Vika
class
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BIOL 151, PRINCIPLES OF SYSTEMATICS

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3 CREDIT COURSE

COURSE OUTLINE

1. Systematics and its principles
2. Importance of systematics
3. Classification and its principles
4. Taxonomy
5. Taxonomic rankings
6. History of taxonomy
7. Nomenclature; principles and application
8. Acceptance of scientific names
9. Identification

REFERENCES:

1. Monger, G & Sangster, M (2000). Systematics and Classification
2. Jeffrey, C. (2001). Introduction to plant taxanomy
3. Gupta, R.K (2006). Introduction to Plant systematics
4. Kershaw, R.D (1983). Animal diversity.
5. Pichenik, J.A (1996). Invertebrate Zoology
6. Purves, Orians & Heller (2000). Life (science of biology).
7. Any related /appropriate literature is acceptable.

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STUDENTS MUST ATTEND LECTURES AT ALL TIMES, AND TAKE PERMISSION FOR ANY OTHER CIRCUMSTANCE.

Systematics is the study of biological diversity and its origins.

Systematics is the branch of biology that deals with the diversity and inter-relationships of living things through time, of both current organisms (neontology) and prehistoric ones (palaeontology), ie. extinct and extant organisms.

It is therefore the study of biodiversity and its historical (evolutionary) and modern patterns and processes, which involves the comparative study of living and fossil species.

Systematics thus involves taxonomy and phylogenetic analysis. The relationships are illustrated by a phylogenetic or evolutionary tree.

Phylogenetics is the science of reconstructing the evolutionary history of the organisms.

Biological systematics is therefore, the study of the diversification of life on the planet earth, both past and present, and the relationships among living things through time.

Relationships are visualized as evolutionary trees (cladograms, phylogenetic trees or phylogenies).

Phylogenies have two components, branching order (showing group relationships) and branch length (showing amount of evolution).

Phylogenetic trees of species and higher taxa are used to study the evolution of traits (e.g., anatomical or molecular characteristics) and the distribution of organisms (biogeography).

Systematics make use of classification and taxanomy.

Classification focuses on placing organisms within hierarchical groups that show their relationships to other organisms while, Taxonomy is the identification, description, and naming (i.e. nomenclature) of organisms.

The study of systematics started with Phenetic systematics which was an attempt to determine the relationships of organisms through a measure of similarity, considering plesiomorphies (ancestral traits) and apomorphies (derived traits).

From the 20th century onwards, it was superseded by cladistics, which considers plesiomorphies to be not enough for resolving the phylogeny of Earth's various organisms through time.

Today's systematists generally make extensive use of molecular biology and computer programs to study organisms.

Importance of systematics

1. Foundamental biology

a) Systematics is fundamental to biology because it is the foundation for all studies of organisms, by showing how any organism relates to other living things.

b) *Biodiversity conservation;* It helps to prevent the extinction of unknown species. Much of life on Earth is still unnamed and undescribed.

In the face of the ever increasing exploitation of forest resources, there is the need to discover and describe the species before they are lost.

Extinction and loss of biodiversity cannot be prevented unless its basic units, the species and their relationships, are known.

Systematics therefore needs to (i) explain the biodiversity of an area which could be useful in allocating limited means to preserve and protect endangered species (protecting one organism against interest of others). And (ii) right habitat for best bleeding; ie, growth of sharks and fish reproduction

One way of achieving this is to look at the genetic diversity among various taxa of plants or animals and decide how much of that it is necessary to preserve. There is also the need to establish 'germplasm' banks for all the threatened plants. (taxanomy).

c) Identifying invasive alien species.

Invasive alien species have been identified as one of the major causes of biodiversity loss worldwide.

These species are able to reproduce and spread more rapidly than their native counterparts.

They therefore, threaten native species and their habitats, and are capable of causing damage to economic interests such as forestry, agriculture and many others.

Taxonomists play a crucial role through identification of new species that have appeared and assess whether they have the potential to become invasive

d) Monitoring climate change

*When taxonomists collect specimens they note down information on where the organisms are collected from (field notebooks).

*Thus, comparing information on where a specimen of a particular species was found in the past, with where it is found now, ie. the shift, and how they thrive.

