TAXONOMIC CHARACTERS

- All biological organisms have owned distinct characters by themselves
- Characters contributing to a taxonomic description is known as taxonomic character.
- Taxonomic character is **any physical structure** or **behavioral system** that can have more than one form (character state) which potentially provides phylogenetic information

¬ Taxonomic character is defined as “any attribute or forms, structure, physiological or behavioral w/c is considered separately from the whole organism for a particular purpose such

- In more general terms **character** is any **attribute** or **feature** of an organism or a specimen that can be measured, assessed or weighed.

Character state

- It is the various patterns of their expression (an expression of a character).

- **Characters and character states**

Character: eye color **Character states:** blue, brown, green

mammary glands present, absent

number of legs 0, 2, 4, 6, 8, etc.

Leaf arrangement Alternate, Opposite, Whorled

Molecular Characters

nucleotide bases A, C, T, G

amino acid codons ACC, CGT, GAT, etc.

Characters can be **qualitative or quantitative.**

- **Quantitative characters** are those characters that can be assessed by size, length, weight, etc.
- **Qualitative characters** are characters that are relating to **form** that can be expressed.
- Qualitative characters are such characters as leaf arrangement (opposite vs. alternate leaves), placentation types (axile, parietal,

- Often the distinction between quantitative and qualitative characters is more apparent that real.
- Many qualitative characters may also be expressed quantitatively. E.g. leaf shape in width/length ratio.

Application of Quantitative and Qualitative Characters

- Quantitative characters appear to be more frequently used in the lower taxonomic categories, at specific and infraspecific levels.
- Thus, species may be separated by leaf size, corolla length, etc.
- Qualitative characters are often used at higher levels in the hierarchy, e.g. family.

"**Good**" and "**Bad**" Characters

- All characters are theoretically of use in classification, but experience has shown that their value or use varies according to the type of taxonomic activity envisaged.

“**Good**” characters are those that:

- Are not subject to wide variation within the samples being considered;
- Do not have a high intrinsic genetic variability;
- Are not susceptible to environmental modification; and
- Show consistencies e.g. agree with the correlation of characters existing in a natural classification that was constructed without their use.

Diagnostic characters

¬ Is a **shortened description** covering only those characters (diagnostic characters) which are necessary to distinguish a taxon from other related taxa.

- Taxonomic characters basically are classified into two types: **continuous** and **discontinuous** characters
- Variations are universal and form the

Continuous characters

¬ When the variations exhibited by a taxon displays a **continuous gradation without obvious break**, we call it continuous variation.

- Continuous characters are related to those variations between species due to genetic and heritable changes.
- These variations result from the influence of many genes and metabolic interactions

- In continuous variation there is a complete range of measurements from one extreme to the other.
- Height is an example of continuous variation - individuals can have a complete range of heights, for example, 1.5, 1.51, 1.52, 1.525 etc. meters high.
- Weight, body size, hand span, shoe size and milk yield could be other examples of continuous variation

- **Discontinuous characters:** are d/t from **continuous** ones in that in the latter variation is always caused by **genetic variation**; in the former it can be **purely environmental** in origin via consequence of the conditions encountered during development

¬ When the variations exhibited by a taxon display **obvious break or discontinuities**, we call it discontinues variation

¬ It is through this gaps the delimiting lines between taxa are drawn.

- Example: Shell coloration in the land snail

- ¬ In taxonomic practice it is the **extent of gaps** that usually determines the taxonomic ranks;
- ¬ The greater the break or the gap the higher is the taxonomic rank attributed
- ¬ About 3millions of species of organisms that have been discovered so far are on the basis of such discontinuity and would remain so unless and until farther investigations reveal intermediates.

TAXONOMIC INFORMATION (EVIDENCE)

¬ Taxonomic characters can be drawn from any part and phase of development of the organism.

- In practice overwhelming reliance is placed on **morphological characters.**
- However, the following are the major sources of taxonomic information/evidence:

Major sources of taxonomic information

1. Morphological and Anatomical Evidence;
2. Embryological Evidence;
3. Cytological/Chromosomal Evidence
4. Phytochemical/Chemical Evidence;
5. Information from Breeding Systems; and
6. Geographical and Ecological Evidence.

