Concept of Taxonomy, Systematics and its significance

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Taxonomy

Variation is the rule of nature. The most impressive aspect of the world of life is its diversity and the uniqueness of its components. No two sexually reproducing populations are the same, nor are any two populations, species or higher taxa. About more than one million species of animals and half a million of plants have already been described and estimates on the number of still un described living species ranges from three to ten millions. Furthermore each species may exist in numerous different forms like sexes, age, seasonal forms, morphs etc. It would beimpossible to deal with this enormous diversity if it were not ordered and classified. Systematic Botany endeavors to order this diversity of the plant world and to develop methods and principles to make this task possible.

Definition of taxonomy

Taxonomy is the theory and practice of identifying plants and animals. In fact, taxonomy dealswith the principles involved in the study of classification of organisms. It is the functional science which deals with identification, nomenclature and classification of different kinds of organisms all over the world. The word 'taxonomy' is derived from the Greek words *taxis* (=arrangement) and *nomos* (=law). The term 'taxonomy' was coined by A.P. de Candolle in 1813. Different workers have tried to define taxonomy from their view point. Someof the accepted definitions of taxonomy are as follows:

· According to **Mason** (1950) taxonomy is the synthesis of all the facts about the organisms into a concept and expression of the interrelationship of organisms.

Harrison (1959) defined taxonomy as the study of principles and practices of classification, in particular in methods, the principles and even in part, the result of biologicalclassification.

Simpson (1961) defines taxonomy as the theoretical study of classification, including its bases, principles, procedures, and rules.

Heywoods (1967) defined taxonomy as the way of arranging and interpreting information's

Blackwelder (1967) explains it as the day to day practice of handling different kinds of

organisms. It includes collection and identification of specimens, the publication of data, the study of literature and the analysis of variations shown by the specimens.· According to Johnson (1979), taxonomy is the science of placing biological form in order.

Christoffersen (1995) defines taxonomy as the practice of recognizing, naming and ordering taxa into a system of words consistent with any kind of relationships among taxa thatthe investigator has discovered in nature.

Systematics

Systematics is the study of diversification and relationships of life forms of extinct extant. The word systematics is derived from the Latinized Greek word 'systema' applied to the system of classification developed by Linnaeus in the 4th edition of his historicalbook ***Systema Nature*** in 1735. Today's systematics generally makes extensive use of molecular biology and computer Programs to study organisms.

Definition of systematic

· According to **Blackwelder** and **Boyden** (1952), "systematic is the entire field dealing with the kind of animals, their distinctions, classification, and evolution.

· **Simpson** (1961) defines systematic as "The scientific study which deals with kinds and diversity of organisms and any or all relationships among them'

· According to **Blackwelder** (1967), systematics is that science which includes both taxonomy and classification, and all other aspects of dealing with kinds of organisms and the data accumulated about them.

Christofferson (1995) defined systematic as the theory, principles and practice of identifying (discovering) systems, i.e., of ordering the diversity of organism (parts) into moregeneral systems of taxa (wholes) according to the most general causal processes.

· According to **Padian** (1999), systematic can be seen as the philosophy of organization nature, taxonomy as the use of sets of organic data guided by systematic principles, and classification as the tabular or hierarchical end result of this activity.

Relationship of taxonomy to the systematics

Kapoor (1998) considered that the relationship of taxonomy to systematics is somewhat like that of theoretical physics to the whole field of physics. Taxonomy includes classification and nomenclature but systematics includes both taxonomy and evolution. Insimple terms, actually there are two parts of systematic. The first part, taxonomy, is concerned with describing and naming the

different kinds of organisms, whether exist or extinct. This science is supported by institutions holding collection of organisms which are curated with relevant data. The second part of systematics, evolution, is concerned with understanding just how all these kinds of animals arose in the first place and what processes are at work today to maintain or change them. Systematics uses taxonomy as a means to understand organisms. Systematics elucidate the new methods and theories that can be used to classify species based on similarities of traits and possible mechanisms of evolution, a change in gene pool of a population over time. According to Wagele (2005), although theoretically the term taxonomy and systematic could be synonyms, in practice, however, differences in uses are obvious and a systematist and a taxonomist can conduct different analyses.