*This can help determine whether (i) the global distributions of species are changing as a result of climate change, and (ii) how fast species are shifting their distributions.

e) Pest and disease control.

*Pest species and their natural enemies must be correctly identified before adequate control measures can be applied. Identification of pest species provides knowledge about the biology and distribution of the pest organisms.

*Identification can help us determine the original home of the species and the area where foreign exploration for parasites, predators or pathogens is likely to be most productive.

*Systematics play an important role in the control of some diseases by identifying which individual species of a group of similar species are responsible for spreading disease(s), e.g. which species of mosquito spreads malaria.

f) Agriculture (Plant and animal breeding (GMO's)).

*The ever increasing human population has necessitated an increase in agricultural production.

*This demand has lead to vigorous research in many areas of study including genetics and plant breeding.

*This also inform them of their probable wild relatives which are essential in crop improvement programs, enabling them to breed for desirable qualities such as disease resistance; eg. Vegetables, maize and fruits.

*All species in the same genus should share many behavioral, biochemical, ecological and biological properties because they are closely related evolutionarily.

*Modern agriculture together with urbanization has created the disappearance of many genetically varied strains of crop plants and their wild relatives.

*Farmers have been induced to rely solely on standard genetically uniform strains leading to the narrowing of the genetic base of crop plants to an alarming degree.

*Majority of the traditional varieties that have gone extinct possess desirable characteristics that can not be fond in GMO's.

*such as disease- and pest-resistance, high yielding ability and photosynthetic efficiency.

*Systematists have been instrumental in solving the problem of genetic erosion of crop plants through gene-banks (in situ) conservation as well as discovering and identifying their wild relatives (ex-situ).

g) Medicine

*Pharmaceutical industries depend on taxonomists for the correct identification and classification of species which have medicinal value.

*For example, when a chemical suitable for a pharmaceutical product is found in one species, biochemists can quickly learn the/from classifications of the close relatives;

* (e.g., other species in the same genus or the 'sister-species') that might contain similar or even better chemicals.

*Taxonomists have a unique role in identifying the wild relatives of medicinal plants and helping to conserve them.

i) Common Language

Systematists provide taxonomic nomenclature which serves as the most fundamental building block for information sharing on biological resources (the scientific name).

Name properly given to a species/organism and accepted becomes universal.

*Name given to an animal can be given to different plant but cannot be given to any other animal.

THANK YOU

LESSONS 5 & 6
CLASSIFICATION

*The systematic grouping of organisms into recognizable categories (groups) based on evolutionary or structural relationships between them.
*Classification facilitates reference to them and transmission of information about them.

Species is the basic unit of the classification system.
*A **species** is a group of morphologically similar organisms that can/do interbreed, thus sharing the same gene pool.
*Closely related species (those sharing one or more significant morphological features) are grouped together in the next highest category, the genus.

* Related genera make up a family.
* Related families are grouped into an order.
*Related orders are grouped into a class,
*Related classes are grouped into a phylum.
*Taxonomic systems used by biologists are hierarchical, that is, each higher group contains all the groups below it.

*Knowing phylogenetic relationships is essential for interpreting the evolution of traits of organisms.
*Many different traits are used to classify organisms because no one type of information is always the most appropriate.
*Any trait that is variable and measurable is referred to as Ordinary Taxanomic Unit (OTU).

Goals of classification

*Biological classification systems should reflect evolutionary relationships among organisms.
*Classification must be easy to use.
*It must be stable.
*It should serve as an aid to memory.
*It must be predictive.
*It must be concise.

Functions of classification

1. The size and diversity of plant and animal kingdoms make classification necessary.
In this light they serve as an aid to memory.
*They help us remember organisms and their traits.
It is an impossible task to record and remember the character and properties of each one of these organisms, individually

2. Classification systems improve our ability to explain relationships among things.

*For biologists, this is especially important when we attempt to reconstruct the evolutionary pathways that have produced the diversity of organisms living today.

3. Classification systems greatly improve our predictive powers.

Eg. the effect of pollution on a species at one location should be similar to the effect on a close relative living in a different area.

4. Classification systems improve our ability to explain relationships among things.
For biologists, this is especially important when we attempt to reconstruct the evolutionary pathways that have produced the diversity of organisms living today.

