oral cavity is ventral. Ex: *Paramecium*

*Paramecium caudatum*: *paramecium* is found in fresh water among submerged plants, it is very easy to cultivate, a simple grain of wheat immersed in a test tube is enough to make paramecium appear after a few days.



***Paramecium sp.***

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**Sexual reproduction in Ciliophora**

In ciliates, sexual reproduction occurs by conjugation. Ex: conjugation in Paramecia :

Two individuals, necessarily from different parents, come together mouth to mouth. The macronuclei dissolve, the micronuclei undergo meiosis, that is to say a multiplication which transforms each 2n micronucleus (double genetic material) into 4 n micronuclei, three of the four micronuclei degenerate and the last divides into two pronuclei . Each partner then exchanges, through the attached membranes, one of its pronuclei, and the pronucleus received unites with the one remaining in place, there is therefore a recombination of the genetic materials of each partner (Syncarion).

The paramecia separate, the nuclei fuse, and divide several times, reforming the macronucleus and the micronucleus. Paramaecia divide by mitosis.

Bas du formulaire

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