The major differences between taxonomy and systematic can be summarized as follows: Taxonomy is the most important branch of systematic and thus systematics is a broader area than taxonomy.

1. Taxonomy is concerned with nomenclature, description, classification and identification of a species, but systematics is important to provide layout for all those taxonomic functions.
2. Evolutionary history of a species is studied under systematics but not in taxonomy.
3. The environmental factors are directly related with systematics but in taxonomy it is indirectly related.
4. Taxonomy is subjected to change in course of time, but systematics is not changed if it was properly done.

Stages in taxonomy

There are several stages of taxonomy such as:-

1. **Alpha taxonomy:-** In this stage species are identified and characterized on the basis of gross morphological features.
2. **Beta taxonomy:-** In this stage species are arranged from lower to higher categories, i.e., hierherarchic system of classification.
3. **Gamma taxonomy:-** In this stage intraspecific differences and evolutionary history are studied.

Classical Taxonomy and Modern Taxonomy:

Classical Taxonomy:

The classical taxonomy is based on observable morphological characters with normal individuals considered to be expression of the same while their variations are believed to be imperfect expressions. Classical taxonomy originated with Plato followed by Aristotle (Father of Zoology), Theophrastus (Father of Botany) up to Linnaeus (Father of Taxonomy) and his contemporaries.

a. Species are delimited on the basis of morphological characteristics.
b. Only a few characters are employed for classification.
c. A few individuals or their preserved specimens are used for study. It is called typological concept.
d. Species are believed to be static.
e. Species is the centre stage of study. Its subunits are not important.

Modern Taxonomy (New Systematics):

The term new systematic was coined by Julian Huxley (1940). New systematic is systematic study which takes into consideration all types of characters. Besides classical morphology, it includes anatomy, cytology, physiology, biochemistry, ecology, genetics, embryology, behavior etc. of the whole population instead of a few typological specimens. In contrast classical systemetics is based on the study of mainly morphological traits of oneor a few specimens with supporting evidences from other fields. New systematics ia also called population systematics and biosystematics. It strives to bring out evolutionary relationship amongst organisms.

1. New systematic is based on the all types of variation in the species.
2. Along with morphological variations, other investigations are also carried out to know the variety of traits.
3. Delimitation of species is carried out on the basis of all types of biological traits. It is also called biological delimitation.
4. Traits indicating primitiveness and advancement are found out.
5. Inter-relationships are brought out.
6. Species are considered as dynamic unit.

Aims and tasks of taxonomist:-

The various aims and tasks of a taxonomist are-

1. To catalogue and preserve the biodiversity collected from different sources.
2. To differentiate the variations among organisms and arranged them on the basis oftheir relationships or associations.

3. To provide scientific name to the taxa, so that one can recorded, stoe and retrievedwhen needed.
4. To establish a set of rules to choice characters for arranging species into hierarchic classification.
5. To study the genetic and phylogenetic relationships among life forms.
6. To make extensive use of computer to analyze and differentiate the intra and interspecific relationships among organisms.

The contribution of systematic to biology:

Systematics is the key to understand fascinating biodiversity around us. Systematics benefits the human beings by providing the fundamental knowledge about the sustainable resource management, environmental protection, and landscape preservation to food security. Systematic biology provides the skill to make policies for successful implementation of preservation and management of our biodiversity, which is critical to have long term quality of life for us as well as to our nature.

The contribution of systematic to biology can be studied into two heads:-

A. Theoretical biology and

B. Applied biology.

A. Theoretical biology:-

Systematics has played some important role in the field of theoretical biology, such as:-

1. It is responsible in making conceptual contribution like population thinking.
2. It is responsible in solving the problems of multiplication of species. It illustrates the structure of species and evolutionary processes.
3. Mimicry and other evolutionary areas also have been a clearly understood through taxonomy.
4. It has also played important role in the development of behavioural science.
5. Taxonomy is the key to the study of ecology, as no ecological survey can be undertaken unless all the species of ecological importance are identified.

