

# Principles of Systematics

## Type Locality

# Type Locality

- According to Article 72h type locality is the place from where type specimen was taken.
- Specimens collected from type locality are called topotype
- Population that occur at type locality is topotypical population
- Preserved specimen/type locality

# Type Locality

- Damage holotype
- Information about environment
- Temperature/Humidity/soil type
- Missing type locality
- Article 72H contains advice on designations or restriction
- Designations or restriction not done routinely but by specialists by their revisionary work

**END**

# Principles of Systematics

## Module# 67

# Principles of Systematics

## Concept of Priority

# Concept of Priority

- Fundamental principal of Zoological nomenclature
- Essentially it is a principle of recognizing first valid name of a species.
- A principle in taxonomy: the first properly published name of a species or genus takes precedence over any subsequently published
- (Article 19)

# Concept of Priority

- The name which was use first time should be valid name
- Once name has been used, no subsequent publication of that name for other texon.
- There are formal provisions for making exceptions to this principle.

# Concept of Priority

## Limitations

- Priority starts from May 01, 1753
- Apply only to family level
- Not according to Zoological code



# Concept of Priority

- If an archaic or obscure prior name is discovered for an established taxon, the current name can be declared conserved name (zoology), and so conserved against the prior name.
- Conservation can may be avoided in Zoology as these names fall in formal category of ***Nomen oblitum***.

# Concept of Priority

## Nomen oblitum

- In taxonomy, a forgotten name; i.e. the name of a senior synonym that has not been used in the zoological literature for at least 50 years.
- Such names should not be used if they upset a better-known name, but should preferably be suppressed by the ICZN.

# Concept of Priority

- If a current name for a taxon have archaic or obscure homonym (same name to different taxon), the current name can be declared as *Nomen protectum* (available name).

**END**

# Principles of Systematics

## Module# 68

# Principles of Systematics

## Concept of priority

# Concept of Priority



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## What does priority means?

- The first Scientific name applied to the leopard shark was *Triakis californica*
- Proposed by British Zoologist Edward Gray (1851)
- He did not provided proper description
- In 1854 *Mustelus felis* by william Orville published
- In 1855 *Triakis semifasciata* by C F Girard

# Concept of Priority

## Error in date recording

- *Triakis semifasciata*
- *Nomen protectum* (available name)
- *Mustelis felis* was invalidated (as a *nomen oblitum* ).

# Concept of Priority



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## Example

- In 1855 John Edward Gray published the name of Pronghorn (*Antilocarpa anteflexa*)
- Based on pairs of horns
- 1815 George Ord Published *Antilocarpa americana* for the same species.
- So the older name *Antilocarpa americana* takes the priority over *the Antilocarpa anteflexa*



# Concept of Priority



[https://www.google.com/search?q=Muraena+anguilla&tbm=isch&ved=2ahUKEwiv5d7\\_gevsAhVNZR0KHcT3BYAQ2-cCegQIABAA&oeq=Muraena+anguilla&gs\\_lcp=CgNpbWcQA1C-amjVYmpo1Y0mgNWgAcAB4AIAB8wOIAfMDkgEDNC0xmAE-AoAEBqgELZ3dzLXdpei1pbWfAAQE&sclient=img&ei=xrujX6\\_qFs3KacTvl4AI&bih=600&biw=1360#imgrc=EvrSudnM3XTF-M](https://www.google.com/search?q=Muraena+anguilla&tbm=isch&ved=2ahUKEwiv5d7_gevsAhVNZR0KHcT3BYAQ2-cCegQIABAA&oeq=Muraena+anguilla&gs_lcp=CgNpbWcQA1C-amjVYmpo1Y0mgNWgAcAB4AIAB8wOIAfMDkgEDNC0xmAE-AoAEBqgELZ3dzLXdpei1pbWfAAQE&sclient=img&ei=xrujX6_qFs3KacTvl4AI&bih=600&biw=1360#imgrc=EvrSudnM3XTF-M)

## Example

- In 1856 Johann Jakob Kaup published the name *Leptocephalus brevirosteris* for new species of eel.
- In 1893 same name was given to juvenile form of European eel whose name was *Muraena anguilla* given by Carl Linnaeus in 1758.
- Old name was retained.

# Principles of Systematics

## Module# 69

# Principles of Systematics

## Concept of Availability

# Concept of Availability

- Taxonomic name which should be used is called Valid (Accepted, correct) name.
- The name must have been published according to requirements detailed in Articles 8-20.
- An available name can be valid or not
- An unavailable name is never valid.
- Availability criteria vary depending on nomenclature

# Concept of Availability

- The term available means “legitimate”
- A name may be available in this technical sense even though as Junior homonym
- It is automatically invalid at the time of publication (Article 53 and 59a).
- Need to differentiate between **available** and **valid names**

# Concept of Availability

- Available (properly published).
- Valid (not preoccupied by senior synonym or homonym)
- Article 11-19 describe prerequisite for making a specific name available.
- Particularly article **13a** is very important.

# Concept of Availability

- According to article **13a** names published after 1930 must be
- Accompanied by description that states the characters that are purported to differentiate the Taxon
- It is good taxonomic practice to include in the original description not only such diagnostic information but also differential diagnosis (comparison with other related species)

**END**

# Principles of Systematics

## Module# 70



# Principles of Systematics

## Concept of Availability

# Concept of Availability

## Nomen nudum

- A name published without satisfying the condition of availability is called nomen nudum.
- Especially if it fails to satisfy the conditions of Article 12-16.
- A nomen nudum has no standing in Zoological nomenclature

# Concept of Availability

## Nomen nudum

- If editors of journals were more familiar with the provisions of the Code, they would not permit publications of so many unavailable names because they violate one or another of Article 8-20.

# Concept of Availability

## Differential Diagnosis

- Description of characters after 1930 (Article 13a)
- Comparison with close relative
- Description of diagnostic differences (NOT mandatory)

# Concept of Availability

## Names Given to Hybrids

- Hybrids are normally individuals not population
- Not considered as Texa
- Article 1b (3) states clearly that a name given to an animal that is later found hybrid remain available for the purposes of homonymy, not for purposes of Synonymy
- A name given to hybrid can not be applied to either of parental species.

# Concept of Availability

## Synonyms

- Different names for same thing
- Earliest published name **senior synonym**
- Later published name **junior synonym**

# Concept of Availability

## Types of Synonyms

### Objective synonym

- The name that objectively refer to the same thing/name based on the same specimen or illustration (at Genera level )

### Subjective synonym

- Name based on different type material (*Antelocarpa anteflexa* 1855 vs *Antelocarpa americana*)
- *Antelocarpa anteflexa* was unusual specimen of *Antelocarpa Americana*)

END

# Principles of Systematics

## Module# 71



# Principles of Systematics

## International Code for Zoological Nomenclature

# International Code for Zoological Nomenclature

## Zoological Nomenclature

- System of scientific names applied to taxonomic units of animals
- The term nomenclature comes from Latin words
- **Nomen** which means Names
- **Calare** mean to call
- Call by names

# International Code for Zoological Nomenclature

## Important requisite of taxonomic names

- **Uniqueness**
- **Universality**
- **Stability**

# International Code for Zoological Nomenclature

## ICZN

- Set of rules for naming animals and resolution of nomenclatural problems
- Authoritative document that contain valid rule of Zoological nomenclature
- Original codes and its revision were the work of International Congress of Zoology

# International Code for Zoological Nomenclature

## ICZN

- Now these congresses are defunct
- Role have been taken over by **General Assemblies of International Union of Biological Sciences** (IUBS)
- International Congresses of Zoology have appointed a judicial body (**International Commission on Zoological Nomenclature**) to interpret the rules and publish opinions on controversial issues.

# International Code for Zoological Nomenclature

## ICZN

- Article 76 through 82 specify the duties of the commission.
- Latest edition of code was published in February 1985
- Can be ordered from International Trust for Zoological Nomenclature 56, Queen Gate London or
- University of California Press, Berkeley and Los Angeles.

# International Code for Zoological Nomenclature

## ICZN

- Code consists of three parts
- The code proper
- Appendices (A section giving additional information at the end of Book)
- Glossary (a list of technical or special words)

# International Code for Zoological Nomenclature

## Code proper

- **Preamble:** Introduction to book or written documents
- 90 articles grouped in 18 chapters
- Each article is composed of one or more mandatory rules
- Followed by recommendations and illustrative examples
- Use of recommendation is not mandatory



# International Code for Zoological Nomenclature

## Appendices

- Appendices are like recommendations not to be followed strictly as article.
- These are five in number and are designated as A-E.

## Glossary

- The terms used in the text are clearly defined in the Glossary.

**END**

# Principles of Systematics

## Module# 72

# Principles of Systematics

## Molecular Systematics

# Molecular Systematics

- Classification of organisms on the basis of **distribution and composition of chemical substances** in them.
- Comparisons of Molecular components (DNA, RNA and Proteins) help to establish relationships among different animal taxa.
- **Molecular Phylogenetics-** relationships based on molecular data and statistical analysis.

# Molecular Systematics

- First phylogenetic tree based on molecular data 1967 **Fitch and Margoliash**
- Researcher realized that although traditional taxonomic methods are good but Molecular evidences could be final confirmatory
- Phylogenetic studies help to assess the historical processes which affect relationships

# Molecular Systematics

- Phylogeographic studies help to understand the distribution
- Phylogenetic and Phylogeographic studies started with the introduction of mDNA markers in population genetic studies.
- The goal is to provide insight into the history of groups of organisms and the evolutionary processes that create diversity among species.

# Molecular Systematics

- The use of amino-acid or nucleotide-sequence data in determining the evolutionary relationships of different organisms.
- Essentially it involves comparing the sequences of functionally homologous molecules from each organism being studied, and determining the number of differences between them.

# Molecular Systematics

- The greater the number of differences, the more distantly related the organisms are likely to be.
- Genetic distances
- Cluster analysis
- Gel electrophoresis
- Agarose/PAGA

**END**



# Principles of Systematics

## Module# 73

# Principles of Systematics

## Molecular Systematics

# Molecular Systematics

## Applications

- Solving taxonomic problems
- Reorganization of tree of life
- Identifications of immature stages
- Identification of cryptic species
- Identification of disease vectors
- Testing food authenticity
- Monitoring of illegal trade
- Monitoring quality of water
- Identification of damage specimens

# Molecular Systematics

## Applications

- Identification of sibling species and sub-species

**END**

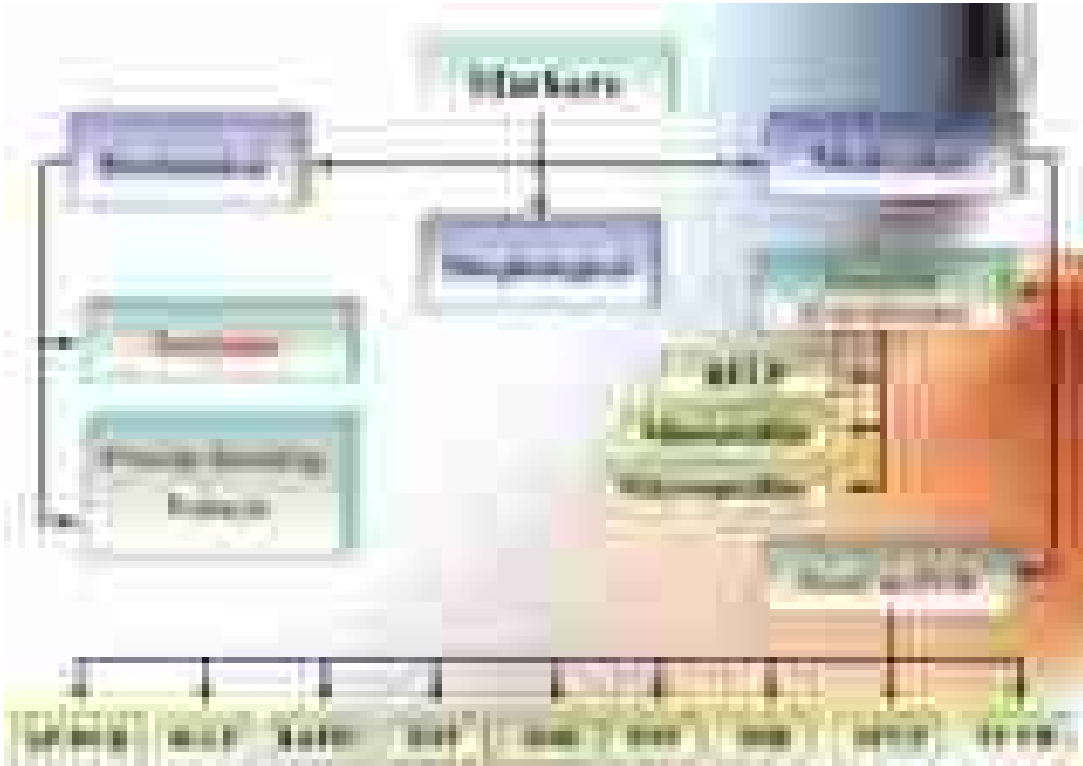
# Principles of Systematics

## Module# 74

# Principles of Systematics

## Molecular Markers

# Molecular Markers

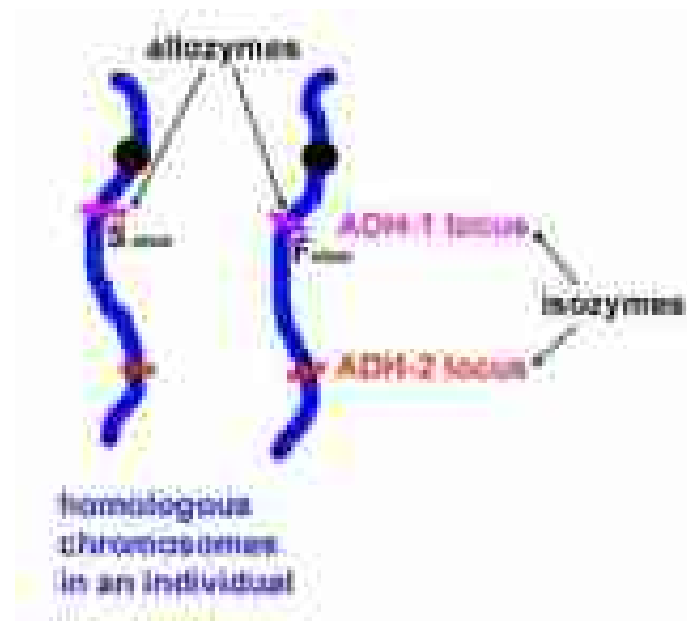


<https://www.slideshare.net/FAOoftheUN/molecular-markers-types-and-applications-55688001>

## Types of Markers

- **Type I:** Associated with genes of known function. Alloenzymes are type I markers as the protein they encode are associated with genes of known function.
- **Type II:** Associated with genes of unknown function. Microsatellite and other neutral markers are type II markers.