1. MORPHOLOGICAL AND ANATOMICAL EVIDENCE

- Taxonomists still rely today to a very large extent on **morphological and anatomical characters.**
- The reasons why morphological characters are more often used than other characters are:
- Morphological features have the great advantage that we can see them easily and therefore appreciate their variability with much less facility than with other kinds of features.
- Even on herbarium specimens with which most taxonomists‟ work has to be performed, morphological characters can

2. Embryological Evidence

- **The early development of an organism.**
- **Some of the embryological characters that are considered to be taxonomically significant include:**
- **Anther – Taxonomic characters of the anther include:** Number and arrangement of the thecae, Type of wall development, Development and organisation of the pollen grains.
- **Ovule**

Development and structure of the ovule, which include:

o Number and structure of integuments.

o Presence or absence of an aril.

3. Cytological/Chromosomal Evidence

Taxonomically important Chromosome data are:

a. Chromosome number

b. Chromosome size and shape (chromosome structure)

c. Chromosome behavior in Meiosis

d. DNA content

Variations in chromosome numbers have been characteristics of the herbaceous dicots, and woody dicots show much less diversity.

Chromosome numbers in flowering plants vary from n = 2, in a species of Asteraceae to n about 250 in *Kalanchoe.*

- **Polyploidy** is the condition in which one or

4. Phytochemical/Chemical Evidence

Two types:

a. **Micromolecules – low molecular weight compounds and** are products of plant secondary metabolites **include:** Flavonoids, Terpenoids, Alkaloids, Betalains\ Gycosinolates

b. Macromolecules

Proteins and Nucleic acids

- They are found in the nucleus, mitochondria and chloroplasts. These are high molecular weight compounds that are part of the basic metabolic machinery of the plant cells.

5. Information from Breeding Systems

- The breeding system of a plant is the mode, pattern and extent to which it interbreeds with other plants of the same or different taxa.
- Breeding systems determine if the pollen grain can germinate on a receptive stigma, penetrate the style, and effect fertilization
- Inbreeders are plants which predominantly or wholly produce seeds from self-fertilisation

Breeding system is taxonomically important for three reasons:

a. The extent of interbreeding largely defines the pattern of variation and hence the delimitation of taxa,

b. A knowledge of the breeding system frequently helps to understand taxonomic complexity, although it does not solve the problems associated with it, and

c. A study of the breeding system is often vital in unraveling evolutionary

- Hybrid formation is common in plants, and there are about 70,000 species of hybrid origin, most between two or among three or more species belonging to the same genus.
- There are also hybrids between species from different genera, but none from different families.

How to recognize hybrids

- A hybrid is usually intermediate in appearance between its parents.

ϖ Whenever reproductive isolation develops speciation has occurred.

ϖ Speciation is the evolutionary process by which new biological sp. arise

Isolating Mechanisms

- There are several factors that operate in the wild which prevent hybridisation. They are;

A. Pre-zygotic Mechanisms

i) Geographical isolation – two species are separated geographically.

ii) Ecological isolation – two species occur in the same general habitat, but are separated ecologically, occupying different habitats.

iii) Seasonal isolation – two species occur in the same locality but flower at different seasons.

iv) Temporal isolation – two species flower during the same

v) **Ethological isolation** - related interfertile species are pollinated by different sorts of vectors, or on any particular forage an individual pollen vector keeps to one species only.

vi) Mechanical isolation – related interfertile species have differently structured flowers which make it difficult for pollen vectors to transfer pollen to the stigmas of flowers other than those of the same species from which it was obtained.

vii) Breeding behavioral isolation –

viii) Gametophytic isolation –cross pollination takes place but the pollen tube fails to germinate or to reach and penetrate the embryo sac of the female parent.

ix) Gametic isolation – the pollen tube releases the male gamete into the embryo sac, but gametic fusion and/or endospermic fusion does not take place.

B. Post-zygotic Mechanisms

x) **Hybrid incompatibility** – the zygote or immature embryo stops development, so that a mature seed is not formed.

xi) **Hybrid inviability** – seed germination occurs, but the resultant F1 hybrid dies sometime before its production of flowers.

xii) Non-fitness of hybrids – the F1 hybrids reach maturity, but are not successful competitors in the wild; no suitable ecological niche.

xiii) F2 hybrid sterility – the F1 hybrids are fully viable but sterile and thus do not contribute to future generations.

xiv) F2 hybrid inviability or sterility – the disability is delayed until the F2 generation, or even later.

xv) Non-fitness of F2 hybrid – Disability delayed until a later generation.