5. Taxonomic systems provide relatively stable, unique, and unequivocal names for organisms.
* If those names are changed, the systems provide means of tracing the changes.
Common names, even if they exist (most organisms do not have common names at all), are unreliable and often confusing.

Principles of Classification
*While developing a system of classification of organisms, certain basic principles are observed.

1. Morphology criteria:
Morphology forms the primary basis for classifying organisms into various taxonomic groups or taxa.

*In earlier artificial systems, only one or a few morphological characters were taken into consideration (e.g. plants were classified into herbs, shrubs, trees, climbers, etc. on the basis of their habit).
* The sexual system proposed by Linnaeus was based mainly on the characteristics of stamens and carpels.

*Later on, Bentham and Hooker's natural systems of classification of plants) took into effect, a large number of morphological characters.
*As a result, classification of plant groups was more satisfactory and their arrangement showed natural relationships with each other well.

*The similarities in the morphological characters are used for grouping the plants together. Because, these similarities indicate their relationships.
*On the other hand, differences or dissimilarities of characters are used for separating the plant groups from each other. Plant groups with greater differences are considered to be unrelated or distantly related

(ii) Phylogenetic considerations :
*In the more recent systems of classification of plants.
* a greater emphasis is given on the phylogenetic arrangement of plant groups, ie. an arrangement which is based on the evolutionary sequence of the plant groups.
* These systems also reflect on the genetic similarities of the plants.

*Some of the phylogenetic systems of classification of plants are the ones proposed by Engler and Prantle (1887-1899), Bessey (1915), Hutchinson (1926 and 1934), etc.
*However, none of these or any other systems is a perfect phylogenetic system.
*This is because, our present knowledge of the evolutionary history of plant groups is very fragmentary and incomplete.

*Modern taxonomy takes into consideration data available from all disciplines of botany for classification of plants.
*This helps immensely in establishing inter-relationships of various plant groups.
*As a result, taxonomic arrangement becomes more authentic and convincing.

Iii) Chemical Taxanomy/ Chemotaxanomy
*It is a comparatively recent discipline.
Chemotaxonomy is the application of phyto-chemical data to the problems of systematic botany.
*The presence and distribution of various chemical compounds in plants serve as taxonomic evidences.
*Nearly 33 different groups of chemical compounds have been found to be of taxonomic significance.

iv) Numerical taxanomy
*Application of numerical methods (data) in the classification of taxonomic units is called numerical taxonomy.
*It involves exhaustive quantitative estimation of taxonomic characters (OTU) from all parts of the plant as well as from all stages in the life cycle.
*The numerical data collected for various plant groups is tabulated systematically. *Computers are used for this purpose.

*The main objective of numerical taxonomy is to clarify and illustrate <u>degrees</u> of relationship or similarity in an <u>objective manner.</u>
*This branch is becoming an indispensable aid in modern systematics.
*Edgar Anderson (1949) was the first to make use of numerical taxonomy in the classification of flowering plants.

Lessons 6 & 7
TAXONOMY and NOMENCLATURE

Taxonomy is the science of discovering, describing, naming and classifying new organisms, and identifying already known ones.

*TAXON
A taxon (taxonomic unit) is a name assigned to an organism or group of organisms.

* A taxon is also designated as a rank and can be placed at a particular level in a systematic hierarchy, reflecting evolutionary relationships.

*It can be used to indicate the rank of a group as well as the organisms contained within that group as was seen under classification.
* The two most important aspects under taxonomy is classification and nomenclature.

BIOLOGICAL NOMENCLATURE
*This deals with the application of correct scientific names to organisms according to nomenclatural system.

·The purpose of a name is to act as an easy means of reference and as an aid to communication.

The criteria for formally naming plants and animals are based on the rules and recommendations of the International Code of Botanical Nomenclature (ICBN) and International Code of Zoological Nomenclature (ICZN) respectively.

Characteristics of names:

Names impart some information about organisms. E.g. leaf shape, flower color, location, etc.

·The use of a name avoids the use of a descriptive phrase.

Systems of nomenclature

1. Polynomial system

This system is NOT IN USE/obsolete.

*Under this system a name was made up of a single word for an organism, followed by a lengthy list of descriptive terms in Latin.

*eg. Ranunculus calycibus retroflexis, pedunculis falcatis, caule erecto, folius compositis. (*means, the buttercup with reflexed sepals, curved flower stalks, erect stem, and compound leaves*).