# Molecular Markers



<https://www.google.com/search?q=allozyme+markers&sa=X&hl=en&sxsrf=ALeKk03E32wxhpW4rE2JMvw2sHLDIUkIGQ:1604826259215&tbm=isch&source=iu&ictx=1&fir=yKMV0K4mxTe3YM%252C37qgcbgAr7dpfM%252C%252Fm%252F02x3b9m&vet=1&usg=AI4>

## Allozymes

- Variant form of an enzyme
- Different structurally but not functionally from other alloenzyme coded by different allele present at same locus.
- Codominant markers that express in heterozygous in MF

## Isoenzymes

- The enzymes that perform the same function, but which are coded by genes located at different loci



# Molecular Markers

## Mitochondrial DNA Markers

- Non-Nuclear DNA
- Present in Mitochondrial
- Maternally inherited as haploid genome
- Entire genome undergo transcription as single unit
- No recombination
- Homologous markers

# Molecular Markers

## Microsatellite

- Simple DNA sequence
- Repeated several times across various points in DNA of an organism
- 2-6 nucleotides
- 5-50 times
- Present at thousands of locations in an organism
- Microsatellite sequences are composed of non-coding DNA and are not parts of genes.



<https://www.youtube.com/watch?v=r-8SXTHzJFU>

# Principles of Systematics

## Module# 75

# Principles of Systematics

## Molecular Markers

# Molecular Markers

## SNPs

- Single Nucleotide substitution
- Single Nucleotide  
insertion/deletion
- These point mutations give rise to  
various alleles with alternate  
bases at particular nucleotide  
position
- Most abundant polymorphism in  
genome of an organism
- Can be detected by PCR, microchip  
array or fluorescence technology

# Molecular Markers

## DNA barcoding

- CO1 gene
- 658 base pairs
- Species specific
- Highly conserved
- High mutation rate
- Widely used in identification of arthropods
- Universal primers
- Reliable and quick method
- Hebert Paul 2003

END

# Principles of Systematics

## Module# 76

# Principles of Systematics

## Molecular Markers



# Molecular Markers

## Protein (Biochemical markers)

- Available since 1950s
- Related to variation in protein and amino acid bending pattern
- Can be studied using Gel electrophoresis e.g esterase, Acid phosphatase, peroxidase etc.
- Advantage
- Require simple equipment
- A vigorous complement to the morphological assessment of variation

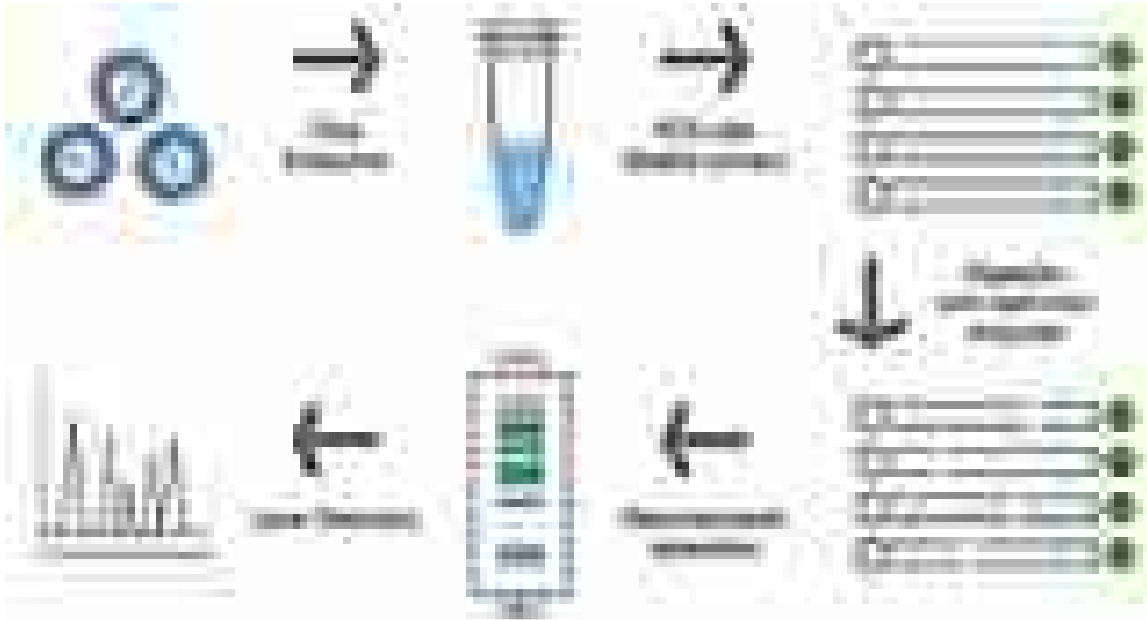
# Molecular Markers

## Protein (Biochemical markers)

### Disadvantages

- Subject to environmental influences
- Limited in numbers

# Molecular Markers



## Hybridization based techniques (Non-PCR)

- RFLPs (Restriction Fragment Length polymorphism) Analysis
- Introduced by Bostein et al. 1980
- Relatively slow process
- Use of radioisotopes has limited use of RFLPs in certified laboratories

# Molecular Markers

## PCR based techniques

- RAPD (Random Amplified polymorphic DNA)
- ISSR (Inter-Simple Sequence Repeat)
- SSR (Simple Sequence Repeat)
- AFLP (Amplified Fragment length Polymorphism)
- EST (Expressed sequence Tags)
- SCoT (Stop Codon targeted marker)

**END**

# Principles of Systematics

## Module# 77

# Principles of Systematics

## Molecular Markers

# Molecular Markers

## Advantages of Molecular Markers

- Ubiquitous
- Stably inherited
- Multiple alleles for each marker
- Devoid of pleiotropic effects
- Detectable in all tissues, all ages
- Long shelf life of DNA samples

# Molecular Markers

## Application of Molecular Markers

- Fingerprinting
- Diversity studies
- Genetic maps
- Gene tagging
- F1 identification
- Seed testing
- Comparative maps

END



# Principles of Systematics

## Module# 78

# Principles of Systematics

## Methods of Animal Preservation

# Methods of Animal Preservation

## Animal Preservation

- Long term animal preservation in best possible condition
- May be assessed as reference collection in future for scientific purposes
- Many methods are used for preservation of vertebrate and invertebrates

# Methods of Animal Preservation

## Reasons of Animal Preservation

- Taxonomic reasons
- For detail examination
- For morphological examination of particular animal as each and every animals can not be in researcher's vicinity
- For zoological museum record

# Methods of Animal Preservation

## Steps for Animal Preservation

- Killing and relaxing of animals
- Fixation (stop cellular respiration, kill bacteria within organism, a good penetrating ability)
- Storage in bottle, vials, jars, bottles etc.

# Methods of Animal Preservation

## Type of specimens

- Entire fluid preserved specimens  
(for study of histology and anatomy, entirely change fur colour)
- Study skins with skulls /partial skeleton (Some bones in skin) for studying colour, hair quality and moulting pattern
- Mounted skins
- Entire skeletons (Anatomy, age determination, geographic variations)

**END**

# Principles of Systematics

## Module# 79

# Principles of Systematics

## Methods of Animal Preservation



# Methods of Animal Preservation

## Formalin as Preservative

- It is used for vertebrate only
- Not used for long term storage
- Acidic and difficult to handle
- Used when colour of animal is important
- Alcohols dissolve most colour immediately
- Penetrate more easily and internal organs remain in better condition

# Methods of Animal Preservation

## Side effects of Formalin

- Fumes of formalin are harmful
- Extreme discomfort of eyes and nose
- Severe irritation if contact with body
- Can cause cancer
- Hand should be rinsed after use
- Should be placed at safe place
- Water-tight

# Methods of Animal Preservation

## Industrial Alcohol (For fixing and storage)

- Not used for killing and fixing of vertebrates.
- For long term storage
- Colour of sample is lost quickly
- Glycerin in alcohol help to preserve colours and to keep specimens flexible
- 70-75% alcohol is used for long term storage
- 95% of DNA studies

# Methods of Animal Preservation

## Side effects

- Skin irritation with prolong contact.
- Industrial alcohol is toxic and should not be drunk
- Highly flammable
- Rapid evaporation
- Should be kept covered not in open jars.

**END**

# Principles of Systematics

## Module# 80

# Principles of Systematics

## Methods of Animal Preservation

# Methods of Animal Preservation

## Iropropyl Alcohol

- Cheep
- Easy to obtain
- Available strengths (90%, 70%)
- For use dilute upto 40%
- Can be hard to specimens and  
specimens tends to brittle over  
the time
- Can be buffered with few drops  
of glycerin
- Pinch of calcium carbonate tablet  
(crush form of tablet)

# Methods of Animal Preservation

## Ethyl Alcohol

- Better solution for long term storage of invertebrate specimens
- 80% ethyl alcohol
- Denatured alcohol
- Painting supplies
- Should be buffered with glycerin/antacid tablets



# Methods of Animal Preservation

## Fish preservation

- After capture fishes are placed in 10% formalin for quick killing.
- This is highly painful
- Fishes dies with its parts well spread off and body straight and well stretched.
- Examination and counting of rays, fins etc. very easy.
- 30 cm fish, Fish in formalin for one week, in water for one day (leech out formalin), use alcohol for long term preservation

**END**

# Principles of Systematics

## Module# 81

# Principles of Systematics

## Methods of Animal Preservation

# Methods of Animal Preservation

## Herptiles

- Individually kept in plastic jars
- Killed by freezing or chloroform
- Shallow trays are used for herptiles
- Snakes should be coiled
- Frogs are placed on their bellies with their limbs set at right angles to their bodies.
- Small salamanders fixing time 2 days
- Month for alligator, snapping turtle

# Methods of Animal Preservation

## Herptiles

- Add water for day or two
- 75% alcohol for long term storage.

# Methods of Animal Preservation

## Birds and Mammals

- Skinned
- Skulls or skeletal mounts
- Remove flesh
- Boiling or dermestid beetle
- Placed defleshed bones in bleach or hydrogen peroxide solution to whiten
- Allow to dry
- Place in bag with complete label

**END**

# Principles of Systematics

## Module# 82

# Principles of Systematics

## Methods of Animal Preservation



# Methods of Animal Preservation

## Preservation of invertebrates

- Use of alcohol is the easiest way
- One should be aware about the type of alcohol
- Each specimen type require different concentration of alcohol
- Preserved in jars, tubes or bottles

# Methods of Animal Preservation

## Coelenterates, platyhelminthes and echinoderms

**Coelenterates** are difficult to preserve

- Preserve in 70% alcohol or 5% formalin
- Hydra can be quickly fixed in warm Bouin's warm not hot.

## Platyhelminthes (flatworms)

- Bouin solution for fixation
- Paraffin is best long term preserving and storage medium for all flatworms.

# Methods of Animal Preservation

- **Echinoderms** are narcotized by addition of magnesium sulphate or methanol to the sea water in which they live
- When completely insensitive to stimulus such as pricking, 70% alcohol for preservation and storage

# Methods of Animal Preservation

- **Arthropods** are easy to process as killed immediately and preserved and store in alcohol
- Crabs and prawn may be killed in formalin but renders their joints hard and brittle.
- Larger invertebrate need to be injected 10% formalin to prevent from rotting
- Industrial alcohol is used for most arthropods.

# Methods of Animal Preservation

- Insects, crustaceans and arachnids can be simply dropped in alcohol for immediate preservation.
- Industrial alcohol is used for most arthropods.