- Alternatively isolating mechanisms 1-7 may be described as **external** and 8-15 as **internal**.

6. Geographical/ Ecological Evidence

Ecological Evidence

Ecological data are different from other types of comparative data in taxonomy.

They deal with plant-environment interactions.

The interactions are the net effect of all the features of the plant with all the aspects of the environment.

- They are of two basic types:
- **abiotic, such as soils,**

- biotic, part of the environment, including aspects such as herbivores and competitors.

One of the most commonly used ecological data in taxonomy is **distribution**, which is also regarded as geographical evidence.

- The associated plants in the local environment are very valuable as comparative data, which are usually given as general plant communities described by dominant taxa, e.g. *Juniperus Olea dry land*

Geographical Evidence

Patterns of Geographical Distribution

- **Allopatric** – taxa which occupy mutually exclusive geographical areas.
  - The isolated population undergo genotypic or phenotypic variation /divergence.
- **Peripatric** –in this new species are formed in isolated, small peripheral populations which are prevented from exchanging genes with the main population.
  - The isolated individuals quickly become incompatible with their former sp. and have become new species.
- **Parapatric** -in this, the zone of two diverging populations are separated, but there is only partial separations like the edge of the forest or the snow line on the mountain.
- **Sympatric** – taxa occupying similar or

Disjunction and Vicariance

- Most taxa are found fairly continuously throughout their area of distribution, but some have distribution patterns that are interrupted by considerable areas from which the taxon is absent.
- The interrupted distribution pattern is called disjunction or disjunct distribution.

Disjunction may originate in two or three ways:

- Long-distance dispersal of the taxon from one area to another, there being

- Disjunctions may represent the former wide, continuous distribution patterns having been depopulated, sometimes because they were covered by sea.
- Another possibility that the taxon may have arisen independently in its separate areas of distribution, thus exhibiting evolutionary parallelism or convergence.

Vicariance/vicariism or vicariads/vicariants

- Two similar taxa occupying separate geographical (or ecological) areas are known as **vicariants** or **vicariads**.
- The phenomenon by which two similar taxa occupy separate geographical (or ecological) areas is called **vicariance** or **vicariism**.
- The difference between **vicariance** and **disjunction** is one of a degree.

Identification

- Identification of an unknown organism is the determination of it as being similar to or identical with an already known element.
- It is the naming of an organism or part of an organism by reference to an already existent classification.

Methods of Identification

- There are four methods of identification. They are:

1. Expert determination;
2. Determination by recognition;
3. Determination by comparison to preserved and well authenticated specimens and drawings, illustrations

- In terms of reliability and accuracy, the best method of identification is **expert** determination.
- In general the expert will have prepared treatments (monographs, revisions, synopsis) of the group in question.
- Recognition approaches expert determination in reliability.
- This is based on extensive, past experience of the identifier with the plant group in question.

- The third method is by **comparison** of the unknown with named specimens, photographs, illustrations or descriptions.
- Even though this is a reliable method, it may be very time consuming or virtually impossible due to the lack of suitable materials for comparison.
- The **use of keys** or similar devices (synopsis, outlines, etc.) is by far the most widely used method and does not require the time, materials, or experience involved in comparison and

KEYS (DIAGNOSTIC KEYS)

Keys are of two types.

- **Single-access or Sequential Keys** –have a single starting point (fixed sequence).
  - **Sequential keys** are nearly always written in the form of the dichotomous keys so familiar in botanical (and zoological) works,
- **Multi-access Keys** –can be commenced at any position.
- Multi-access keys are usually produced not on pages in a book, but on separate punched cards.

Single-access or Sequential Keys

- Sequence keys are nearly always written in the form of the **dichotomous keys**.
- **Dichotomous keys are devices consisting of a series of contrasting or contradictory statements or propositions requiring the identifier to make comparisons and decisions based on statements in the key as related to the material to be identified.**
- The dichotomous key consists of a series of couplets or mutually exclusive pairs of statements each statement or lead of a pair leading on to a further couplet.
- At each couplet a decision to follow one lead or the other has to be taken so that the number of taxa with which the unknown specimen can be

- The dichotomous or sequential written in one of two ways:
  - **Bracketed key**
  - **Indented key**
- The essential difference between these two layouts is that in the **indeted key** all the possibilities arising from the first lead are dealt with before the second lead is mentioned.
- Bracketed key (are known as parallel keys) keep the two leads of every couplet together and easier comparison of the alternatives .
- *The bracketed keys utilize the space in each page efficiently and so they are cheaper to print
- Each method has its advantages, and the

