Thinking in the Future of Plant Taxonomy

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Abstract:

This review is a trial to summarize the history of plant taxonomy to understand the situation of the taxonomical works and their progression. Taxonomy starts as an artificial classification and gradually with the increase of knowledge, civilization and facilities, plant taxonomy developed. Here, the most affected steps in the progression of plant taxonomy have been mentioned. Starting from the oldest period of using vegetative, floral and anatomical characters to the most recent works on palynology, chemotaxonomy and molecular biological data. Thinking of the modern plant taxonomy has been mentioned in response to the environmental changes and peoples thinking. Experimental biology and breeding experiments must be done to understand the way of speciation and to protect the wild species from extinction. Taxonomy must be cooperating with ecology for better understanding of the changing in the taxonomic characters and to precise identifications. Taxonomists have to survey the vegetation and try to find ways to protect the plants. We have to understand the relationships between the taxa in the populations. We have to modulate our thinking according to the new situation. Meanwhile the environmental conditions and their effect on plant characters must be kept in mind, as new species may arise and other extinct

Key words: Anatomy- Chemotaxonomy- Future- morphology- Palynology-Taxonomy.

Introduction:

Taxonomy, which is the science of grouping and organizes any things according to morphological similarities, has been known from the first day of human creature. To predict the future of plant taxonomy, we have to scan how this branch developed through time. If we go through the history of plant taxonomy science we can understand how peoples were in need to organize and classify everything in their surroundings according to their needs and uses. Gradually and with the increase in knowledge, materials, ways and techniques of examinations and analyses, this branch of science developed gradually. Classification, which is the grouping of similar objects in order to produce similar groups, is from the objectives of taxonomy. It is a necessary process of all living creatures to maintain an overview of the complex environment around them by reducing the amount of information captured by perception. Modern biology and as well as ecology, pharmacology and all aspects of knowledge could evolve only when a universal classification of all living beings was finally possible, first proposed by Carolus Linnaeus in 1735. A species without a name does not exist in terms of science and conservation. Each plant species has a unique scientific name that is the tag that allows it to be found, counted, researched, and
monitored, and the index key that retrieves everything we know about it from the Internet, books, studies, databases and specimens. The specimens in turn document the physical attributes of plant, and its geographic distribution. When we mention the science of taxonomy, here in this paper, plant taxonomy will be our main interest.

Taxonomy is the work that gives the plant its scientific name and classifies it among all the other plants in the world. The classification give us information about which other species are related to our plant, and thus indexes yet more information about it – such as the diseases that attack its relatives, poisonous chemicals or drugs it contains. Taxonomy is the same as other areas of biology; it develops with the increase of the available information. More information is always useful, and sometimes makes us change our minds; in taxonomy a ranking change based on new found information which takes the form of a change in scientific name or taxonomic position.

Classification, generally speaking, may be described as the arrangement of plants into groups of objects or phenomena which are related to one another by the possession of certain genes giving some characters in common. The principle of classification, is one which is "inherent in the human mind"; it is a principle " which we find pervading all science, and without which all knowledge would exist as a disorderly and shapeless mass, too huge for the memory to grasp and too heterogeneous for the understanding to employ."