**END**

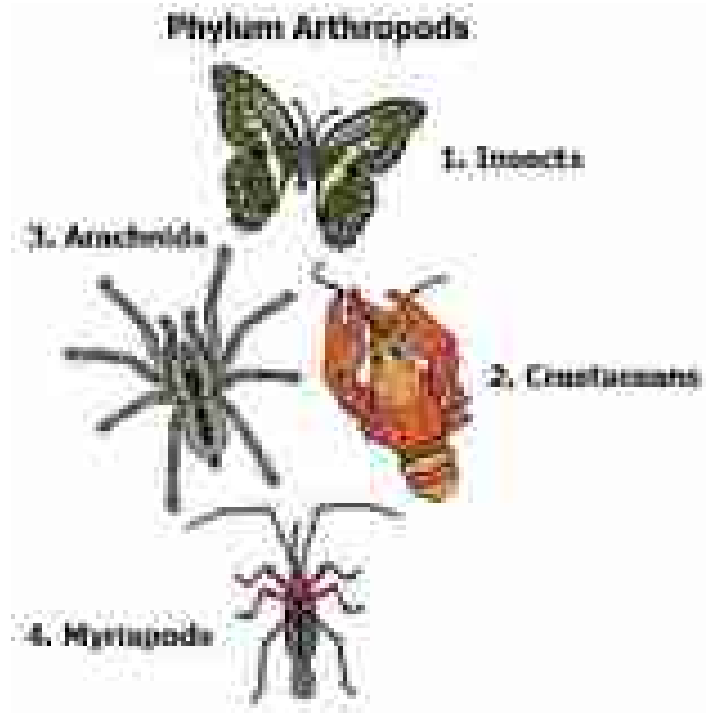
# Principles of Systematics

## Module# 83

# Principles of Systematics

## Morphological Identifications of Model Arthropod

# Morphological Identifications of Model Arthropods



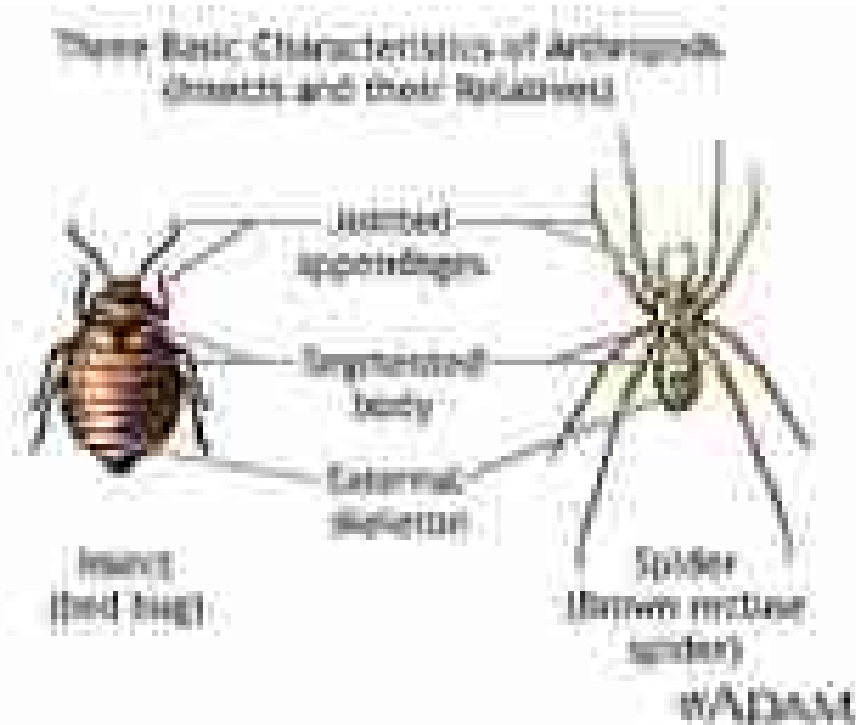
## What is an Arthropod?

- Any member of Phylum Arthropoda
- Include lobster, prawn, mites, insects, spiders, centipedes, millipedes
- Represented in every habitat of earth
- Show great diversity of adaptations

[https://www.google.com/search?q=distribution+and+abundance+of+arthropods&tbm=isch&ved=2ahUKEwiHrMC3i5XtAhU1gc4BHc6LBOEQcCegQIABAA&oeq=distribution+and+abundance+of+arthropods&gs\\_lcp=CgNpbWcQAzoECCMQJzoECAAQZoCCAA6BggAEAgQHjoECAAQGD0ECAAQHjoGCAAQBRAeULTPcljDgtgq78LaABwAHgDgAHUCYgB6luSAQ4yLTizLjluMC4yLjEuM5gBA6ABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=0Mq5X4eED7WCur4PzpeSiA4&bih=657&biw=1360#imgsrc=Wkf1B\\_slQaOUyM&imgdii=b2K7h2f-v7gNoM](https://www.google.com/search?q=distribution+and+abundance+of+arthropods&tbm=isch&ved=2ahUKEwiHrMC3i5XtAhU1gc4BHc6LBOEQcCegQIABAA&oeq=distribution+and+abundance+of+arthropods&gs_lcp=CgNpbWcQAzoECCMQJzoECAAQZoCCAA6BggAEAgQHjoECAAQGD0ECAAQHjoGCAAQBRAeULTPcljDgtgq78LaABwAHgDgAHUCYgB6luSAQ4yLTizLjluMC4yLjEuM5gBA6ABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=0Mq5X4eED7WCur4PzpeSiA4&bih=657&biw=1360#imgsrc=Wkf1B_slQaOUyM&imgdii=b2K7h2f-v7gNoM)



# Morphological Identifications of Model Arthropods



[https://www.google.com/search?q=basic+body+characteristics+of+arthropods&sxsrf=ALeKk024Jhkr92CzBt-ISL1YUUtAMZ600A:1606011594113&source=lnms&tbn=isch&sa=X&ved=2ahUKEwiPv8m0i5XtAhVXShUIHV4dBeAQ\\_AUoAXoECCIQAw&biw=1360&bih=657#imgrc=82cOAzf5eyewuM](https://www.google.com/search?q=basic+body+characteristics+of+arthropods&sxsrf=ALeKk024Jhkr92CzBt-ISL1YUUtAMZ600A:1606011594113&source=lnms&tbn=isch&sa=X&ved=2ahUKEwiPv8m0i5XtAhVXShUIHV4dBeAQ_AUoAXoECCIQAw&biw=1360&bih=657#imgrc=82cOAzf5eyewuM)

- Some are aquatic, others are terrestrial, some are free living, other are parasitic
- All arthropods have a body supported by hard exoskeleton
- Legs, antennae and mouth are jointed
- Tube like heart
- Overall body bilateral symmetrical

# Morphological Identifications of Model Arthropods

- Seven million species
- Arthropods are the most successful of all animal phyla based on diversity, distribution, and numbers.
- Nearly one million species identified so far, mostly insects.
- The exoskeleton, or cuticle, is composed of protein and chitin.

# Morphological Identifications of Model Arthropods

- Molting of the cuticle is called ecdysis
- Extensive cephalization
- Open circulatory systems in which a heart pumps hemolymph through short arteries and into open spaces (sinuses)
- Aquatic members- gills for gas exchange; terrestrial members- tracheal system of branched tubes leading from surface throughout body

END

# Principles of Systematics

## Module# 84

# Principles of Systematics

## Morphological Identifications of Model Arthropod

# Morphological Identifications of Model Arthropods

- Appendages in arthropods are modified for a number of functions:
- Walking legs
- Mouth parts
- Antennae
- Claws
- Organs for mating
- Holding eggs

# Morphological Identifications of Model Arthropods

- Segmentation is an ancestral characteristic that carries over from the Annelids
- Note the similarity of the insect caterpillar to polychaete worms
- The exoskeleton provides rigid support and strong points for muscle attachment
- The exoskeleton also forms a protective shell

# Morphological Identifications of Model Arthropods

- The exoskeleton prevents drying out, but also prevents respiration through the skin
- The exoskeleton provides rigid support, but prevents growth – requiring molting
- **Striated muscle** associated with the exoskeleton, and **smooth muscle** associated with the gut



# Morphological Identifications of Model Arthropods

- Reduced body cavity, filled with blood, forming an ***open circulatory system***
- Specialized ***excretory glands*** (coxal, antennal or maxillary glands; malpighian tubules)
- Specialized ***respiratory organs*** (gills, tracheae, book lungs)
- Dorsal brain with fused ventral nerve cords

# Morphological Identifications of Model Arthropods

## Four lineages of arthropods

- Trilobites – extinct
- Chelicerates – horseshoe crabs, spiders
- Uniramians – centipedes, millipedes, insects
- Crustaceans – crabs, lobsters, barnacles

From these lineages arose five major classes of arthropods.

**END**

# Principles of Systematics

## Module# 85

# Principles of Systematics

## Identification Keys and catalogues

# Identification Keys and Catalogues

- Identification keys aids in the identification of biological identities:
- Plants
- Animals
- Fossils
- Microorganisms
- Pollens

# Identification Keys and Catalogues

- Keys are constructed so that user is presented with series of choices about the characteristics of unknown organisms
- By making correct choice at each step of key user is ultimately let to identity of unknown specimen
- At each step use must answer a question about one of more character of gentility to be identified.

# Identification Keys and Catalogues

- If at each step there are only two alternative, the key is said to be **DICHOTOMOUS** (sequential key, analytical key, pathway key)
- **POLYTOMUS** key

# Identification Keys and Catalogues

## Methods of using taxonomic keys

- Read introductory comments, format of the key, abbreviations etc before using key
- Read both choices at each step of the key
- Use glossary to find out the definition of any term you do not understand
- Use a ruler if measurements are needed, do not guess
- Examine several specimens of same species

**END**



# Principles of Systematics

## Module# 86

# Principles of Systematics

## Identification Keys and catalogues

# Identification Keys and Catalogues



## Dichotomous keys

- If each step in a key has only two alternative the key will be dichotomous
- A dichotomous key is a device for identifying unknown organisms to some taxonomic levels such as species, genus or family level.
- These most commonly published keys were first published by Jean B. Lamarck 1778

# Identification Keys and Catalogues



## Dichotomous keys

- Consists of series of paired statements, called couplets.
- Couplets describes some features of organism
- Each statements in a couplet is called a lead
- The statements or leads are in contract (Mutually exclusive)

# Identification Keys and Catalogues



<https://www.youtube.com/watch?v=srJ4aab5RYc>

## Dichotomous keys

- The use of key begins with first couplet and select the statement which best fit the organism to be identified
- The leads typically begins with board characteristics and become narrower as more choicely are required.
- We move through key-Single choice remains

# Identification Keys and Catalogues



<https://www.youtube.com/watch?v=srJ4aab5RYc>

## Dichotomous keys

- If we continue to select correct option of couplets for unknown organism, correct identification of animals will be achieved.

# Principles of Systematics

## Module# 87

# Principles of Systematics

## Identification Keys and catalogues



# Identification Keys and Catalogues

## Catalogue

- No study in science is complete until it is made available to others
- The best way is to made it available through circulation
- In taxonomy publication may be in the form of Books, pamphlets, journal articles, catalogues, checklist etc.

# Identification Keys and Catalogues

## Catalogue

- Catalogue is mainly an index to the taxa arrange in such a way that as to give a vivid picture of references for both zoological and nomenclatural purpose.
- The **Catalogue** currently compiles data from 168 peer-reviewed **taxonomic** databases, that are maintained by specialist institutions around the world.

# Identification Keys and Catalogues

## Catalogue of life

- The Catalogue of Life is an online database
- It provides the most comprehensive and authoritative index of known species of organisms .
- The Catalogue interface is available in twelve languages and is used by research scientists, citizen scientists, educators, and policy makers

# Identification Keys and Catalogues

## Catalogue of life

- June 2001; 19 years ago
- Current status is active
- Registration not required
- Not commercial
- Available in English

# Identification Keys and Catalogues

## Catalogue of life

- The Catalogue listed 300,000 species by 2003, 500,000 species by 2005, and over 800,000 species by 2006. As of 2019, the Catalogue lists 1.9M extant and extinct species.
- There are an estimated 14M mainly unpublished species.

END

# Principles of Systematics

## Module# 88

# Principles of Systematics

## Construction of Identification Key

# Construction of Identification Key

## Key /Taxonomic aids

- Key is a list of statements
- Used for identification
- Similarities and dissimilarities
- Used pair of contrasting characters “couplet”
- Each statement in couplet is “Lead”



# Construction of Identification Key

- Taxonomist have different opinions about the design and format of the key
- Some use numbers to separate the couplets
- Other use letters
- Some taxonomist place each couplets together
- Others may seprate couplets

# Construction of Identification Key

## Types of Keys

- Indented Key
- Bracket Key
- Pictoral Key
- Polyclave Key

# Construction of Identification Key

In indentd key we have sequences of choices between two or more statements

For example: BAT, CAT, FISH, FROG, SNAKES, BIRDS



# Principles of Systematics

## Module# 89

# Principles of Systematics

## Construction of Identification Key

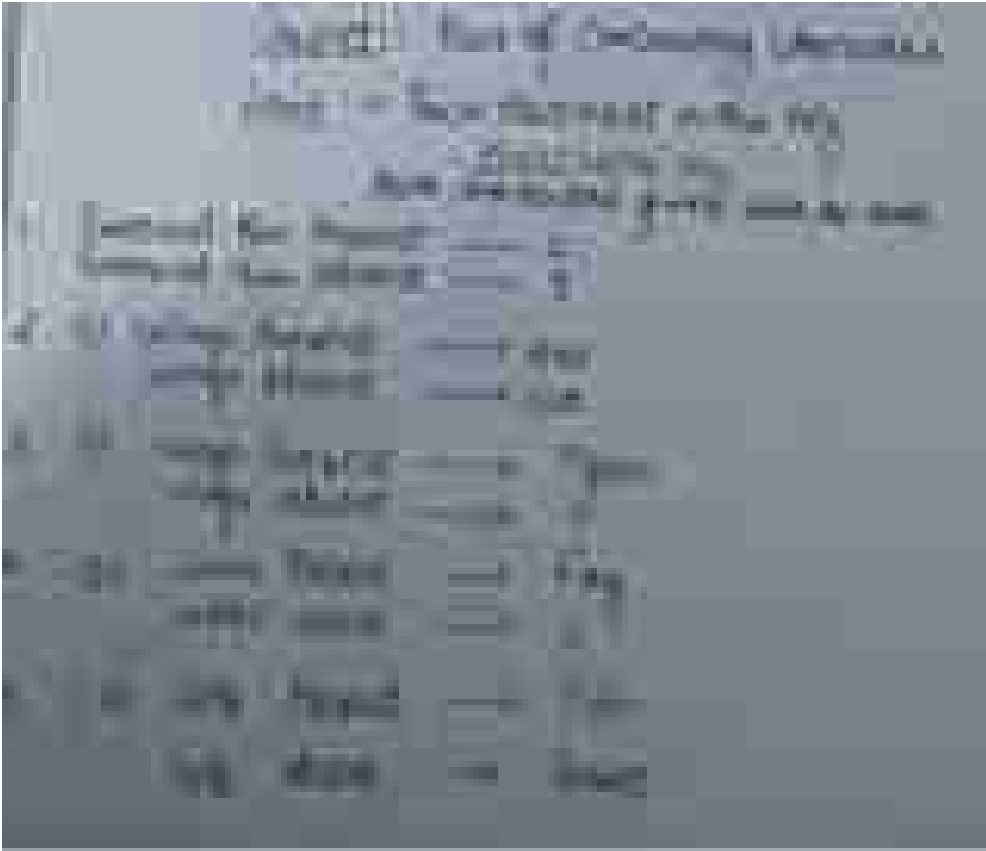
# Identification Keys and Catalogues

## Bracketed Key

| Characters               | Vertebrates |
|--------------------------|-------------|
| (1) External ear present | 2           |
| (1) External ear absent  | 3           |
| (2) Wings present        | BAT         |
| (2) Wings absent         | CAT         |
| (3) Wings present        | BIRDS       |
| (3) Wing absent          | 4           |
| (4) Gills present        | FISH        |
| (4) Gills absent         | 5           |
| (5) Limbs Present        | FROG        |
| (5) Limbs absent         | SNAKE       |

- Pair of contrasting characters are taken in brackets
- Simple to use
- It is most commonly used in the field of taxonomic study.