Another example;

Mentha floribus spicatis, foliis oblongis serratis

Meaning ????

Mentha (mint) with flowers in a spike, leaves oblong and serrated

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Weakness in polynomial system.

*The use of polynomials was discontinued because

(i) different polynomials existed for the same plant, making them cumbersome to remember

(ii) they were not standardized

(iii) they served as labels for the taxon and at the same time as diagnosis of the species.

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2. Binomial system

This system was first used by Linnaeus in his famous and influential treatises, Genera Plantarum (1737) and Species Plantarum (1753).

*In the binomial system a species name consists of two words, a generic name and a specific epithet. E.g. *Vigna unquiculata*.

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*Generic names are usually singular nouns and are, with certain optional exceptions, written with a capital letter/initial.

*Specific names/epithet is a bit descriptive and starts with small letter

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*In addition, the generic names and specific epithets are italicised when in text or underlined when hand written.

*While the generic name can be used to represent all the species in the genus, the specific epithet cannot be used to represent any species because it does not convey any sense when used alone.

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*Two or more members of a genus may be referred to by using the generic name together with the abbreviation spp. eg. *Strophantus* spp.
*A single species of a genus may be referred to by using the generic name followed by the abbreviation sp. e.g. *Strophantus* sp.
*Instead of repeating a generic name several times in a paragraph, it is abbreviated to the initial letter after it has been written fully for the first time. E.g. *S. barteri*

Scientific Names

Latin is the language of biological nomenclature. To this end all scientific names must be in Latin or Latinised.

Advantages are as follows:

➢This overcomes the difficulty of multiplicity of different languages which makes common names confusing and unsatisfactory.

- Latin was the common language of learned men in Europe, where formal botany originated and developed.
- Linnaeus himself was born Carl von Linne, which he latinized to Carolus Linnaeus, a practice common among scholars of the time.

➢Latin is essentially a **"dead" language** –
Ie.
➢it is no longer spoken as a native tongue by any people, #
➢avoiding elements of national bias and jealousy,
➢ and, words are no longer being added or subtracted to the language.

REGULATION OF SCIENTIFIC NAMES

- Scientific names are universal, precise and often help infer certain character details and interrelationships of the taxa concerned.
- They are governed by rules captured in the International Code of Zoological Nomenclature (ICZN) and the International Code of Botanical Nomenclature (ICBN).

1. International Code of Botanical Nomenclature (ICBN)

- In 1867, a group of botanists at the International Botanical Congress in Paris established the rules governing plant nomenclature and classification.
- They established Species Plantarum as the starting point for scientific names and, through **the International Code** of Botanical Nomenclature, formalized and standardized plant naming procedures and rules.

- The code was divided into three divisions.
- Division I contains a set of six principles which form the very basis of the system of nomenclature (ie. both zoological and botanical).
- These are:

➢ Scientific names of taxonomic groups are treated as Latin regardless of their derivation.

➢ Botanical nomenclature is independent of zoological nomenclature..

➢ The nomenclature of a taxonomic group is based upon priority of publication.

➢ Each taxonomic group with a particular circumscription, position and rank can bear only one correct name, the earliest that is in accordance with the rules, except in specified cases.

➢ The application of names of taxonomic group is determined by means of nomenclatural types

➢ The rules of nomenclature are retroactive unless expressly limited.

- Division II contains detailed rules, distributed over 75 articles, and recommendations. Names which contravene any one or more of the rules are illegitimate and cannot be maintained.
- Recommendations deal with subsidiary points and are intended to bring in greater uniformity in plant nomenclature.

- Names contrary to recommendations need not be rejected, but are not examples to be followed.

- Division III contains detailed provisions for modification of the Code.

2. International Code of Zoological Nomenclature (ICZN)

- In 1901, a report by the International Commission on Zoological Nomenclature (ICZN) was adopted at a congress and a Code of rules embodying the decision of that Congress was published in French, English and German in 1905.
- This Code, entitled Règles internationales de la Nomenclature zoologique.

- This code underwent a series of amendments at subsequent Congresses.
- In 1961 it was replaced in its entirety by the first edition of the International Code of Zoological Nomenclature.
- The International Commission on Zoological Nomenclature (ICZN) was established in 1895 to create, publish and, periodically, revise the International Code of Zoological Nomenclature.

