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A STUDY OF CONCEPT, TYPOLOGY, LEVELS AND IMPORTANCE OF PLANT TAXONOMY

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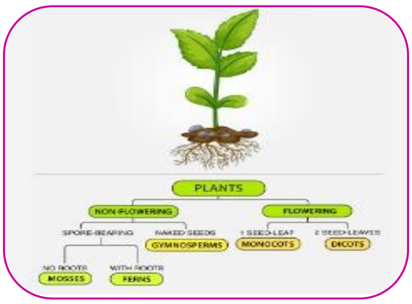
ABSTRACT

Taxonomy, in a general sense, refers to the science of classification, but it more specifically pertains to the classification of both living and extinct organisms—essentially, biological classification. The word originates from the Greek words taxis ("arrangement") and nomos ("law"). Taxonomy encompasses the principles and methods of systematic botany and zoology, creating hierarchies of plants and animals divided into superior and subordinate groups. The term was first introduced by the Swiss botanist Augustin Pyramus de Candolle in 1813 in relation to plant classification. He used this term in his well-known work—Theory élémentaire de la botanique (Elementary Theory of Botany). Thus, taxonomy is the systematic organization of plants and animals based on established laws. This Paper is a modest attempt to study the Concept, Typology, levels and Importance of Plant Taxonomy.

KEYWORDS: *Biodiversity, Geographic Information Systems, Phenotypic plasticity, Taxonomy.*

INTRODUCTION

Simpson (1961) describes taxonomy as the theoretical exploration of classification, encompassing its foundations, principles, methods, and regulations. Ernst Mayer also characterizes taxonomy as both the theory and practical application of categorizing organisms. Thus, the discipline concerned with classification is termed taxonomy. Kristofferson (1995) defines taxonomy as "the practice of identifying, naming, and arranging taxa within a system of terminology that reflects any relationships among taxa that the researcher has observed in nature." Generally, the classification of living organisms emerges out of necessity and often lacks depth. Anglo-Saxon terminology such as worm and fish have been employed to refer to any crawling creature—be it a snake, earthworm, intestinal parasite, or dragon—and to any aquatic organism. Although the term fish is commonly associated with shellfish, crayfish, and starfish, the anatomical differences between a shellfish and a starfish are greater than those between a bony fish and a human being. Common names can differ significantly. For instance, the American robin (Turdus migratorius) is distinct from the English robin (Erithacus rubecula), and the mountain ash (Sorbus) bears only a superficial likeness to a genuine ash.



Biologists, on the other hand, have sought to examine all living organisms with equal rigor and have therefore developed a formal system of classification. Such a classification establishes a foundation for a relatively consistent and globally recognized nomenclature, making it easier to cross-reference and retrieve information. The meanings of the terms TAXONOMY and SYSTEMATICS in relation to biological classification differ significantly. American evolutionary biologist Ernst

Mayr remarked that "taxonomy involves the theory and application of classifying organisms" and "systematics pertains to the science of the diversity of organisms"; thus, the latter is closely related to evolution, ecology, genetics, behavior, and comparative physiology in ways that taxonomy does not necessarily engage with.

Typology of Taxonomy

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 forms the foundation of this concept. This concept asserts that every legitimate taxon originates from a common ancestor; however, similar characteristics within a biological domain do not always indicate a shared lineage. A category of biological classification referred to as evolutionary or Darwinian classification employs phylogenetic connections and general similarities to categorize species. In this taxonomy approach, taxa are given greater significance than individual species. (iii) Experimental taxonomy or neo-taxonomy: This is linked to genetic studies that focus on a common gene pool within a taxon and has been effective in distinguishing between two taxa. Techniques for gathering morphological data utilize modern methods. Investigations into the fine structures beneficial for morph taxonomy are conducted using an electron or scanning electron microscope on various types of invertebrates, including 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 : This text addresses taxonomic characteristics identified through the chemical analysis of peptides, nucleic acids, amino acids, and sugars found in proteins, hormones, and enzymes. The sequences of amino acids in proteins vary across many organisms and play a significant role in the classification of different species. Various methods are employed to study enzymes, hormones, nucleic acids, amino acids, and other biomolecules that contribute to systematics. In systematic studies, multiple techniques are utilized to analyze chemical components, including immunological methods, chromatography (such as paper chromatography and column chromatography), and electrophoresis. Immunological data is used to differentiate between two taxonomic groups. Blood group genes are used to classify pigeons and primates. Chromatography encompasses various methods for separating intricate liquid mixtures, such as biological fluids (including amino acids, steroids, carbohydrates, etc.), as they travel through a column filled with adsorbing material (like paper or magnesium oxide), where different elements of the mixture adhere in distinct layers. This approach is employed for snails and other groups of arthropods, providing valuable insights for animal systematics.