# Identification Keys and Catalogues



<https://www.youtube.com/watch?v=Uqbm-8Zlqwo>

## Bracketed Key

- Pair of contrasting characters are taken in brackets
- Simple to use
- It is most commonly used in the filed of taxonomic study.

# Identification Keys and Catalogues

## Pectoral Keys

- For non-scientists
- Simple to use
- Key with pictures
- Jungle or desert/easy for identification of plants and animals



# Identification Keys and Catalogues

## Polyclave Key

- Based on computer program
- Simple to use
- Plant identification
- Take  
photos/Google/identification

**END**

# Principles of Systematics

## Module# 90

# Principles of Systematics

## Morphological Identifications of Model Arthropod

# Morphological Identifications of Model Arthropods

- Spiders (Arthropoda: Arachnida) Most
- Most abundant natural predators
- Present in all types of habitat
- Highly diverse groups of Arthropod
- More than 46000 species
- Ranked 7<sup>th</sup> in animal Kingdom

# Morphological Identifications of Model Arthropods

- Present on every continent
- Excellent predators
- Types of spiders
- Can survive without food for several months
- Low metabolic rate
- Prey switching ability

# Morphological Identifications of Model Arthropods

- Prey switching
- Four pairs of legs
- Two body parts
- No antennae

**END**

# Principles of Systematics

## Module# 91

# Principles of Systematics

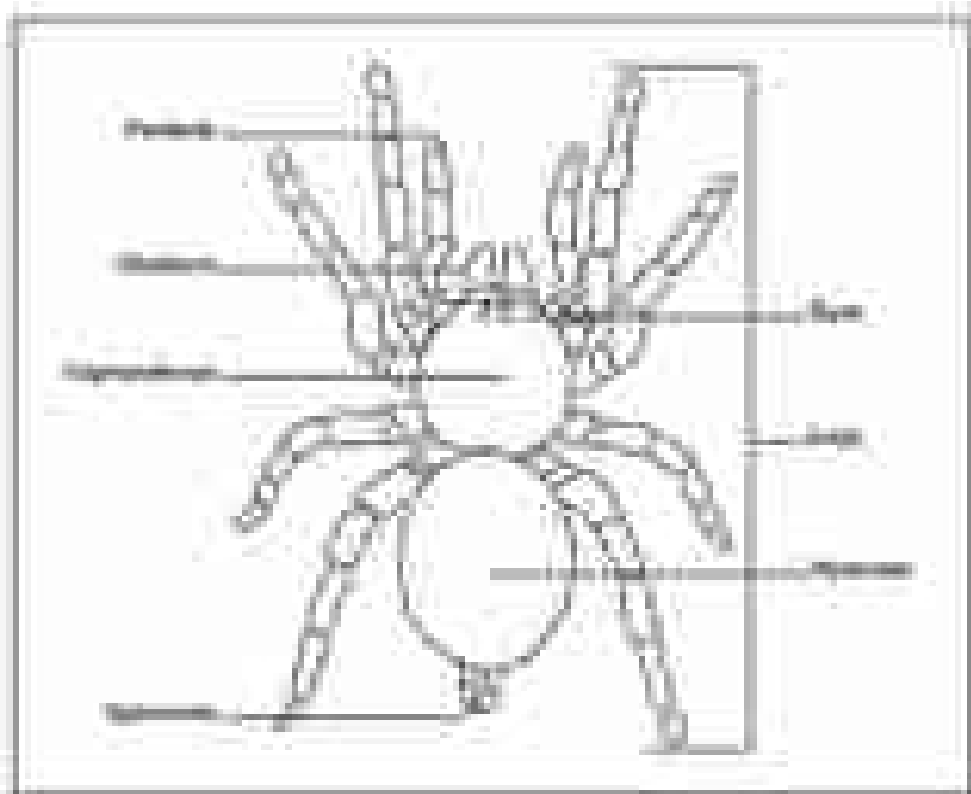
## Morphological Identifications of Model Arthropod



# Morphological Identifications of Model Arthropods

- Spiders have two body segments
- Front segment is called  
**Cephalothorax**
- It contain eyes, mouth parts, fangs, brain, venom gland etc.
- Legs are also connected to this parts
- Four pairs of legs/Chelicera/padipalp

# Morphological Identifications of Model Arthropods



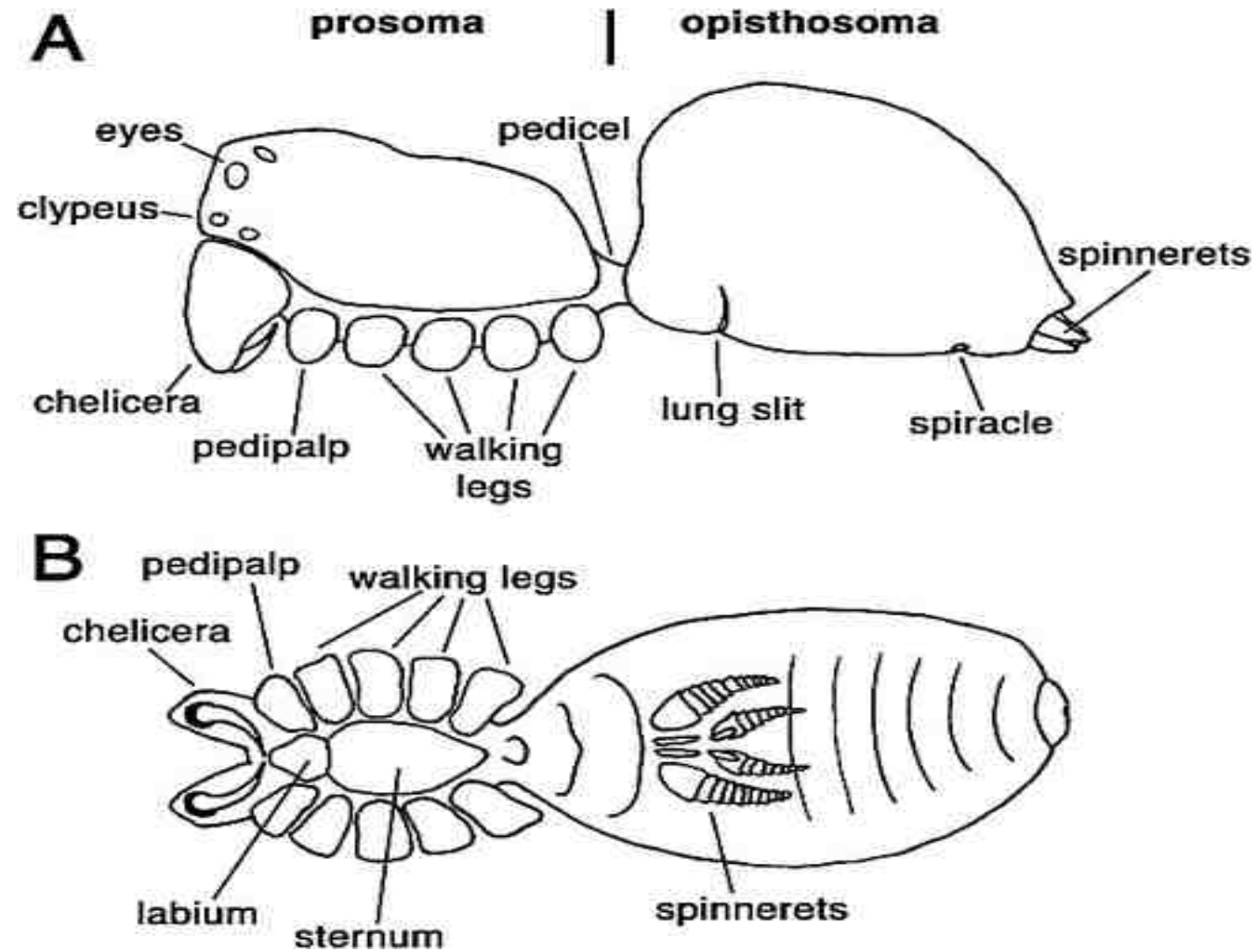
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- 2<sup>nd</sup> part is abdomen
- Spinneret are attached at the end of this part
- Silk glands
- Legs are covered with many hairs
- Hairs pick up vibrations and smell from air
- Claws 2-3 at the end of legs

# Morphological Identifications of Model Arthropods

- 2<sup>nd</sup> part is abdomen
- No skeleton inside their bodies
- Hard outer shell called exoskeleton
- Molting
- Males are smaller than females

# Morphological Identifications of Model Arthropods



[https://www.google.com/search?q=spiders+morphology+ventral+side&tbm=isch&ved=2ahUKEwjYslm0m5TtAhVX\\_IUKHblUAhMQ2-cCegQIABAA&oeq=spiders+morphology+ventral+side&gs\\_lcp=CgNpbWcQAzoECAAQHIC-xRZYgecWYInpFmgAcAB4AIABpwOIAfwckgEHMi03LjQuMZgBAKABAAoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=WFw5X9ikEdf4lwS5qYmYAO&biw=657&bih=1360#imgsrc=wi6EJC0oSRchlm&imgdii=g-x\\_VzORBM7K5M](https://www.google.com/search?q=spiders+morphology+ventral+side&tbm=isch&ved=2ahUKEwjYslm0m5TtAhVX_IUKHblUAhMQ2-cCegQIABAA&oeq=spiders+morphology+ventral+side&gs_lcp=CgNpbWcQAzoECAAQHIC-xRZYgecWYInpFmgAcAB4AIABpwOIAfwckgEHMi03LjQuMZgBAKABAAoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=WFw5X9ikEdf4lwS5qYmYAO&biw=657&bih=1360#imgsrc=wi6EJC0oSRchlm&imgdii=g-x_VzORBM7K5M)