- Commission also considers and rules on specific cases of nomenclatural uncertainty. These rulings are published as 'Opinions' in the *Bulletin of Zoological Nomenclature*.

COMMON NAMES

- Common names are very often descriptive and poetic references to plants.
- They are not suitable for biological nomenclature **because:**
  - They may refer to more than one plant or, conversely, many plants may have the same common name.

- Common names are often ambiguous and often regional or local, rarely universal.
- They are available for only relatively a few plant and animal species.
- The same taxonomic group may be known by different names in different linguistic areas and even in different parts of the same area.

(ii) *Arbutus unedo* has many different common names including osage orange, mock orange, wild orange and horse apple.

(b) They are often ambiguous.

(c) They are not universal but often regional or local.

(d) They are available for only relatively a few plant and animal species.

(e) Most common names do not give any information about the organisms. In some cases the information given is misleading.

E.g. (i) Jerusalem cherry is a woody plant with berry fruits. Its fruit is not cherry and does not come from Jerusalem.

(ii) Pineapple is neither a pine nor an apple.

(f) Common names do not indicate any relationship with other organisms.

THANK YOU

TAXANOMIC GROUPINGS

A. **SPECIES GROUP NAMING:**

*The species scientific name consists of a generic name and a specific epithet.

1). The specific epithet must be in accord with the gender of the genus,
ie. endings must be the same.

However, there are **3 types**; (where gender matches)

- Thus, it is *Chenopodium album* (not *alba* or *albus*),
- *Hirschfeldia incana* (not *incanum* or *incanus*),
- and *Caulanthus heterophyllus* (not *heterophylla* or *heterophyllum*).

2) There are also specific names for which the masculine and feminine forms are the same, but the neuter form is different,

- Thus masculine and feminine *acaulis* and neuter *acaule*,
- and masculine and feminine *campestris* and neuter *campestre*.

3) There are specific names for which the form is the same for all three genders, such as (*Lupinus bicolor*) and (*Trifolium repens*).

- The name (s) of the author (s) of a scientific name form an official part of the name under ICBN. E.g. *Eragrostis acraea* Linneaus.
- However, in ICZN, **the authors name does not form an official part.**

- The **sub-species' scientific name** is made up three names; generic name, specific epithet and a third term denoting the sub-species.
- There is a word between the specific epithet and the third term that indicates the rank of the species. E.g. *Andropogon ternatus* subsp. *macrothrix*, or
- *Herniaria hirsuta* var. *diandra*.

B. Generic Names

- The name of a genus is a noun in the nominative singular, or a word treated as such. ie. uni-nomial
- It is written with an initial capital letter.
- It may be taken from any source whatever, and may even be composed in **an absolutely arbitrary manner,**
- but must not end in '-*virus*.
- A generic name cannot be composed of two words, ie. two - word genus names are REJECTED (regarded as illegitimate name).

- However, if the two words are joined with a hyphen it is legitimate. Eg. ***Sebastiano-schaueria***
- Names of sub-divisions of the same genus (i.e. subgenera), even if they differ in rank, are homonyms if they have the same epithet but are based on different types.
- The name of a subdivision of a genus consists of a generic name and a sub-divisional epithet connected by a term denoting its rank.

C. **FAMILY NAMES**

i) Family Group Names (ICBN)

- The name of a family is usually based on the name of the type genus.
- This can be done in two ways;
- **(a)** If latin; the genitive singular inflection (Latin *-ae, -i, -us, -is;* transliterated as **-aceae.**
- If Greek, *-ou, -os, -es, -as,* or *-ous,* including the latter's equivalent *-eos*) of a legitimate name of an included genus can be replaced by the suffice **–aceae.**

- (b) Secondly, the suffix, -aceae can be added to the full word when the generic name has no genitive singular inflection.
- Eg. 1 *Rosaceae* (from *Rosa, Rosae*),
- *Plumbaginaceae* (from *Plumbago, Plumbaginis*),
- *Rhodophyllaceae* (from *Rhodophyllus, Rhodophylli*)