(ii)Cytotaxonomy : It focuses on taxonomic characteristics identified through cytological studies. Cytotaxonomy is a branch of taxonomy that examines the relationships and chromosome-based classification of living organisms. A crucial element of chromosome structure that supports taxonomic research is the position of the centromere.

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.

Importance of taxonomy's in botany:

- **Accurate identification:**

Taxonomy enables the precise identification of plant species, which is vital for research on plant ecology, genetics, and potential uses in medicine or agriculture.

- **Understanding relationships:**

By classifying plants into hierarchical groups like families, genera, and species, taxonomy reveals evolutionary relationships between different plants, allowing scientists to study their ancestry and diversification.

- **Global communication:**

Standardized scientific names provided by taxonomy allow scientists worldwide to communicate effectively about plants, regardless of language barriers.

- **Conservation efforts:**

Accurate identification of species through taxonomy is critical for identifying threatened or endangered plants and designing effective conservation strategies.

- **Biodiversity studies:**

Taxonomy forms the foundation for studying and documenting plant biodiversity, allowing researchers to analyze the variety of plant life in different regions.

- **Ecological research:**

Understanding plant taxonomy is crucial for studying plant communities, interactions within ecosystems, and the impact of environmental changes.

- **Agriculture and forestry:**

Plant taxonomy is vital for identifying crop varieties, managing pests and diseases, and selecting suitable plant species for cultivation.

Taxonomy in Modern Days

In contemporary botany, the classification of plants mainly emphasizes their evolutionary connections, employing methods such as molecular genetics and phylogenetic analysis in addition to conventional morphological traits, commonly known as "biosystematics." The aim of this approach is to grasp the evolutionary history of plant groups rather than merely outlining their physical attributes; this represents a notable shift from previous classification techniques that relied solely on morphology.

Key Aspects of Modern Plant Taxonomy:

- **Molecular data:** DNA sequencing is widely used to determine evolutionary relationships between plant species, providing a more accurate picture of their ancestry compared to just looking at physical traits.
- **Phylogenetic analysis:** Computer programs are used to construct evolutionary trees (phylogenies) based on molecular data, which helps to group plants according to their shared evolutionary history.
- **Numerical taxonomy:** Statistical methods are employed to analyze large datasets of plant characteristics, assigning numerical values to different traits to identify patterns and relationships.
- **Cytotaxonomy:** Studying chromosome number and structure to aid in plant classification
- **Chemotaxonomy:** Analyzing plant chemical compounds to identify taxonomic relationships

Importance for conservation:

Accurate plant taxonomy is crucial for identifying and protecting endangered plant species.

Key Problems in Botanical Taxonomy

In botanical classification, significant challenges consist of: restricted access to specimens, extensive species diversity, hidden species, convergent evolution, variations in physical characteristics, insufficient funding for taxonomic studies, a shortage of trained taxonomists, and difficulties in identifying species solely through morphological traits, particularly when considering variations across various environments; resulting in possible misclassifications and complications in accurately establishing evolutionary connections among plant species.

- **Species diversity:**

Many plant groups have a vast number of species, making comprehensive identification and classification extremely challenging, particularly in regions with high biodiversity hotspots.

- **Cryptic species:**

Species that appear morphologically similar but are genetically distinct can be difficult to identify using traditional taxonomic methods, leading to potential misclassifications.

- **Convergent evolution:**

Different plant species may evolve similar traits due to similar environmental pressures, causing confusion in identifying evolutionary relationships.

- **Phenotypic plasticity:**

A single species can exhibit a wide range of morphological variations depending on environmental conditions, making species delimitation complex.

- **Limited specimen availability:**

Access to adequate plant specimens, especially from remote areas or rare species, can be restricted, hindering accurate taxonomic studies.

- **Inadequate funding:**

Lack of sufficient funding for taxonomic research can limit the capacity to conduct comprehensive studies and adequately train new taxonomists.

- **Taxonomic expertise shortage:**

A decline in the number of trained plant taxonomists can hinder accurate identification and classification of plant species.

- **Morphological limitations:**

Relying solely on physical characteristics for identification can be problematic, especially when dealing with subtle variations between closely related species.

Solutions and advancements to address these problems:

- **Molecular techniques:**

Utilizing DNA sequencing and other molecular methods to identify species based on genetic data, providing a more robust approach to taxonomy.

- **Geographic Information Systems (GIS):**

Integrating geographic data with taxonomic information to better understand species distribution and potential variation across different regions.

- **Citizen science initiatives:**

Engaging the wider community in data collection and species identification to improve taxonomic knowledge.

- **Improved taxonomic databases:**

Creating comprehensive online databases with detailed descriptions, images, and distribution data for easier species identification.

- **Training and capacity building:**

Investing in training programs to develop a new generation of plant taxonomists with expertise in modern techniques.

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