- However, the indented key has advantages when the key is short, as the pattern of characters is clearer, but when the key is long there is much wastage of page space and the user has to turn pages to find two halves of a couplet.
- *There is a wastage of paper because the keys utilize the right side of the paper and so they are expensive to print .
- It is often better to key very distinctive taxa first, for in so doing the user may be more likely to arrive at a correct identification despite having used a

Suggestions for Construction of Keys

- Identify all groups to be included in a key;
- Prepare a description of each taxon;
- Select key characters with contrasting character states; use macroscopic morphological characters and constant character states when possible; avoid characteristics that can only be seen in the field or on specially prepared specimens, i.e., use those characteristics that are generally available to the user;
- Prepare a comparison chart;
- Construct strictly dichotomous keys;

- Use parallel construction and comparative terminology in each lead of a couplet;
- Use at least two characters per lead when possible;
- Follow key format – indented or bracketed;
- Start both leads of a couplet with the same word if at al possible and successive leads with different words;
- Mention the name of the plant part before descriptive phrase, e.g. leaves alternate but not alternate leaves;
- Place those taxa with numerous variable character states in a key several times when necessary; and
- Construct separate keys for dioecious plants for flowering or fruiting materials

Suggestions for the Use of Keys

- Select appropriate keys for the materials to be identified; the keys may be in a Flora, Manual, Guide, Handbook, Monograph or Revision.
- If the locality of an unknown plant is known select a Flora, Guide or Manual treating the plants of that geographical area.
- If the family or genus is recognised, one may choose to use a monograph or revision.
- Use a glossary to check the meaning of

- If the locality is unknown select a general work;
- Read the introductory comments on format details, abbreviations, etc., before using the key;
- Read both leads of a couplet before making a choice.
- Even though the first lead may seem to describe the unknown material, the second lead may be even more appropriate;

- Measure several similar structures when measurements are used in the key, e.g. measure several leaves not a single leaf;
- Try both choices when dichotomies are not clear or when information is insufficient, and make a decision as to which of the two answers best fits the description; and
- Verify your results by reading a description, comparing the specimens with an illustration or authentically

Examples of the Two Types of a Dichotomous Key

Type 1: Bracketed

1. Leaves simple. ***Olea europaea* subsp. *cuspidata***
- Leaves compound. 2

2. Crown flat; leaves twice pinnate; leaflets upto 40 pairs, less than 4 mm long. ***Acacia abyssinica***
- Crown variously-shaped but not flat; leaves once-pinnate; leaflets much longer than 4 mm. 3

3. Branches prickly. ***Erythrina brucei***
- Branches not prickly. 4

4. Leaves alternate, pinnately 3-foliolate; leaflets elliptic. ***Allophylus abyssinicus***
- Leaves opposite, pinnately 5- or 7-foliolate; leaflets linear-lanceolate. ***Fraxinus* excelsior**

Type II: Indented

1. Leaves simple. ***Olea europaea*** subsp. ***cuspidata***

1. Leaves compound

    2. Crown flat; leaves twice pinnate; leaflets up to 40 pairs, less than 4 mm long. ***Acacia abyssinica***

    2. Crown variously-shaped but not flat; leaves once-pinnate; leaflets much longer than 4 mm

        3. Branches prickly. ***Erythrina brucei***

        3. Branches not prickly

            4. Leaves alternate, pinnately 3-foliolate; leaflets elliptic. ***Allophylus abyssinicus***

            4. Leaves opposite, pinnately 5- or 7-foliolate; leaflets linear-lanceolate. ***Fraxinus* excelsior**

- Select any 10 plant species inside the campus and construct indented and bracketed keys using vegetative& reproductive characters/ features following key construction procedures.

Character ↓	**Species**									
	1	2	3	4	5	6	7	8	9	10
Habit										
Leaf type										
Leaf arrangement										
Lamina shape										
Lamina base										
Lamina margine										
Lamina apex										
Lateral veins No.										
Lamina indumentum										
Petiol length										
Petiol shape										
Petiol indumentum										
Inflorescence										
Sepals No.										
Sepals-free/fused										
Petals-colour										
Petals-free/fused										
Petal/corolla length										
Petal indumentum										
Stamen number										
Filament length										
Filament indumentum										
Fruit type										