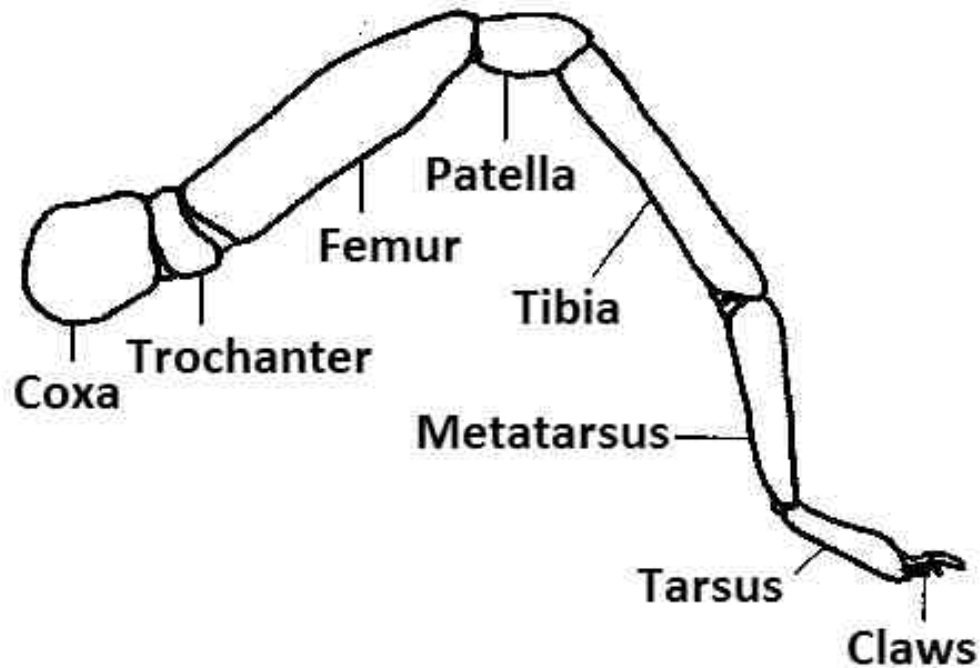
# Principles of Systematics

## Module# 92

# Principles of Systematics

## Morphological Identifications of Model Arthropod

# Morphological Identifications of Model Arthropods

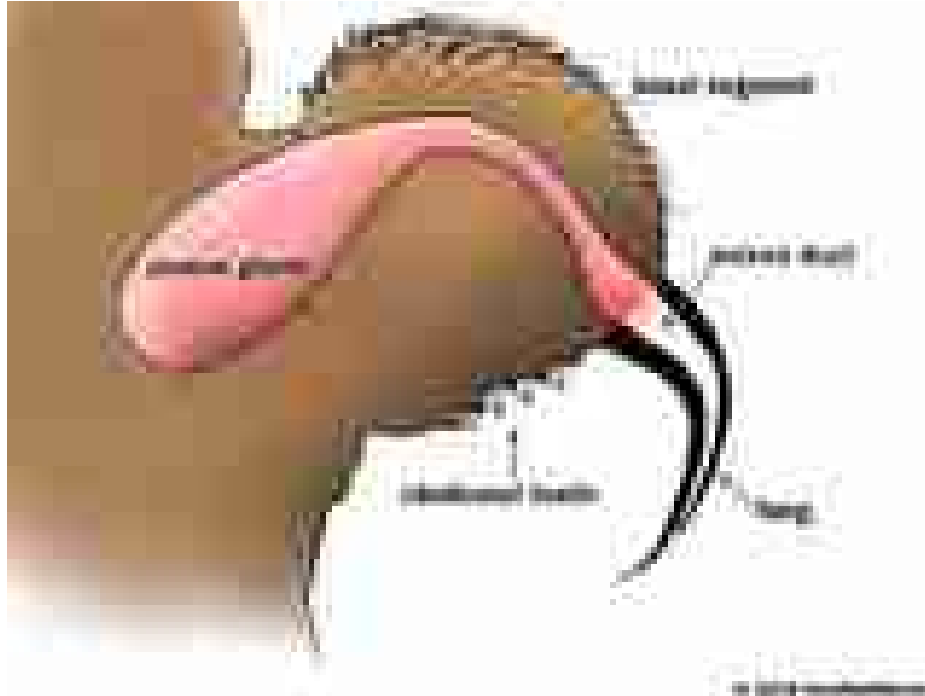


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## Parts of Legs

- Coxa
- Traochanter
- Femur
- Patella
- Tibia
- Metatarsus
- Tarsus
- Claws

# Morphological Identifications of Model Arthropods



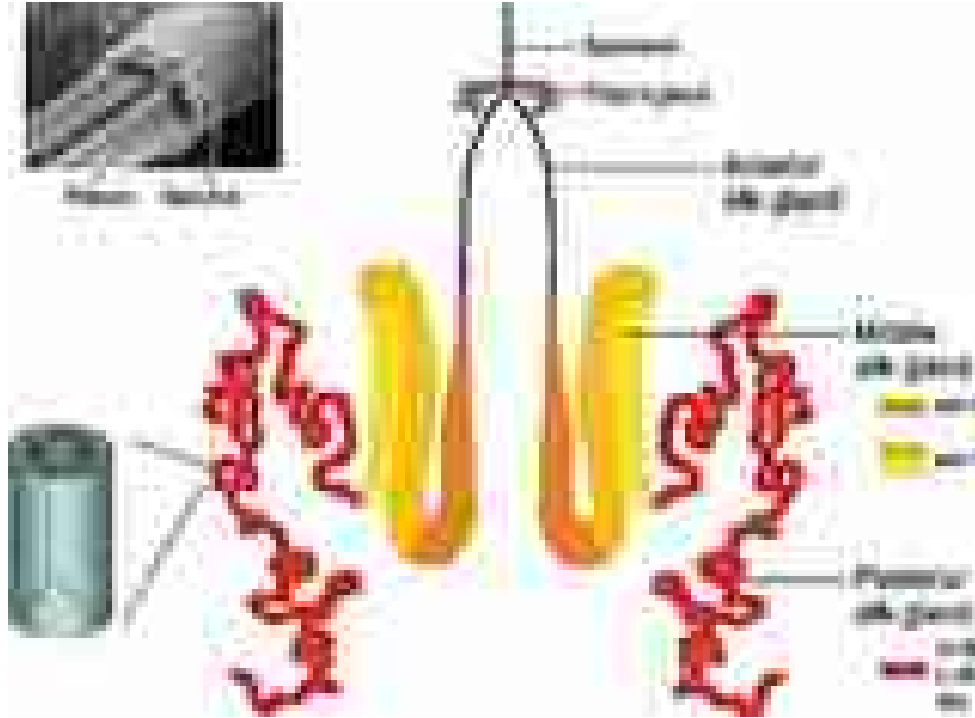
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## Parts of Venom gland and use

- Poison gland
- Poison Duct
- Fang
- Absent in the family Uloboridae.  
The **glands** are located either in the chelicerae or under the carapace.



# Morphological Identifications of Model Arthropods



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## Parts of Silk gland and use

- For capturing prey
- For food storage
- Travelling
- Ballooning

# Principles of Systematics

## Module# 93

# Principles of Systematics

## Morphological Identifications of Model Arthropod

# Morphological Identifications of Model Arthropods

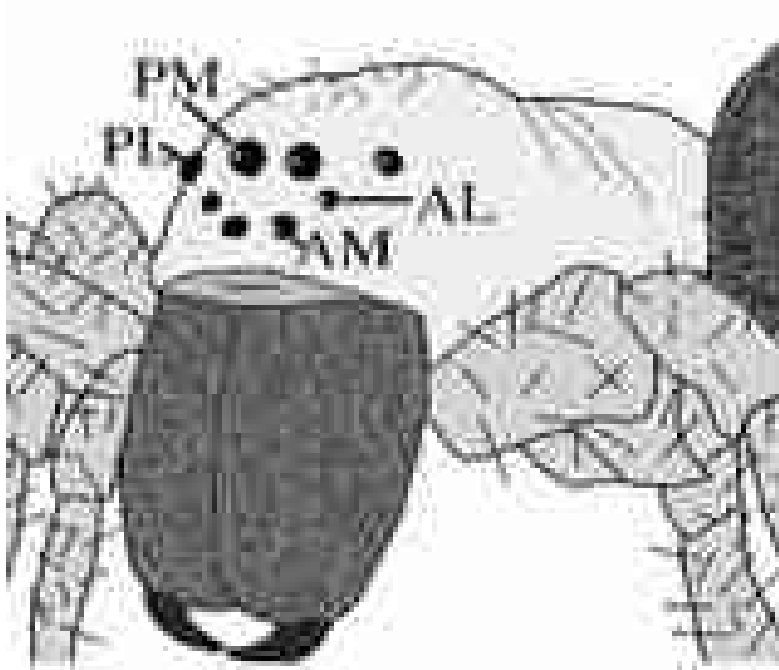


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## Eyes in spiders

- Most spiders have **eight eyes**. Some species have **six or fewer eyes**, but they always come in an **even number**.
- Some species of spiders, such as those that live in **caves or under the soil**, have no eyes at all. Even those species with eight eyes don't usually see very well.

# Morphological Identifications of Model Arthropods

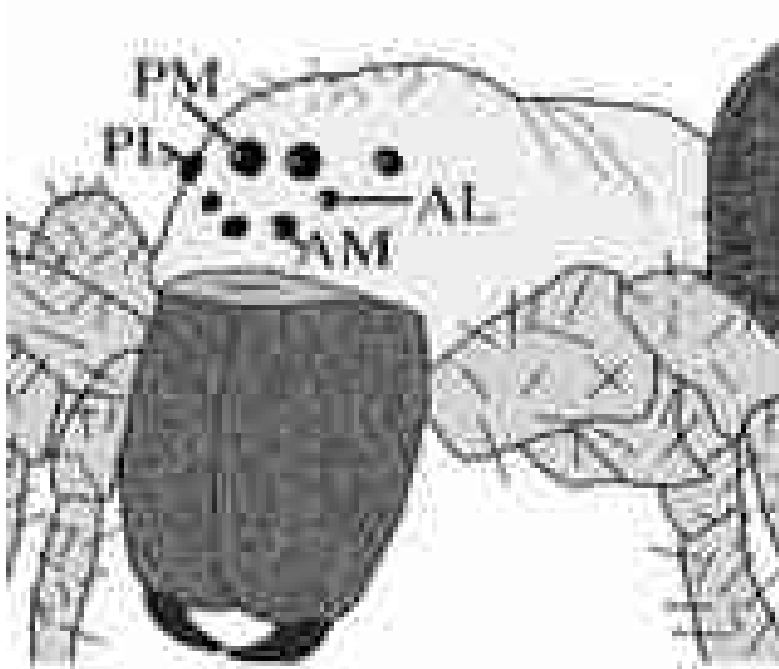


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## Eyes in spiders

- Important Taxonomic character
- Eye arrangement in different families is unique

# Morphological Identifications of Model Arthropods

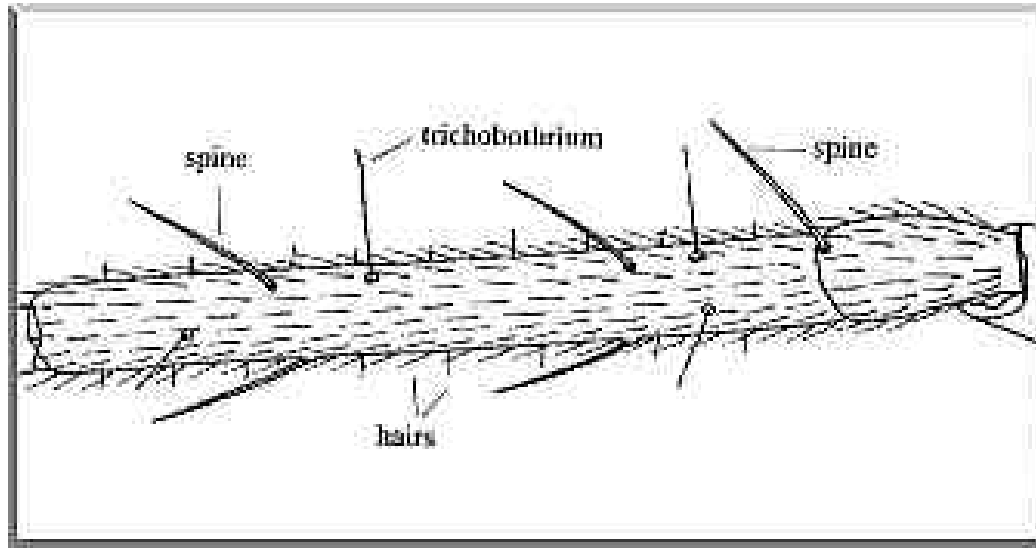


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## Eyes in spiders

- 99% of all spiders have 8 eyes
- 1% nearly all have 6, but there are a few exceptions.
- Varying number of eyes in the same spider family.
- For example, there are spiders in Cybaeidae that have eight eyes, six eyes, and two eyes

# Morphological Identifications of Model Arthropods



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## Sensory structures

- **Spiders**, in fact, do taste, and also smell, through special **sensory organs** on their legs, as well as on their pedipalps.
- And they hear – or, more specifically, they sense vibrations – through hairs and tiny slits distributed over much of their body.
- A **spider's** sensitivity to vibrations is finely tuned.

# Principles of Systematics

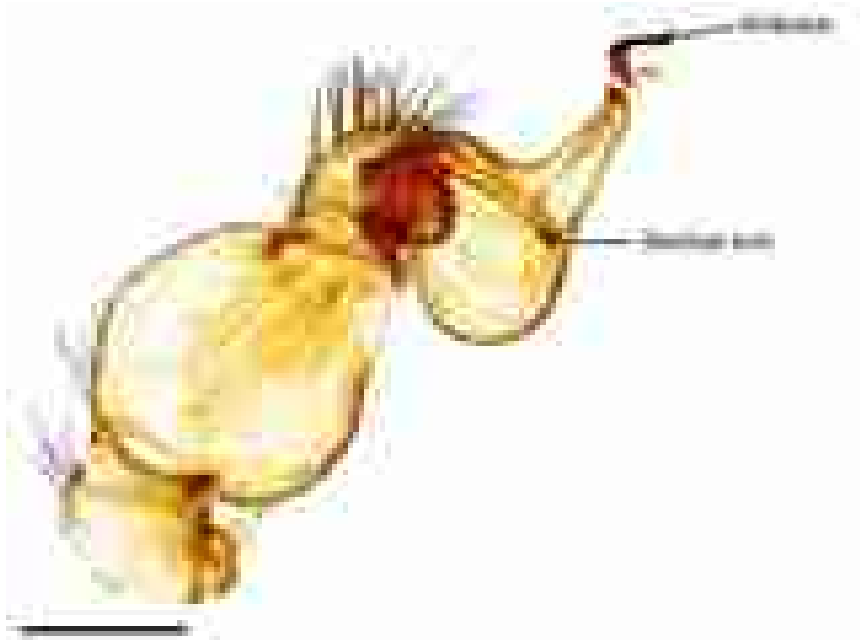
## Module# 94



# Principles of Systematics

## Morphological Identifications of Model Arthropod

# Morphological Identifications of Model Arthropods

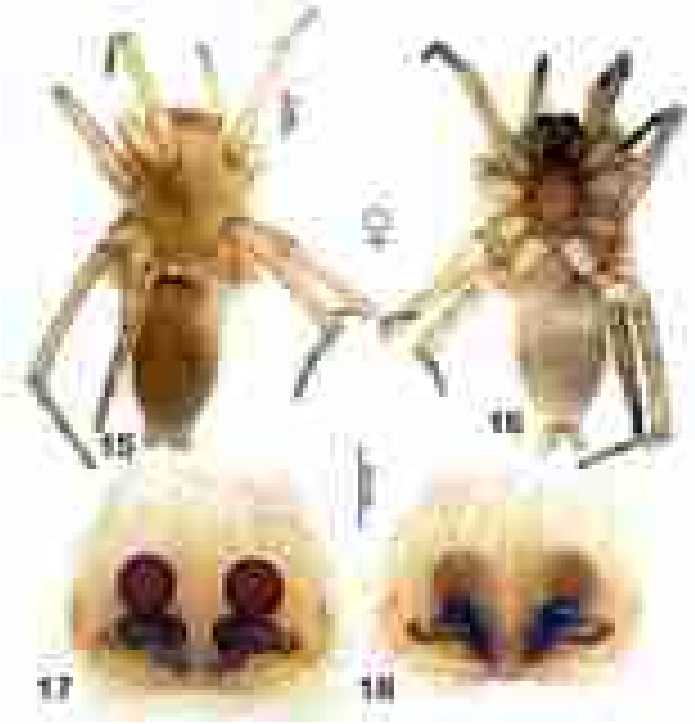


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## Padipalp/Epigyne

- **Pedipalps** (commonly shortened to palps or palpi) are the second pair of appendages of chelicerates
- **Epigyne** or epigynum is the external genital structure of female spiders.