- *Sclerodermataceae* (from *Scleroderma, Sclerodermatos*).
- The names of a **subfamily, tribe and subtribe** are formed in the same manner as the name of a family but with the endings –**oideae**, -**eae** and –**inae** respectively.
- Eg below

- Eg. The type of the family name *Poaceae* comes from genus *Poa* L.
- The subfamily and tribe which include *Poa* are to be called *Pooideae* Asch. and *Poeae* R. Br.
- The family *Asteraceae* (*Compositae)* includes *Aster* L.,
- the Subfamily name, is called *Asteroideae* Asch., and the tribe and subtribe including *Aster* are to be called *Astereae* Cass. and *Asterinae* Less., respectively.

ii) Family names under ICZN

- A family name is formed by adding the suffice –**idae** to the stem of the name of the type genus, or to the entire name of the type genus.
- If a generic name is or ends in a Greek or Latin word, or ends in a Greek or Latin suffix, the stem is found by deleting the case ending of the appropriate genitive singular. Eg. *Coccinella* (genitive Coccinellae, stem Coccinell-)gives family name Coccinellidae.

- Similarly, *Culex* (genitive Culicis, stem Culic-) gives Culicidae,
- *Archaeopteryx* (genitive Archaeo-pterygis, stem Archaeopteryg-) gives Archeaopterygidae.
- The names of **superfamily, subfamily, tribe and subtribe** are formed in a similar manner by using the suffice **–oidea, -inae, -ini** and **-ina** respectively.

Suffices for naming Ranks of names;

RANK	PLANT	ALGAE	FUNGI	ANIMALS
Division/Phylum	-phyta	-phyta	-mycota	
Subdivision /Phylum	-phytina	-phytina	-mycotina	
Class	-opsida	-phyceae	-mycete	
subclass	-idae	-phycidae	-mycetidae	
Super Order	- anae	-anae	-anae	
Order	-ales	-ales	-ales	

continuation

RANK	PLANT	ALGAE	FUNGI	ANIMALS
Sub-order	-ineae	-ineae	-ineae	
Infra-order	-aria	-aria	-aria	
Super-family	acea	acea	-acea	-oidea
Family	-aceae	-aceae	-aceae	-idae
Sub-family	- oideae	-oldeae	-oldeae	-Inae
Tribe	-eae	-eae	-eae	-ini
Sub-tribe	-inae	-inae	-inae	-ina

COMMON NAMES

- Common names are very often descriptive and poetic references to plants.
- They are not suitable for biological nomenclature **because:**
  - ➢They may refer to more than one plant or, conversely, many plants may have the same common name.
  - ➢Common names are often ambiguous and often regional or local, rarely universal.
  - ➢They are available for only relatively a few plant and animal species.
  - ➢The same taxonomic group may be known by different names in different linguistic areas and even in different parts of the same area.

MODIFICATION OF THE CODES

- Modifications to the ICBN can only be made by a decision a plenary session of the International Botanical Congress, while that of ICZN is made by the International Congress of Zoology based on the recommendations from the International Commission on Zoological Nomenclature.

BIOL 157: PRINCIPLES OF SYSTEMATICS

PRIORITY

- PRINCIPLES OF PRIORITY
- The valid name of a taxon is the oldest available name applied to it, unless that name has been invalidated or another name is given precedence by any provision of the Code or by any ruling of the Commission.

- For this reason priority applies to the validity of synonyms, to the relative precedence of homonyms, the correctness or otherwise of spellings, and to the validity of nomenclatural acts (such as acts taken under the Principle of the First Reviser and the fixation of name-bearing types).
- **Advantage**: Priority promotes stability.

ACCEPTANCE OF SCIENTIFIC NAMES

- To be accepted by the ICBN, plant names have to be **effectively and validly published** to be legitimate and correct.
- The processes below should be observed;

1. Effective publication

- A name becomes effectively published when it is published in printed form and made available to the general public,
- or at least to botanical institutions with libraries accessible to botanists generally;

2. Unacceptable practices;

- *It is not effected by communication of new names at a public meeting,*
- *by the placing of names in collections or gardens open to the public,*
- *by the issue of microfilm made from manuscripts, typescripts or other unpublished material,*
- *by publication online,*
- *or by dissemination of distributable electronic media*

3. Valid publication;

- In order to be validly published, a name of a taxon must have these 4 characteristics,
- (1) effectively published
- (2) published in an approved form,

- (3) accompanied by a description or diagnosis
- or by a reference to a previously and effectively published description or diagnosis.
- (4) for taxa of the rank of genus and below, a nomenclatural type and its location must be indicated.