**Brief History of the Progression in Taxonomical Tools:**

If we go to the history of the tools of classifications, we have to start from vegetative morphological tool. This was the first way of classifying plants according to the similarity in shape, life forms and span, leaf and stem characters. Really, it is very important tool till now as mentioned by Davis and Heywood (1973) that the neglect of vegetative morphological characters considered from the serious errors in the history of classification and delay the achievement of a natural system. From the time of Theophrastus (372-287 BC) till Carl Linnaeus (1707-1778) vegetative and floral characters were the main ways for classifying plants. Thus, the modern taxonomists have agreed to consider the year 1753 as the starting point of nomenclature of Phanerogams, Pteridophyta, and Sphagnum. In Linnaeus “Philosophia Botanica” principles of botanical nomenclature have been laid down, which later formed the basis of the International Code of Botanical Nomenclature. Till now, and more recently, many taxonomists still relay on morphological variations between taxa. Few examples of such works are those of Taia and Ismael (1994 a, b& 1995) on the vegetative and floral morphological characters of family caryophyllaceae in Egypt. Taia (1994) and Taia Mohammed (1994 & 1995) continued their works on the seed morphology of the caryophyllaceae. Borba et al. (2002) who made a morphometric analyses of vegetative and floral characters in 21 populations of five Pleurothallis (Orchidaceae) and their results were in agree with the taxonomic delimitation of the species. Mbagwu and Onuoha (2007) studied the floral and vegetative morphology on five variants of genus Viscum and their investigation showed some variations that could be exploited taxonomically. Moawed et al.(2015) studied the macro- and micromorphological beside vein architectural characters of 34 taxa of Euphorbiaceae (14 genera, 29 species and eight varieties) which facilitate the recognition of the studied species. Taia al. (2015 & 2017) studied the vegetative and floral variations between the Fagonia species in both Egypt and Libya. Mobarak et al. (2017) studied the morphological variation among Moringa oleifera populations in 8 sites in Egypt. They concluded that the variations in the morphology of this species in the different population may be not only related to environmental conditions, but also genetic differences within species. El-Gazar et al. (2018) studied 58 morphological characters in 76 species from family Asclepiadaceae R.Br. and recognized two groups representing two subfamilies. Soliman et al. (2018) studied the morphological variations among members of
Ludwigia stolonifera grown in 32 different populations and recorded seven morphotypes grown in five different habitats. Amer et al. (2019) studied the morphological variations in Brassica nigra growing in 26 different populations and recorded two varieties among this species. Turki et al. (2019) used the morphological characters, habit, inflorescence type, bract shape, calyx, pod shape and seed coat pattern to distinguish between the three genera Anthyllis, Hymenocarpos and Tripodion. After Linnaeus plant-taxonomists conceived the idea that the plants belonged to some natural groups rather than their vegetative and floral characters, and they tried to designate and distinguish such groups and tried to classify the plant kingdom accordingly. Such systems are known as natural systems of classification. The natural system of classifications started with the theory of inheritance of Acquired Characteristics (1801) by Lamarck, who switched the thinking that the external environment has its effect on living creature. Thus ecological factors have been considered in examining any specimens and affect the taxonomical decisions. Lamarck noticed the similarities between the animals he studied, and was impressed by the fossil record. This led him to think that life was not fixed. Organisms had to change their behavior to survive when environments changed. This is followed by Darwin theory of natural selection (1859) who said that "If an organism changes during life in order to adapt to its environment, those changes are passed on to its offspring". This theory made a revolution in the science thinking and accordingly, plant systematic and the origin of species started its period.

New thinking arose in this period with the advancing in microscopes and examination tools. Bureau (1864) was the first who apply the internal structure in plant classification beside the external morphological characters. After wards taxonomists start to use the internal structure of the closely related species. Although Wedell (Monograph of Utricaceae, 1856) had indicated to the possible value of using the internal structures of the plants in their taxonomy, but the microscopes were not in use and the lens was the only way of investigation. The first publication of using the internal structure of the plant in taxonomy was that of Duval-Jouve's work on the Equisetum (1863) and followed by his works on Coniferae and Gnetaceae and by Bureau's work on the Bignoniaceae (1864). Gradually, and with the development of the examining tools and microscopes, Plant anatomy becomes a necessary tool in plant taxonomic investigations. Bailey and his students (1954) elucidated the necessity of the anatomical features as tool in taxonomic works and phylogeny. Scott (1955) approved Bailey opinion in using the internal structures in constructing relationships in phylogenetic works. From this point, the internal structures of plants became important in taxonomic decisions. According to the type of vascular bundles; tracheids versus vessels; major phyla of plants can be distinguished. Angiosperms are characterized by the presence of vessels which are absent in gymnosperms. Thus phylogenetic works used wood anatomy in predicting relationships. Meanwhile many families have been separated into different families according to their internal structures. Nodal anatomy, as well, has its role in angiosperm systematic; unilacunar versus trilacunar. From the anatomical investigations as a taxonomical tool are those of Taia et al. (2017 & 2018).
Dilcher (1974) indicated to the importance of the leaf remains in distinguishing many taxa and their phylogeny. Stace (1984) indicated to the importance of using leaf surface characters in plant taxonomy. In 1989, Stace distinguished 35 stomatal types within the angiosperm families which can be used in the circumscription of them. Micromorphological characters of the leaves and the seeds took their role in taxonomy, as Stace (1965) found that the cuticle can be used in taxonomy. Barthlott (1984) hinted to the importance of seed surface structure in taxonomical works. In the same time, floral anatomy played a role in plant taxonomy and phylogeny as Melville (1962, 1963, 1969a & 1983) developed his gonophyll theory after studying the venation types in both the leaves, carpels and other floral parts, he postulated that the angiosperm carpels originated as a modification of dichotomous fertile branch adnate to the leaf petiole.