# Morphological Identifications of Model Arthropods

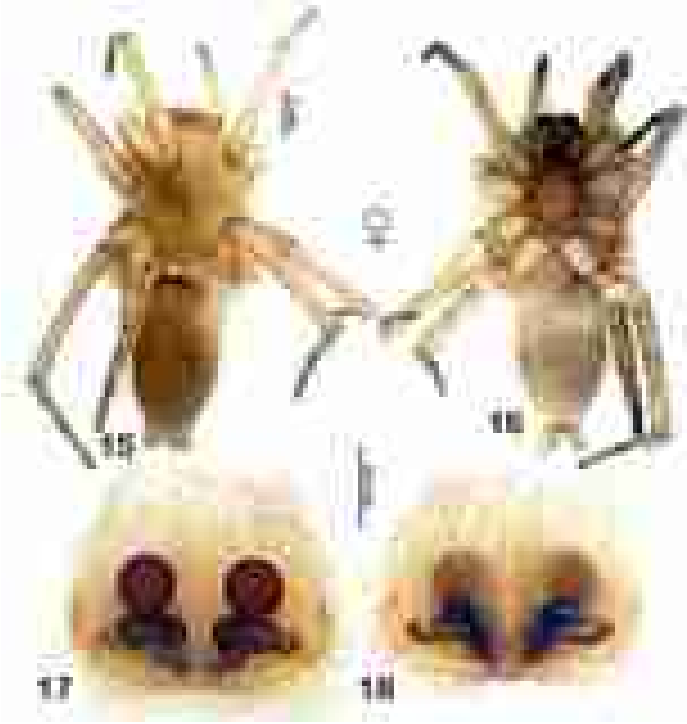


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## Padipalp/Epigyne

- As the epigyne varies greatly in form in different species, even in closely related ones.
- Distinctive characteristic for recognizing species.

# Morphological Identifications of Model Arthropods



[https://www.google.com/search?q=eyes+of+spiders&hl=en&sxsrf=ALeKk03MPwHBA8hK0MNcLPNSAuHBGFOVoQ:1606355925079&source=lnms&tbn=isch&sa=X&ved=2ahUKEwj89K-Sjp\\_tAhU1rHEKHfiCALgQ\\_AUoAXoECBEQAw&biw=1360&bih=657](https://www.google.com/search?q=eyes+of+spiders&hl=en&sxsrf=ALeKk03MPwHBA8hK0MNcLPNSAuHBGFOVoQ:1606355925079&source=lnms&tbn=isch&sa=X&ved=2ahUKEwj89K-Sjp_tAhU1rHEKHfiCALgQ_AUoAXoECBEQAw&biw=1360&bih=657)

## Reproduction in Spiders

- Male find a female
- A male spider deposits his sperm into a sperm web, holding it in his palps.
- Female spiders produce either one egg sac containing several to a thousand eggs or several egg sacs each with successively fewer eggs. Females of many species die after producing the last egg sac.

# Principles of Systematics

## Module# 95

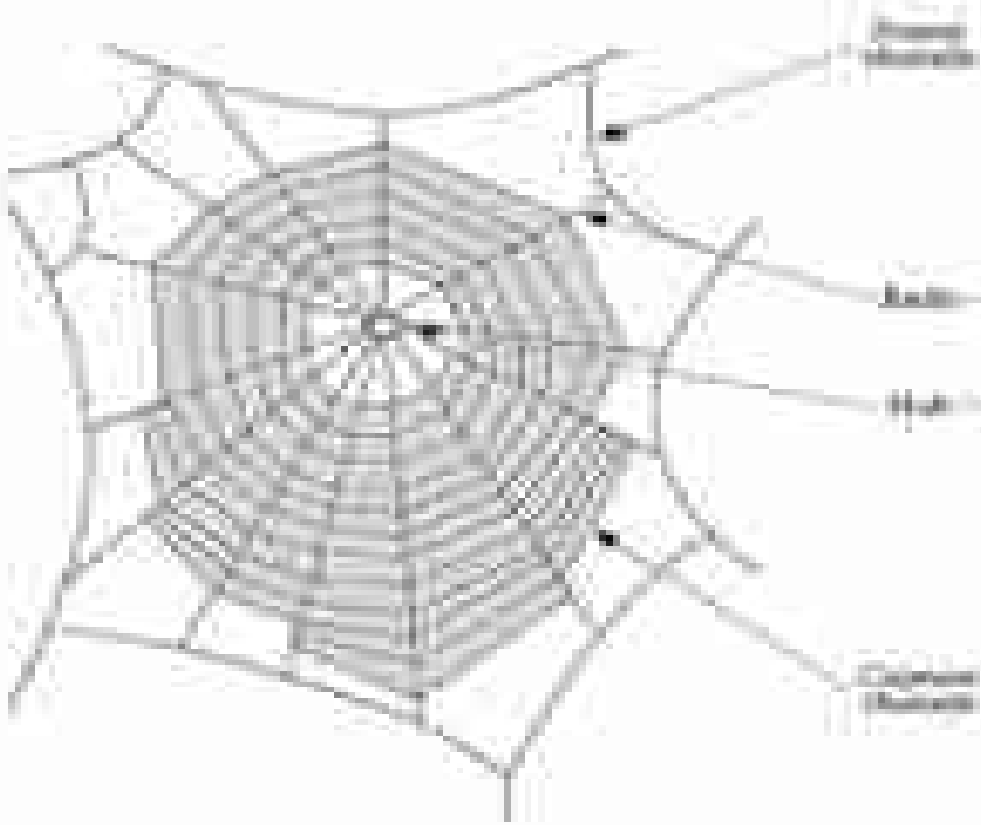
# Principles of Systematics

## Morphological Identifications of Model Arthropod

# Morphological Identifications of Model Arthropods

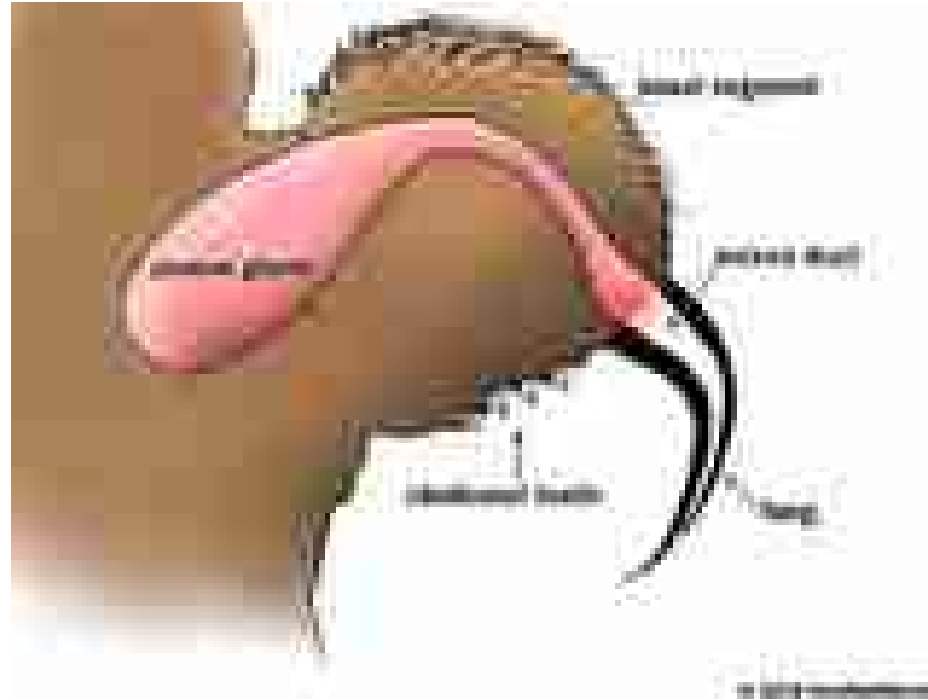
## Spider web

- Orb-web spiders
- Hunters
- Design of web
- Web/prey size
- Wind director/prey density
- Repair/vibrations/self-eating/sticky nature/quality of silk



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657

# Morphological Identifications of Model Arthropods



[https://www.google.com/search?q=venom+gland+of+spiders&sxsrf=ALeKk03L0hhd-Hg2f\\_BL\\_MYyBTdPVy7X5w:1606355341110&source=lnms&tbn=isch&sa=X&ved=2ahUKEwjWm\\_X7i5\\_tAhWCThUIHVHSDmEQ\\_AUoAXoECBEQAw&biw=1360&bih=657#imgsrc=JnmQ\\_pY9IUUA\\_M](https://www.google.com/search?q=venom+gland+of+spiders&sxsrf=ALeKk03L0hhd-Hg2f_BL_MYyBTdPVy7X5w:1606355341110&source=lnms&tbn=isch&sa=X&ved=2ahUKEwjWm_X7i5_tAhWCThUIHVHSDmEQ_AUoAXoECBEQAw&biw=1360&bih=657#imgsrc=JnmQ_pY9IUUA_M)



# Morphological Identifications of Model Arthropods

- 2<sup>nd</sup> part is abdomen
- No skeleton inside their bodies
- Hard outer shell called exoskeleton
- Molting
- Males are smaller than females

**END**

# Principles of Systematics

## Module# 96

# Principles of Systematics

## Identifications of Family Salticidae

# Identification of Family Salticidae



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- As of 2019, it contained over 600 described genera
- Over 6000 described species.
- Largest family of spiders
- 13% of all species

# Identification of Family Salticidae



- Jumping spiders are generally recognized by their eye pattern.
- All jumping spiders have four pairs of eyes, with the anterior median pair being particularly large.
- Best vision among arthropods

[https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs\\_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQcGAQgqAQtn3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360](https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQcGAQgqAQtn3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360)

# Identification of Family Salticidae

- The legs are not covered with any very prominent spines.
- Their front four legs generally are larger than the hind four
- Not held in the outstretched-arms attitude characteristic of the Thomisidae.
- The body length from 1 to 25 mm (0.04–0.98 in).

# Identification of Family Salticidae



- Prior to jumping, the spider attaches a silk thread to the surface beneath it, so it can climb quickly back to its perch if needed.
- Jumping spiders hunt and feed on small insects.
- All are carnivorous, but a few species also eat pollen and nectar.

[https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs\\_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQcGAQgqAQtnD3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360](https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQcGAQgqAQtnD3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360)

# Identification of Family Salticidae



- Female jumping spiders build a silk case around their eggs and often stand guard over them until they hatch.
- Young jumping spiders emerge from the egg sac looking like miniature versions of their parents.
- They molt and grow into adulthood.

[https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs\\_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQCGAQGqAQtnD3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360](https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQCGAQGqAQtnD3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360)



# Principles of Systematics

## Module# 97

# Principles of Systematics

## Identifications of Family Salticidae

# Identification of Family Salticidae

- Jumping spider can jump quite far, achieving distances more than 50 times its body length.
- Legs not strong or muscular in appearance.
- Salticids are able to quickly increase the blood pressure in their

# Identification of Family Salticidae

- Some jumping spiders mimic other insects such as ants.
- Others are able to camouflage themselves to blend into their surroundings, helping them sneak up on prey.
- Salticids hunt diurnally as a rule, which is consistent with their

# Identification of Family Salticidae



- Although jumping spiders are generally carnivorous.
- Many species have been known to include nectars in their diets and one species, *Bagheera kiplingi* feeds primarily on plant matter

[https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs\\_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQCGAQGqAQtnD3Mtd2l6LWltZ8ABAQ&scclient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360](https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQCGAQGqAQtnD3Mtd2l6LWltZ8ABAQ&scclient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360)

# Identification of Family Salticidae



[https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs\\_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQf9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQCGAQGqAQtnD3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360](https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oeq=salticidae+family+eyes&gs_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQf9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQCGAQGqAQtnD3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360)

- During courtship "dance" colored or iridescent parts of the body are displayed.
- In addition to the display of colors, jumping spiders perform complex sliding, vibrational, or zigzag movements to attract females.
- Many males have

# Identification of Family Salticidae

- These amplified sounds presented to the females resemble buzzes or drum rolls.
- Species vary greatly in visual and vibratory components of courtship.
- If receptive to the male, the female assumes a passive, crouching position.

# Identification of Family Salticidae



- The male then extends his front legs towards the female to touch her.
- If the female remains receptive, the male climbs on her back and inseminates her with his palps.