- The description consists of an obligatory diagnosis in Latin; and
- (i) describing the main characters that distinguish that species from other similar species, and
- (ii) an optional, full description in an international language.

3. LEGITIMATE NAMES

- Legitimate names are those that are in accordance with the rules of the International Code of Botanical Nomenclature.
- Any name that violates one or more rules of the ICBN is known as an illegitimate name

4. AUTHOR CITATION

- All scientific names of plants at and below the rank of family have authors.
- An author is the person who first validly published the name.
- The botanical code requires that when a plant name is written in full, it if followed by the author's or authors' names.

- For example,

1. the full name (including authorship) of the family Rosaceae is Rosaceae Jussieu ; because **de Jussieu** first formally named the family.
2. Author names are often **abbreviated,** such as Haemodoraceae R. Br. (for Robert Brown)

- or *Liquidambar styraciflua* L. ("L." being the standardized abbreviation for Linnaeus).

3. If a species is moved to a different genus, the author's name is placed in parentheses, followed by the name of the author who made the new combination.

- E.g. *Radinosiphon leptostachya* (Baker) N.E. Brown.
- This species was first published as *Lapeirousia leptostachya* Baker by Gilbert Baker, but Nicholas Edward Brown later transferred it to the new genus *Radinosiphon*.

4. 'Ex' is used to connect the names of two persons.

- The first person only proposed a name but never validly published it. The second person validly published the name.
- E.g. *Agrostis montevidensis* Spreng. ex Nees.
- Sprengel proposed the name by writing it on a label of the specimen and mentioning it in an article
- Or ..

- even suggesting it in a letter but did not publish it validly
- Subsequently, Nees von Esenbeck published the name validly.
- It is permissible to omit the first name although for clarity sake both authors are usually cited

5. **'In'** is used to connect the names of two persons,

- the second of which was the editor, or overall author,
- of a work in which the first was responsible for validly publishing a name.

- The second name may be omitted for the sake of brevity. e.g. Tricholaena konus Schrad. In Schult.
- This means Schrader validly published the genus name in a publication by Schultes.

Nomenclatural Types

- The second principle of the ICBN states that scientific names must be associated with some physical entity, known as a **nomenclatural type** or simply **type**.
- A nomenclatural type is almost always a specimen, e.g., a standard herbarium "sheet" specimen, but it may also be an illustration.

- The type serves the purpose of acting as a reference for the name, upon which the name is based.
- If there is ever any doubt as to whether a name is correct or not, the type may be studied.

Types of Nomenclatural types

- These are made up of the holotype, isotype, syntype, etc.
- A **holotype** is the one specimen or illustration upon which a name is based, originally used or designated at the time of publication.
- It serves as the definitive reference source for any questions of identity or nomenclature.

- It is recommended that a holotype be deposited in an internationally recognized herbarium and cited as one of the criteria for the valid publication of a name.
- **Holotypes** constitute the most valuable of specimens and are kept under safe keeping in one (usually a major) herbarium.

- 2. An **isotype** is a duplicate specimen of the holotype, collected at the same time by the same person from the same population.
- The ICBN recommends that isotypes be designated in the valid publication of a new name.

- Isotypes are valuable in that they are reliable duplicates of the same taxon and may be distributed to numerous other herbaria to make it easier for taxonomists of various regions to obtain a specimen of the new taxon.

- 3. A **lectotype** is a specimen that is selected from the original material to serve as the type when no holotype was designated at the time of publication, if the holotype is missing, or if the original type consisted of more than one specimen or taxon.

- 4. A **neotype** is a specimen chosen to act as a type when the original material is lost.

- 5. **syntype**, which is any specimen has been cited in the original work when a holotype was not designated;

- alternatively, a syntype can be one of two or more specimens that were all designated as types.

- 6. **paratype**, a specimen cited but that is not a holotype, isotype, or syntype.
- **7. epitype**, a specimen (or illustration) that is selected to serve as the type if the holotype, lectotype, or neotype is ambiguous with respect to the identification and diagnosis of the taxon