''बेटी बचाओ, बेटी पढ़ाओ''

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Faculty Name - JV'n Dr. Abinash Parida (Assistant Professor)

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Session No. & Name - 1.1 (Name of the Session): Taxonomy

Academic Day starts with –

- Greeting with saying **'Namaste'** by joining Hands together following by 2-3 Minutes Happy session, Celebrating birthday of any student of respective class and **National Anthem**.

Lecture Starts with-

- Academic Day ends with- National song' Vande Mataram'

Taxonomy

INTRODUCTION

In a broad sense, taxonomy is the science of categorization, but more specifically, it is the biological classification of living and extinct creatures. The word is derived from the Greek words for "arrangement" and "law": taxis and nomos. Therefore, taxonomy is the methodology and guiding principles of systematic botany and zoology. It organises different plant and animal species

into hierarchies of superior and inferior groupings. Augustin Pyramus de Candolle, a Swiss botanist, coined the phrase for the classification of plants in 1813. In his well-known book, Theory elementaire de la botanique (Elementary Theory of Botany), he coined the phrase. Taxonomy is the classification of plants and animals according to a set of rules.

According to Simpson (1961), taxonomy is the theoretical study of classification, encompassing its foundations, guiding principles, methods, and regulations. Taxonomy, according to Ernst Mayer, is the study and application of classifying living things. Taxonomy is the study of classification, thus.

"The practise of recognising, naming, and ordering taxa into a system of words consistent with any kind of relationships among taxa that the investigator has discovered in nature," according to Kristofferson (1995), is the definition of taxonomy. Generally speaking, superficial categorization of living things develop according to necessity. Any crawling object, such as a snake, earthworm, intestinal parasite, or dragon, has been referred to, respectively, by the Anglo-Saxon phrases worm and fish. There are more anatomical distinctions between a shellfish and a starfish than there are between a bony fish and a man, despite the fact that the terms shellfish, crayfish, and starfish all include the term "fish." Vernacular names come in a vast variety. The English robin (Erithacus rubecula) is not the American robin (Turdus migratorius), for instance, while the mountain ash (Sorbus) only superficially resembles a real ash.

However, biologists have made an effort to examine every living thing as thoroughly, leading them to create a systematic taxonomy. Cross-referencing and information retrieval are made easier by using a formal classification as the foundation for a nomenclature that is largely consistent and understood globally.

When it comes to biological classification, the terms TAXONOMY and SYSTEMATICS are used in a variety of ways. According to American evolutionist Ernst Mayer, "taxonomy is the theory and practise of classifying

organisms," while "systematics is the science of the diversity of organisms"; the latter, in this sense, has significant interactions with evolution, ecology, genetics, behaviour, and comparative physiology that taxonomy need not.

The process of taxonomy involves two distinct steps:

(i) Correct recognition and definition of the organisms and their relationships and

(ii) Application of suitable designations for the organisms and to different groups which

include them.

The former is called classification which includes study of characters and grouping of individuals while the latter is termed as nomenclature.

History

People who are surrounded by nature frequently have a thorough understanding of the local fauna and flora that is significant to them. They are also frequently familiar with many of the broader groups of living creatures (such as fishes, birds, and mammals). However, their knowledge is based on necessity, and they hardly ever make generalisations.

However, the ancient Chinese and Egyptians made some of the earliest attempts at formal, albeit constrained, classification. Later hydrological research were based on a Chinese list of 365 types of medicinal herbs. The catalogue was probably created during the start of the first millennium, even though it is said to be from the mythological Chinese monarch Shennong, who flourished around 2700 bce. Similar descriptions of various medicinal plants, together with instructions on how to utilise them to treat ailments and injuries, can be found in ancient Egyptian medical papyri dated between 1700 and 1600 BC.

Aristotle, who practically created the science of logic, of which categorization was a component for 2,000 years, was the first great generalizer in Western classification. Aristotle appears to have studied the ocean and marine life extensively while he was on the island of Lesbos because the Greeks were constantly in contact with them. He mentioned many different natural groups in his writings, but his ranking of them from simple to sophisticated was not an evolutionary one. But he was far ahead of his time in categorising invertebrate creatures into distinct subgroups and was aware that whales, dolphins, and porpoises were not fish but had mammalian characteristics. Naturally, he was unable to deal with the minuscule forms of life as he lacked a microscope.