B. Applied biology:-

Systematics provides basic understanding about the components of biodiversity which is

necessary for effective decision making about conservation and sustainable use. The most important are:-

1). Agriculture and forestry: - Presently we are faced with the acute problem of saving our crops and trees from the attack of various kinds of pests. So, it is necessary to know the correct names of such pests; before their proper control, and eradication. Taxonomists can give correct identification of pest species, which is vital for its effective control. Similarly, many of the plant diseases are caused by certain vectors. The correct identification of a particular vector is vital for bringing the vector under control by killing its transmitters.

2). Biological control: - Natural enemies of pests can be introduced for biological control of pests. The biological control is much more economical than the chemical control. In 1940s a parasite *Archytus incertus* was introduced from Uruguay and Argentina into the U.S.A. to control armyworms. The sytematists are presently greatly involved in designing and implementing the biological contol programmes of pests and diseases most effectively.

3). Public health: - Taxonomy plays an important role in public health program also. There are number of diseases, which are spread by many Arthropods. So, our controlled measures should be planned to attack the target species. As for example, All *Anopheles maculipennis* are not responsible for transmitting malaria. This species consists of several sibling species, of which a few were responsible for transmitting malaria. An expert taxonomist can identify this particular sibling species. A correct identification ensures a maximum of effective control at minimum cost.

4). Quarantine: - Many new pests and diseases of plants, animals and human beings can spread from one country to another through transportation. Respective Governments have established quarantine laboratories at aerodromes, ports etc. to check such transmissions. Taxonomists play a vital role here in prompt identification of these pests anddiseases.

5). Wild life management: -Presently great attention is being paid to conserve and propagate wild life. The indiscriminate killing and felling of trees have already resulted in great disturbance in the natural environment. Taxonomists can help all environmental

protectors by identifying the economically and ecologically important wild life. The task isimportant for the preservation and protection of our biodiversity.

6). Mineral prospecting: -The identification of fauna and flora in sedimentary rocks gives a clear picture of the sequence of geological events, which helps in search for fuels and mineral deposits. The paleontologists play a major role in the identification of such fossil specimens of the sedimentary rocks and thus give us a clear picture of the correct sequence of geological events. Such works have been great success in the industrializationin America.

7). National defense: - Information concerning disease vectors and parasites is an obvious application of systematics to national defense. The use of biological means in thewar is economical and requires fewer efforts in their operation. During World War II, Japanese paper balloons carrying paper balloons created havoc in the forest of north east America. Eventually a balloons was recovered with sand contained a large number of shellsof micro-organisms. The taxonomists of America observed the shells of micro-organisms and confirmed that this type of sand represent mainland island of Japan. Subsequent bombing of this beach area destroyed the balloon launching site. Moreover, the identification of potential disease vectors is vital to the health of both military and civilianpopulations all over the world.

8). Environmental problem: - Taxonomists have played an important role in detecting some of the environmental problems. Certain pesticides are entered in the food chain of ecosystem and biomagnification of pesticide takes place at certain trophic level. Here a taxonomist can play important role in detecting such problem and can take effectivemeasures to control it. Presently water pollution is considered as a major environmental problem. Certain planktons are reliable indicator of the degree of water pollution. The identification of such organism by taxonomoists give rapid information for detecting pollution.

9). Soil fertility: - Some organisms play important role in increasing the fertility ofsoil. So, it is necessary to know such animals for their proper management in agriculture.

10) In commerce: - Many animals and animal's products are used commercially by human beings such as, - honey, silk, lac, dyes etc. Systematics play important role inincreasing and improving the qualities of these products by manipulating the useful species.

Systematists and taxonomists are presently employed by universities, research institute, museum, central and state govt. agencies,

Industries and zoos, A well trained taxonomist is well qualified teacher to teach course of zoology or biology as he has a great background in morphology, physiology, genetics and ecology.

Importance of Biosystematics:

The importance of biosystematics in biology can be briefed as under –

1. Biosystematics gives us a vivid picture of the existing organic biodiversity of ourearth.
2. It provides much of the information permitting a reconstruction of the phylogeny of the life.
3. It reveals numerous evolutionary phenomena and thus makes them available for casualstudy by the other branches of biology.
4. It supplies, almost exclusively, the information needed for entire branches of biology.
5. It is indispensable in the study of ecologically and medically important organisms.

It supplies classifications which are of great heuristic and explanatory value in most branches of biology like evolutionary biology, biochemistry, immunology, ecology, ethology and historic