In the progression of microscopes Nehemiah Grew in the 1640s was the first to observe fine particles which he calls it pollen grains. Robert Brown, in 1809 pointed to the use of pollen grains in systematic studies of seed plants. The first successful use of pollen characters in plant taxonomy was that of John Lindley (1830), in genera and species of family orchidaceae. From that time the study of pollen grains and palynomorphs has attracted many scientists. In 1921, the Swedish botanist called Gunnar Erdtman, published his thesis about pollen as a tool for study the Quaternary vegetation and climate change. In the middle of the seventeenth century, with the development of microscopes, pollen morphology attained great attention by botanists. Nehemiah Grew, an Englishman, notice that pollen grains in different plant species are of different size and form, but that the pollen grains of flowers belonging to the same species are all alike (Mantin, 1966). Erdtman (1952 & 1957) published complete descriptions of pollen grains and their use in taxonomy. From that time and till now plant taxonomists use pollen morphology as taxonomical tool in the recognition of taxa. Lot of works have been done in this field after the invention of the electron microscopes from them, for example, those of Taia (1994, 1996,1997 & 2004) Taia and Shiha (1999 & 2001).

New era in plant taxonomy began with the revolution in plant technique analyses. Chemotaxonomy and protein sequencing started its period in constructing the phylogenetic keys and predicting the relationships between species. The origin of species and the presence-absence criteria for most morphological characters became unsatisfactory and chemical substances took their way in plant identification. In fact from the oldest ways of classifying plants were according to their chemical constituents and their medicinal uses, but their uses in constructing systems of classification between plants were inapplicable. Dahlgren (1975) was the first to use chemical data in characterizing orders and families. Cronquist (1981) took into consideration the chemical constituents in the plants in his integrated system of classification of the angiosperm. The two classes of substances; iridoids and glucosinolates; appear to be restricted to the dicotyledons and makes them of multiple origins. Dahlgren et al. (1981) in his system changed the taxonomical position of the families containing them.

From the different sources of data used in taxonomy and systematic is the molecular biological data. This source of data has been started more than 60 years ago by Watson and Crick (1953). The problem was how to get this data, restriction enzymes in the chloroplast genome were used to compare fragment patterns among taxa. Mullis et al. (1986) used the polymerase chain reaction (PCR) technique, while Saiki et al. (1988) used the high temperature tolerant polymerases to provide easy access to specific base pair sequence data. Thousands of works have been done afterwards to know the relationships between taxa and to understand the phylogeny and evolution. From the fruitful works in taxonomy are those of the APGI, II, III and IV. In which all the plant kingdom has been reclassified. These APG systems of plant classification have been considered as artificial classification and faced with many objections.
In the time taxonomists try to use all the available data from all the available tools to achieve more natural classification. Computerization and numerical analyses and many programs have been postulated to give us natural relationships. In spite of this, there are many questions still unanswered. The most important questions what we have to do? What is else? How we can understand the extinction of many taxa and the appearance of new taxa? We are facing new challenges and we have to modulate our thinking. Our planet facing huge disturbance, climate disorders, habitat fragmentation, pollution and human urbanization. All of these beside other factors not only affect plant life but also affect animals and humans and destruct the biological balance.

**Future of plant taxonomy and conclusion:**

From the above mentioned progression in taxonomy, we can notice that this branch of science has been affected by human thinking, civilization and development in facilities of knowledge. Now and in these circumstances, we have to look carefully how we can protect our planet through the protection of the wild plant life. Taxonomists have to survey the vegetation and try to find ways to protect and propagate the plants. We have to understand the relationships between the taxa in the populations. We have to modulate our thinking according to the new situation. Meanwhile the environmental conditions and their effect on plant characters must be kept in mind for precise identifications and to recognize the new species as the result of speciation and protect others from extinction. Taxonomists have to cooperate with ecologists to better understanding for the situation of the taxa, mode of seed dispersal and breeding experiments must be done to know whether speciation is going on or not. In the same time taxonomy must use physiological features and evaluate the electronic signals between the cells and the surroundings to understand relationships between the different taxa.

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