Up to the 19th century, the Aristotelian method dominated classification. He basically proposed that in order to categorise a living thing according to its nature—that is, what it truly is, as opposed to superficial similarities—it is necessary to examine numerous specimens, discard variable characteristics (since these must be unintentional and not essential), and establish constant characteristics. The essence of the living thing—what makes it what it is and cannot be changed; the essence is, of course, immutable—can then be stated using these to construct a definition. The Greeks were enthralled by mathematics, particularly geometry, which serves as the model for this process. Since its definitions were flawless and its inferences from axioms were assured, regardless of whether a perfect geometrical object could ever be produced, mathematics looked to them to be the type and example of perfect knowledge. However, the Aristotelian method used to study living things does not proceed by deduction from established and well-known axioms, but rather by induction from observed examples, which does not result in the discovery of an unchanging essence but rather in a lexical definition. Although it offered a method for trying to characterise living things via meticulous analysis for centuries, it ignored the diversity of living things. It is interesting that

empiricists, who did not believe in an essence of each, were among the few in the mid-19th century who comprehended Charles Darwin's ORIGIN OF SPECIES.

For 1,400 years, neither Aristotle nor Theophrastus, his botany student, had any significant successors. Around the 12th century, botanical publications required for medicine started to include realistic plant images, and some even started grouping related plants together. Encyclopaedists also started to combine some modern observations with conventional wisdom. The treatise on human anatomy by Andreas Vesalius was published in 1543, and the first university botanic garden was established at Padua, Italy, in 1545, during the first blooming of the biological Renaissance. Work in zoology and botany blossomed after this. The systematic knowledge that was then available was compiled by John Ray in the late 17th century, along with helpful classifications. In 1703, he distinguished between monocotyledonous and dicotyledonous plants, identified the actual affinities of whales, and provided a practical description of the species concept, which had already evolved into the fundamental unit of biological taxonomy. He used practical observation to modify the Aristotelian logic of classification.

Levels of Taxonomy

There are three levels of taxonomy corresponding with three periods of taxonomy:

(i) Alpha taxonomy : The level of taxonomy by which species are characterized and naming of the species is done.

(ii) Beta taxonomy : The level of taxonomy by which the arrangement of species in their natural system of categories is made.

(iii) Gamma taxonomy : The level of taxonomy which deals with the intra specific variations and evolutionary sequence and also a causal interpretation of organic diversity.

Mayer and Ashlock (1991) have divided the taxonomy into two levels:

(i) Micro taxonomy : The level which deals only the problems related to species.

(ii) Macro taxonomy : The level which deals with the problems and principles of higher taxa (from subgenus and above) only.

Mayer and Ashlock (1991) recognize three schools of macro-taxonomy such as:

(i) Phonetics (or Numerical taxonomy),

(ii) Cladistics (Phylogenetic systematics) and

(iii) Evolutionary taxonomy (or Evolutionary systematics).

(i) **Phenetics (or Numerical taxonomy) :** It is an effort to categorise species based on general traits as opposed to their shared evolutionary history. On the basis of similarities and differences, phenetics aids in the drawing of phyletic lineage (connection). Pheneticists do not rely on plesiomorphic and apomorphic primitive and derived features.

(ii) Cladistics (Phylogenetic systematics) : The term "cladistics" refers to taxonomy, which ranks and categorises species based on their "recency of common descent." According to this idea, the location of branching nodes on the evolutionary tree determines the animal's category status.

Taxa with wholly derived (synapomorphic) shared characteristics descended from a single ancestor. Identification of monophyletic lineages or clades is accomplished by phylogenetic analysis. 'Clade' was first used by Julian Huxley in 1958, while 'cladistic' was coined by Cain and Harrison in 1960.

(ii) **Evolutionary taxonomy (or Evolutionary systematics) :** The Darwinian theory underlies the entire idea. This idea holds that every valid taxon descends from a common ancestor, but that similar traits of a biological domain do not always involve a shared ancestry.

A branch of biological classification known as the evolutionary or Darwinian classification uses phylogenetic relationships and general similarity to classify species. In this kind of taxonomy, taxa are valued more highly than individual species.

Usually taxonomists agree to divide the taxonomy into two types:

(i) Classical taxonomy and

(ii) Neo-taxonomy or experimental taxonomy.

(i) Classical taxonomy : The Darwinian theory underlies the entire idea. This idea holds that every valid taxon descends from a common ancestor, but that similar traits of a biological domain do not always involve a shared ancestry.

A branch of biological classification known as the evolutionary or Darwinian classification uses phylogenetic relationships and general similarity to classify species. In this kind of taxonomy, taxa are valued more highly than individual species.

(iii) **Experimental taxonomy or neo-taxonomy :** It is connected to genetic research based on a shared gene pool for a taxon and has proven useful in differentiating between two taxa. Data collection for morphology is done using some contemporary techniques. The study of the fine structures that are useful in morph taxonomy is done using an electron or scanning electron microscope on several types of invertebrates, such as protozoans, helminthes, and arthropods.