[https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oq=salticidae+family+eyes&gs\\_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQCGAQGqAQtnD3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360](https://www.google.com/search?q=salticidae+family+eyes&tbm=isch&ved=2ahUKEwjbw9fQnK3tAhVE3hoKHZygBl4Q2-cCegQIABAA&oq=salticidae+family+eyes&gs_lcp=CgNpbWcQAzoGCAAQCBAeUKuKAVi9lQFg9JgBaABwAHgBgAG5BogB8g-SAQkzLTluMS4wLjGYAQCGAQGqAQtnD3Mtd2l6LWltZ8ABAQ&scient=img&ei=EnLGX9vyCsS8a5zBmvAF&bih=600&biw=1360)



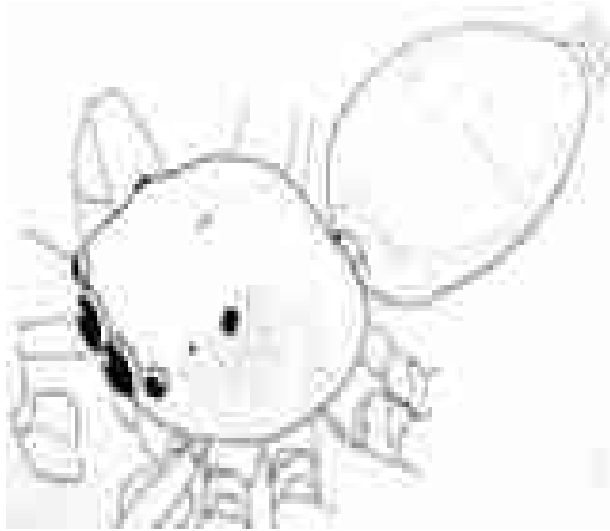
# Principles of Systematics

## Module# 98

# Principles of Systematics

## Identifications of Family Salticidae

# Identification of Family Salticidae



- Note that there are eight eyes, four in front and four on top.

[http://tolweb.org/accessory/Jumping\\_Spider\\_External\\_Anatomy?acc\\_id=1952](http://tolweb.org/accessory/Jumping_Spider_External_Anatomy?acc_id=1952)

# Identification of Family Salticidae



[http://tolweb.org/accessory/Jumping\\_Spider\\_External\\_Anatomy?acc\\_id=1952](http://tolweb.org/accessory/Jumping_Spider_External_Anatomy?acc_id=1952)

- The body is divided into two main parts, the posterior of which is the opisthosoma or abdomen, shown in blue:
- The spinnerets are shown in red. These are the silk-producing appendages.
- Jumping spiders, although they do not usually use silk to catch

# Identification of Family Salticidae



- The anterior body part is the prosoma or cephalothorax.
- It is covered above by a shell or carapace:

[http://tolweb.org/accessory/Jumping\\_Spider\\_External\\_Anatomy?acc\\_id=1952](http://tolweb.org/accessory/Jumping_Spider_External_Anatomy?acc_id=1952)

# Identification of Family Salticidae



[http://tolweb.org/accessory/Jumping\\_Spider\\_External\\_Anatomy?acc\\_id=1952](http://tolweb.org/accessory/Jumping_Spider_External_Anatomy?acc_id=1952)

- Belonging to the prosoma are the main appendages:
- In this diagram the chelicerae (jaws with fangs) are shown in red, the palpi in green, and the legs in blue.

# Principles of Systematics

## Module# 99

# Principles of Systematics

## Identifications of Family Oxyopidae



# Identification of Family Oxyopidae



[https://www.google.com/search?q=lynx+spider&tbm=isch&ved=2ahUKEwiMyJWp07ftAhWO0YUKHcLSCQoQ2-cCegQIABAA&oeq=lynx+spider&gs\\_lcp=CgNpbWcQA1DijCdY4ownYJCPJ2gAcAB4AIABAlgBAJIBAJgBAKABAaoBC2d3cy13aXotaW1nwAEB&scient=img&ei=mOnLX4ycJ46jlwTCpadQ&bih=657&biw=1360#imgsrc=Zf71CWvaO3PBXM&imgdii=gpTVaNJ4dzXzs](https://www.google.com/search?q=lynx+spider&tbm=isch&ved=2ahUKEwiMyJWp07ftAhWO0YUKHcLSCQoQ2-cCegQIABAA&oeq=lynx+spider&gs_lcp=CgNpbWcQA1DijCdY4ownYJCPJ2gAcAB4AIABAlgBAJIBAJgBAKABAaoBC2d3cy13aXotaW1nwAEB&scient=img&ei=mOnLX4ycJ46jlwTCpadQ&bih=657&biw=1360#imgsrc=Zf71CWvaO3PBXM&imgdii=gpTVaNJ4dzXzs)

- Lynx spiders
- The common name refers to their quickness and agility; lynx-like in nature.
- Family Oxyopidae  
Thorell, 1870
- 9 genera worldwide,  
419 species (WSC)

# Identification of Family Oxyopidae



[https://www.google.com/search?q=lynx+spider&tbm=isch&ved=2ahUKEwiMyJWp07ftAhWO0YUKHcLSCQoQ2-cCegQIABAA&oeq=lynx+spider&gs\\_lcp=CgNpbWcQA1DijCdY4ownYJCPJ2gAcAB4AlABAlgBAJlBAJgBAKABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=mOnLX4ycJ46jlwTCpadQ&bih=657&biw=1360#imgsrc=Zf71CWvaO3PBXM&imgdii=gpTVaNJ4dzXzs](https://www.google.com/search?q=lynx+spider&tbm=isch&ved=2ahUKEwiMyJWp07ftAhWO0YUKHcLSCQoQ2-cCegQIABAA&oeq=lynx+spider&gs_lcp=CgNpbWcQA1DijCdY4ownYJCPJ2gAcAB4AlABAlgBAJlBAJgBAKABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=mOnLX4ycJ46jlwTCpadQ&bih=657&biw=1360#imgsrc=Zf71CWvaO3PBXM&imgdii=gpTVaNJ4dzXzs)

- Oxyopid body length ranges from 3-25mm.
- Primarily tropical and subtropical in distribution, but also in temperate zones
- Primarily vegetation dwellers found on grasses, shrubs, and trees.

# Identification of Family Oxyopidae



[https://www.google.com/search?q=lynx+spider&bm=isch&ved=2ahUKEwiMyJWp07ftAhWO0YUKHcLSCQoQ2-cCegQIABAA&oq=lynx+spider&gs\\_lcp=CgNpbWcQA1DijCdY4ownYJCPJ2gAcAB4AlABAlgBAJIBAJgBAKABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=mOnLX4ycJ46jlwTCpadQ&bih=657&biw=1360#imgsrc=Zf71CWvaO3PBXM&imgdii=gpTVaNJ4dzXzs](https://www.google.com/search?q=lynx+spider&bm=isch&ved=2ahUKEwiMyJWp07ftAhWO0YUKHcLSCQoQ2-cCegQIABAA&oq=lynx+spider&gs_lcp=CgNpbWcQA1DijCdY4ownYJCPJ2gAcAB4AlABAlgBAJIBAJgBAKABAaoBC2d3cy13aXotaW1nwAEB&sclient=img&ei=mOnLX4ycJ46jlwTCpadQ&bih=657&biw=1360#imgsrc=Zf71CWvaO3PBXM&imgdii=gpTVaNJ4dzXzs)

- Feed on Insects and spiders
- Oxyopids are active hunters during both day and night.
- They use their vision to detect and legs to catch prey, sometimes jumping up to 2cm into the air to catch insects in flight

# Identification of Family Oxyopidae



[https://www.google.com/search?q=lynx+spider+eyes&sa=X&bih=657&biw=1360&hl=en&sxsrf=ALeKk003VLVpvTPYJB8licBluXuhwHQEtA:1607200368560&tbm=isch&source=iu&ictx=1&fir=IC6Pj2HMuL3D0M%252CluWdmL9rJcOQ1M%252C\\_&vet=1&usg=AI4\\_-kSrgqaPxx4TYZ8ivqKJD-\\_e84Bo2Q&ved=2ahUKEwjf37P417ftAhWHWxUIHUiPBRCQ9QF6BAgLEAE#imgrc=IC6Pj2HMuL3D0M](https://www.google.com/search?q=lynx+spider+eyes&sa=X&bih=657&biw=1360&hl=en&sxsrf=ALeKk003VLVpvTPYJB8licBluXuhwHQEtA:1607200368560&tbm=isch&source=iu&ictx=1&fir=IC6Pj2HMuL3D0M%252CluWdmL9rJcOQ1M%252C_&vet=1&usg=AI4_-kSrgqaPxx4TYZ8ivqKJD-_e84Bo2Q&ved=2ahUKEwjf37P417ftAhWHWxUIHUiPBRCQ9QF6BAgLEAE#imgrc=IC6Pj2HMuL3D0M)

- Some lynx's also capture prey by jumping from a stationary location much like a Salticid.
- An interesting member of *Tapinillus* is a web building, social lynx spider.
- Eight eyes

# Identification of Family Oxyopidae



[https://www.google.com/search?q=lynx+spider+eyes&sa=X&bih=657&biw=1360&hl=en&sxsrf=ALeKk003VLVpvTPYJB8licBluXuhwHQEtA:1607200368560&tbm=isch&source=iu&ictx=1&fir=IC6Pj2HMuL3D0M%252CluWdmL9rJcOQ1M%252C\\_&vet=1&usg=AI4\\_-kSrgqaPxx4TYZ8ivqKJD-\\_e84Bo2Q&ved=2ahUKEwjf37P417ftAhWHWxUIHUiPBRcQ9QF6BAgLEAE#imgrc=IC6Pj2HMuL3D0M](https://www.google.com/search?q=lynx+spider+eyes&sa=X&bih=657&biw=1360&hl=en&sxsrf=ALeKk003VLVpvTPYJB8licBluXuhwHQEtA:1607200368560&tbm=isch&source=iu&ictx=1&fir=IC6Pj2HMuL3D0M%252CluWdmL9rJcOQ1M%252C_&vet=1&usg=AI4_-kSrgqaPxx4TYZ8ivqKJD-_e84Bo2Q&ved=2ahUKEwjf37P417ftAhWHWxUIHUiPBRcQ9QF6BAgLEAE#imgrc=IC6Pj2HMuL3D0M)

- Most species make little use of webs
- Instead spending their lives as hunting spiders on plants.
- Many species frequently visit flowers in particular, ambushing pollinators, much as crab spiders do
- Most of them have

# Identification of Family Oxyopidae



[https://www.google.com/search?q=lynx+spider+eyes&sa=X&bih=657&biw=1360&hl=en&sxsrf=ALeKk003VLVpvTPYJB8licBluXuhwHQEtA:1607200368560&tbm=isch&source=iu&ictx=1&fir=IC6Pj2HMuL3D0M%252CluWdmL9rJcOQ1M%252C\\_&vet=1&usg=AI4\\_-kSrgqaPxx4TYZ8ivqKJD-\\_e84Bo2Q&ved=2ahUKEwjf37P417ftAhWHWxUIHUiPBRcQ9QF6BAgLEAE#imgsrc=IC6Pj2HMuL3D0M](https://www.google.com/search?q=lynx+spider+eyes&sa=X&bih=657&biw=1360&hl=en&sxsrf=ALeKk003VLVpvTPYJB8licBluXuhwHQEtA:1607200368560&tbm=isch&source=iu&ictx=1&fir=IC6Pj2HMuL3D0M%252CluWdmL9rJcOQ1M%252C_&vet=1&usg=AI4_-kSrgqaPxx4TYZ8ivqKJD-_e84Bo2Q&ved=2ahUKEwjf37P417ftAhWHWxUIHUiPBRcQ9QF6BAgLEAE#imgsrc=IC6Pj2HMuL3D0M)

- Oxyopidae in general rely on keen eyesight in stalking, chasing, or ambushing prey, and also in avoiding enemies.
- Active hunters/Chase prey
- Some members of the genus *Oxyopes* are abundant enough to be

# Principles of Systematics

## Module# 100

# Principles of Systematics

## Identifications of Family Oxyopidae



# Identification of Family Oxyopidae

- High carapaces
- Distinctive eyes
- Numerous spines on their legs
- Bright colors in some species
- Some have cryptic coloration.

# Identification of Family Oxyopidae



[https://www.google.com/search?q=oxyopidae&sxsrf=A LeKk02lear-tKcnT56n8kqrbe2HRLd-Ow:1607225520796&source=lnms&tbm=isch&sa=X&ved=2ahUKEwizofbRtbjtAhXBRBUIHRosD1gQ\\_AUoAXoECAUQAaw&biw=1360&bih=657#imgsrc=SOcXM8zGlXgFCM&imgdii=AhcO2CW\\_UUh5OM](https://www.google.com/search?q=oxyopidae&sxsrf=A LeKk02lear-tKcnT56n8kqrbe2HRLd-Ow:1607225520796&source=lnms&tbm=isch&sa=X&ved=2ahUKEwizofbRtbjtAhXBRBUIHRosD1gQ_AUoAXoECAUQAaw&biw=1360&bih=657#imgsrc=SOcXM8zGlXgFCM&imgdii=AhcO2CW_UUh5OM)

- The abdomen is usually oval shaped and tapers to a point.
- The long legged hunting spiders are capable of running very fast and jump on their prey like a cat. This is why their common name is lynx spider.
- Although their eyesight is not as good as that of the jumping spiders

# Identification of Family Oxyopidae



[https://www.google.com/search?q=oxyopidae&sxsrf=ALeKk02lear-tKcnT56n8kqrbe2HRLd-Ow:1607225520796&source=lnms&tbm=isch&sa=X&ved=2ahUKEwizofbRtbjtAhXBRBUIHRosD1gQ\\_AUoAXoECAUQAaw&biw=1360&bih=657#imgrc=SOcXM8zGlxgFCM&imgdii=AhcO2CW\\_UUh5OM](https://www.google.com/search?q=oxyopidae&sxsrf=ALeKk02lear-tKcnT56n8kqrbe2HRLd-Ow:1607225520796&source=lnms&tbm=isch&sa=X&ved=2ahUKEwizofbRtbjtAhXBRBUIHRosD1gQ_AUoAXoECAUQAaw&biw=1360&bih=657#imgrc=SOcXM8zGlxgFCM&imgdii=AhcO2CW_UUh5OM)

- The male performs a dance before the female using its legs, abdomen and especially his palps.
- The female spider spins a cocoon that she attaches to a plant.
- She will guard the eggs until they hatch.
- Identified by the very

# Identification of Family Oxyopidae

- Their abdomen is like a pencil ending in a point.
- Some oxyopids may produce several egg sacs, while others only one.
- Lynx's are very protective of their egg sacs, guarding them avidly.