The closely related two current aspects in taxonomy are taken into consideration,

such as:

(i) Biochemical taxonomy and

(ii) Cytological taxonomy.

(i) Biochemical taxonomy : It deals with taxonomic traits discovered through chemical investigation of peptides, nucleic acids, amino acids, and sugars in proteins, hormones, and enzymes.

The amino acid sequences of proteins change in many organisms and are useful for classifying various species. Enzymes, hormones, nucleic acids, amino acids, and other constituent bio-molecules are studied using a variety of approaches that aid in systematics.

In the study of systematics, several techniques are used to examine the chemical components, including immunological, chromatography (paper chromatophy and column chromatography), and electrophoretic method. Two distinct taxa are distinguished using the immunological data. Pigeons and primates are categorised using the blood group genes.

Chromatography is a variety of techniques for the separation of complex liquid mixtures, such as biological fluids (such as amino acids, steroid, carbohydrate, etc.), that pass through a column of adsorbing material (such as paper, magnesia), where the mixture's components are adsorbed in separate layers.

Snails and other groups of arthropods use this strategy, and the data is particularly useful for animal systematics.

(ii) Cytotaxonomy : It deals with taxonomic traits discovered through cytological research. A discipline of taxonomy known as cytotaxonomy

studies the relationships and chromosome-based classification of organisms. An essential aspect of chromosome structure that aids in taxonomic investigations is the location of the centromere.

Periods of Taxonomy

(i) **First period :** From the time of Aristotle (384-322 B.C.) until Linnaeus (1707-1778), this era may be added. During this time, Linnaeus vigorously promoted binominal nomenclature for both plants and animals and classified animals in accordance with Aristotelian and Democritus principles. He was also the first to introduce the class, order, genus, and species categories used to classify both plants and animals.

(ii) Second period : Charles Robert Darwin (1809–82) created the evolutionary classification during this time, and it was widely discussed how variety among organisms is the driving force behind evolution. In 1859, Darwin released the highly regarded book "On the Origin of Species by Means of Natural Selection."

Although it was founded on the work of Lamarck, Cuvier (1768-1832), and Erasmus Darwin (1731-1802), the grandfather of Charles Darwin, the theory of evolution through natural selection in his book was his original invention. This theory significantly aided systematic zoology. The principles governing biological life were laid out in E. Darwin's work Zoonomia (1794). He proposed the battle for survival in Zoonomia, which Charles Darwin developed.

(iii) Third period : The contemporary taxonomy's development, which began around 1930, is included in this time frame. Typical taxonomy served as the foundation for the study of genetics and population biology.

The science of population genetics was founded in 1908 by G. H. Hardy and W. Weinberg, who independently discovered a principle concerned with the

frequency of genes (alleles) in a population in the context of evolutionary theory. This time period is notable for the publication of New Systematics by J. S. Huxley in 1940, the study of intraspecific variations, and the beginning of population genetics.

Concepts of Taxonomy

Micro-taxonomy was first proposed by Mayer and Ashlock in 1975. Micro-taxonomy, or the science of species, was the term used by Mayr (1982) to describe the evolution of the species debates, which focused mostly on the so-called biological species notion.

The idea of species is one of the main issues with micro-taxonomy. Micro-taxonomy was created as a result of the blending of many study traditions in systematics, as well as in palaeontology and genetics. The study of species conceptions, such as typological species concepts, nominalistic species concepts, biological species concepts, evolutionary species concepts, etc., is referred to as micro-taxonomy.

In the living world or in certain groupings of organisms to whom any two, three, or all species definitions apply, micro-taxonomy deals with issues like the evolution of species and estimation of the population of species.

Geographic variation, the identification of polytypic species, the definition of subspecies and species, the taxonomic status of emerging species, and the significance of non-morphological features in the delimitation of species are also covered. In each case, the morphological distinction is incidental to the biological distinction.

Macro-taxonomy is the science of classification:

Theories ranged from denying the existence of supra-specific taxa to making generalisations about the more naturalness of phylogenetic classification. How can phylogeny be reconstructed? How would we formalise this representation?

These were the issues that macro-taxonomy was addressing. The study of homology, analogy, affinities, systematic status, and phylogeny are all part of macro-taxonomy.

Both macro- and micro-taxonomies are necessary for proper functioning, hence they are connected. Understanding the science of species is crucial for the science of species classification. Macro-taxonomy entails the creation of comparable bases for each feature. How therefore can grouping (Macro-taxonomy) be accomplished without being aware of the features of the item (Micro-taxonomy)? One is therefore greatly dependent on the other.

Modern Trends in Taxonomy

The definition of "new" or "modern" is a relative one because what is currenty deemed new or contemporary may later be deemed to be outdated. Huxley's 1940 introduction of a new systematics may actually be a rather outdated one today. The writings of Mayr (1964) are of great assistance in eradicating such erroneous interpretations of new systematics.

What then is the new systematics, said Mayr? It might be best described as a point of view, a way of thinking, or a general philosophy. It all began as an uprising against the nominalistic typological and wholly non-biological methodology of some, regrettably, far too many taxonomists of the previous era.

Therefore, the population taxonomists' approach is known as the "New Taxonomy," which is very different from the straightforward categorization of traditional Linnaean taxonomy. Instead of considering themselves filing clerks, employees in the new systematics identify as scientists.

New Taxonomy is neither a special technique nor a special method but an attitude which can be applied at every taxonomic level. It deals with –

1. The utilisation of an ever-increasing number of characters and a continued depreciation of key characters — in contrast to the typological approach.
2. A ready acceptance of new tools and techniques such as —
    (a) Visual analysis of sounds in insects, frogs and birds,
    (b) Analysis of courtship displays and other behaviour,
    (c) Utilisation of biochemical characters,
    (d) Utilisation of computers.
3. A further clarification of concepts, such as
    (a) Clear separation of taxon from categories,
    (b) Recognition of the subspecies as a category and not as an evolutionary unit, and
    (c) Clean understanding of the causes of similarities and differences between taxa.

The Linnaean system

The principles for naming plants and animals were developed by Carolus Linnaeus, who is commonly credited with founding modern taxonomy. His publications are also regarded as the beginning of modern botanical and zoological nomenclature. Carolus Linnaeus was the first to systematically employ binomial nomenclature (1758). Although he established the conventional hierarchy of class, order, genus, and species, in his day, his primary achievement was the development of practical keys that allowed readers to recognise plants and animals from his writings. He used the hitherto underutilised, lesser floral portions for plants.

Linnaeus tried to classify things naturally, but he had little success. His theory of a natural taxonomy was founded on Aristotle's logic and conception of the essential characteristics of living things, or it was Aristotelian. He divided animals into mammals, birds, reptiles, fish, insects, and worms, but his division was less precise than Aristotle's. He characterised the first four as apparent and well-known groupings; the final two include around seven of Aristotle's groups.

Frank Franklin II/AP

Aristotle typically defined a shape in terms of its genus and differentia. The genus established the broad category of the entity being described, while the differentia determined its unique characteristics. For instance, a genus may be "Bird" and a species might be "Feeding in water," or it might be "Animal" and a species might be "Bird." The definition, which may be used as a name, was made up of the two components. Unfortunately, the differentia grew longer and longer as more species of a genus were discovered. Linnaeus added a catch name, the genus name, and one word from the differentia or from a previous name to the margins of some of his publications. He developed the binomial, or binary, nomenclature in this way. Thus, modern humans are HOMO SAPIENS, Neanderthals are HOMO NEANDERTHALENSIS, the gorilla is GORILLA GORILLA, and so on.

Classification since Linnaeus

Since Linnaeus, classification has integrated new knowledge and has become closer to resembling a natural system. For instance, when the life cycle of barnacles was found, it became obvious that they were arthropods (jointed-legged animals like crabs and insects), and therefore could no longer be connected with mollusks. Despite his misperceptions about evolution, Jean-Baptiste Lamarck was a superb taxonomist who first distinguished spiders and crustaceans from insects as distinct classes. He also established the distinction between vertebrates—i.e., those having backbones, such as fish, amphibians,

reptiles, birds, and mammals—and invertebrates, which lack backbones, a division that is no longer universally acknowledged by scientists.

The diversity of all animals is actually accounted for by the invertebrates, which are distinguished by a trait they lack rather than a one they possess. The French biologist Felix Dujardin divided the heterogeneous group "Infusoria," which encompassed all the microscopic forms that would emerge when hay was allowed to stand in water, into experimentally discernible groupings. When he realised that there could no longer be a definite division between plants and animals at the level of single cells, the German biologist Ernst Haeckel proposed the word Protista in 1866 to include primarily the unicellular plants and animals.

Clarifying relationships is still a process. Only in 1898 were disease-causing agents (viruses) identified that could get past the strictest filters, and it took until 1935 for the first virus to be totally purified. In Canada, in 1859, the earliest spore-bearing land plants (Psilophyta) from the Cambrian Period, which spanned 541 million to 485 million years ago, were found. The first reliable description of the alternation of generations in numerous nonflowering (cryptogamous) plants was made by the German botanist Wilhelm Hofmeister in 1851. This description is the foundation for several significant divisions of higher plants. Only in the 20th century was the phylum Pogonophora (beard worms) officially recognised.