END

# Principles of Systematics

## Module# 101

# Principles of Systematics

## Identifications of Family Oxyopidae

# Identification of Family Oxyopidae

- Generalist predator that feeds on a wide variety of insect prey, including several economically important insect pests.
- This family is one of the most abundant beneficial spider species in gardens, yards, and agricultural fields throughout world

# Identification of Family Oxyopidae

- To capture prey, the striped lynx spider will sit and wait in grassy areas and herbaceous vegetation for small insects to land close enough for them to stalk and capture.
- This spider can detect odors given off by insect prey and will spend time in areas



# Identification of Family Oxyopidae

- There is evidence that spiderlings can learn specific odors during foraging and retain specific prey preferences from these experiences later in life.
- Newly hatched spiderlings can feed on nectar, which can help them live longer and reduce cannibalism

# Identification of Family Oxyopidae

- Other sources of sugars, including honeydew, may be potentially important to immature spiders
- The striped lynx spider is considered a major predator of bollworm and tobacco budworm larvae in cotton fields and the southern green stink bug in soybean

# Identification of Family Oxyopidae

- The striped lynx spider is significantly affected by insecticide use that causes decreased survival and other sublethal effects, such as causing males to decrease the amount of time they spend courting and mating with females

END

# Principles of Systematics

## Module# 102

# Principles of Systematics

## Identifications of Family Araneidae

# Identification of Family Araneidae

- The family Araneidae is a member of the order Araneae (Foelix, 1982).
- The Araneidae include the spiders who spin the elaborate webs most often seen.
- Araneids are one of the most successful of the spider families; they have over 3,500 species

# Identification of Family Araneidae

- The spiders vary greatly in size as well, some species of *Singa* are about 2 mm in length while some of the *Nephila* can grow to over 50 mm, even killing small birds.
- Because of this great variety of species a great variety of orb web designs exists.

# Identification of Family Araneidae

- Eight eyes
- Eyes are arranged in two horizontal rows
- Males are usually smaller than females
- Spiders in the family Araneidae will demonstrate several different strategies of predation.



# Identification of Family Araneidae

- Some will immediately wrap their prey in the web then bite
- Some wrap, move, then bite
- Some just seize their prey with their chelicerae, move them to the hub of the web, and then wrap up their prey.

# Identification of Family Araneidae

- Spiders are found in woods, caves, grasses and almost any other habitat imaginable
- Being bitten by an orb weaver is very uncommon
- Only bite if they feel threatened and trapped without a chance for escape
- A bite is often compared to a bee sting, and for most people, is nothing serious. Should be observe in their environments

END

# Principles of Systematics

## Module# 103

# Principles of Systematics

## Identifications of Family Araneidae

# Identification of Family Araneidae

- Present anywhere with abundant prey and structures to support the web
- Most noticeable in late summer in fall, when webs and adults reach their largest size.
- Food sources vary, but typically any small insects they catch in

# Identification of Family Araneidae

- Some of the bigger orb weavers (Argiope genus) have been observed eating small frogs and humming birds (only if ensnared within the web).
- The adult males will wander in search of a mate, and as such, typically do not stay on a web for long, if they

# Identification of Family Araneidae

- The most commonly noticed orb weaver is female, since she sits on her web, feeding and eventually waiting for the males to find her.
- Toward the end of fall, the females will lay their last clutch of eggs, and then die at the first frost.

# Identification of Family Araneidae

- The warmth of the spring will cause the eggs to mature, releasing a new generation of orb weavers.
- A single egg sac can contain upwards of several hundred eggs
- Juvenile orb weavers will spin "perfect" orb



# Identification of Family Araneidae

- Orb weavers are very docile, non-aggressive spiders that will flee at the first sign of a threat (typically they will run or drop off the web).
- They **are not dangerous** to people & pets, and are actually quite beneficial because they will catch and eat a lot of pest-

# Identification of Family Araneidae

- Feed on medium-sized insect in the web
- Spider bite the prey, wrap it in silk, wait for it to die, then begin to eat.
- As a first step in eating, the spider will literally vomit digestive fluid over the prey.
- The prey is chewed with the "jaws" (chelicerae), and the

# Identification of Family Araneidae

- The spider repeats this process as often as necessary to digest, and ingest, all but the inedible hard parts.
- What is discarded afterwards is a small ball of residue.

END

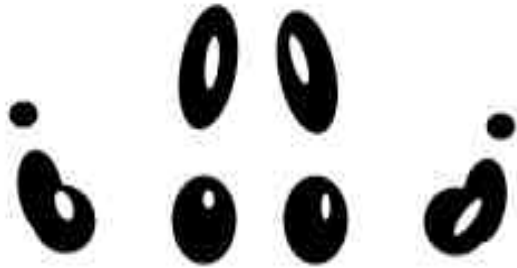
# Principles of Systematics

## Module# 104

# Principles of Systematics

## Identifications of Family Araneidae

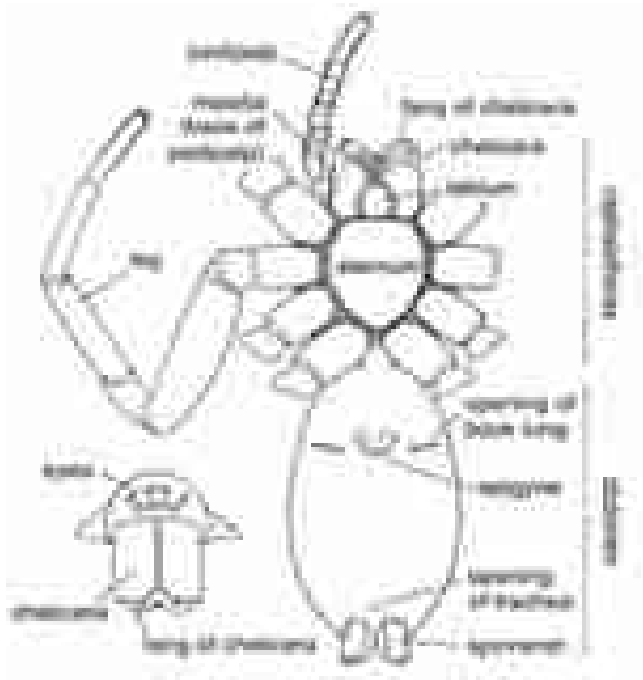
# Identification of Family Araneidae



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- Eight eyes
- Three tarsal claws
- The eyes in 2 rows of 4 with the lateral eyes widely separated from the medial eyes.
- The carapace is often flat with a distinct head region.

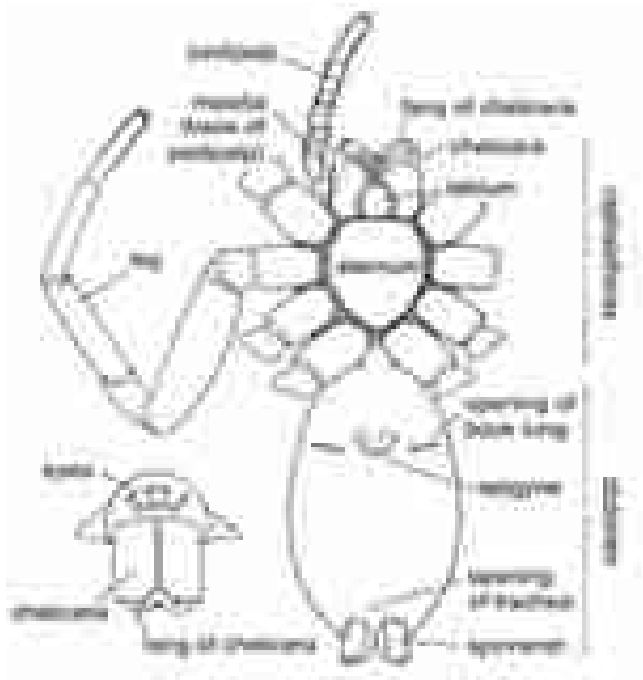
# Identification of Family Araneidae



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- Labium is wider than long and swollen at anterior edge
- Maxilla are widest anteriorly
- Legs with 3 claws and often furnished with strong spines and trichobothria on all segments except tarsi.

# Identification of Family Araneidae

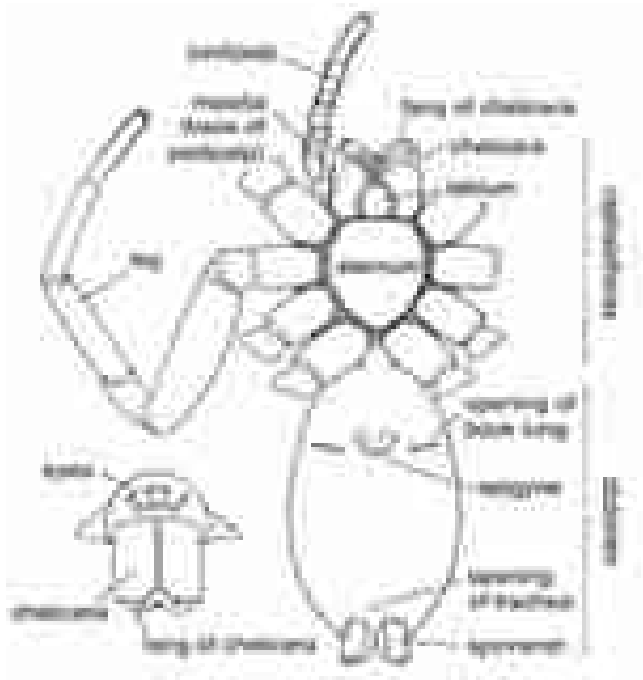


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- Often legs are clearly annulated.
- The abdomen is usually globose and nearly always with species-specific often bright colour patterns.
- The tracheal spiracle is situated close to spinnerets.



# Identification of Family Araneidae



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- Neoscona
- Tetragnathidae
- Regular webs/Time of web making
- Repair/new web
- Common in agro-ecosystems

# Principles of Systematics

## Module# 105

# Principles of Systematics

## Identifications of Family Lycosidae

# Identification of Family Lycosidae

- Wolf Spiders
- Active hunters
- Ground spiders
- Some species climb plant to chase prey
- Widespread from the Arctic to the Subtropics.

# Identification of Family Lycosidae

- Preferred habitat varies between species but includes open grasslands, suburban lawns, deciduous forests, deserts, coastal dunes, sandy soil and wet terrain such as marshes and swamps

# Identification of Family Lycosidae

- Preferred habitat varies between species but includes open grasslands, suburban lawns, deciduous forests, deserts, coastal dunes, sandy soil and wet terrain such as marshes and swamps
- Mainly feed on insects

# Identification of Family Lycosidae



<https://bugguide.net/node/view/89936>

- Eight dark eyes of unequal size arranged in three rows, the first having four eyes.
- The abdomen and the cephalothorax are usually as long as wide.
- The long legs have three microscopic claws at each tip.

# Identification of Family Lycosidae



<https://bugguide.net/node/view/89936>

- Nocturnal
- Their dark mottled colors help camouflage them among the leaves.
- Do not spin webs
- Some dig burrows in the ground, others make holes under rocks, and many have



# Identification of Family Lycosidae



<https://bugguide.net/node/view/89936>

- They are robust and agile hunters with excellent eyesight.
- Do not spin webs
- Some dig burrows in the ground, others make holes under rocks, and many have no retreat at all.

# Identification of Family Lycosidae



<https://bugguide.net/node/view/89936>

- The abdomen must be held in a raised position to keep the egg case from dragging on the ground.
- However, despite this handicap, they are still capable of hunting
- Another aspect unique to wolf spiders is their

# Identification of Family Lycosidae



<https://bugguide.net/node/view/89936>

- Spiderlings emerge from their protective silken case
- Climbed up their mother's legs and crowd onto the dorsal side of her abdomen.
- The mother carries the spiderlings for several weeks before they are

# Identification of Family Lycosidae



<https://bugguide.net/node/view/89936>

- Wolf spiders inject venom if continually provoked.
- Symptoms of their bites include swelling, mild pain, and itching.

American Wolf spider

- Australian wolf spiders have also been associated with

# Principles of Systematics

## Module# 106

# Principles of Systematics

## Identifications of Family Lycosidae

# Identification of Family Lycosidae



<https://www.biodiversityexplorer.info/arachnids/spiders/lycosidae/index.htm>

- They are robust and agile hunters with excellent eyesight
- They live mostly in solitude and hunt alone
- Wolf spiders resemble Nursery Web Spiders (family Pisauridae), but wolf spiders carry their egg sacs by attaching them to their spinnerts, while the Pisauridae carry

# Identification of Family Lycosidae



<https://bugguide.net/node/view/89936>

- Two of the wolf spider's eight eyes are large and prominent, which distinguishes them from the nursery web spiders whose eyes are all of roughly equal size.
- 10-35 mm size
- Unlike most other arachnids, which are generally blind or have poor vision, wolf spiders have **excellent eyesight**.



# Identification of Family Lycosidae

- *Hogna* is the genus with the largest of the wolf spiders
- Found everywhere
- Body colour is brown and dull so inconspicuous on ground
- Collector notice them when spiders are disturbed by ground vibration

# Identification of Family Lycosidae

- Do not spin web
- *Hippasa* and *Sosippus* are seen build funnel retreat, outside of which expended into sheet web
- These spiders wait for prey
- Prey into sheet/spiders come out/bite/kill/suck prey

# Identification of Family Lycosidae

- No particular location of these webs on ground
- Danger/Extreme end of tube
- Morning travelling on vehicle/Train
- *Hippasa* webs look very conspicuous due to deposition of dew drops on them.

END

# Principles of Systematics

## Module# 107

# Principles of Systematics

## Identifications of Family Lycosidae

# Identification of Family Lycosidae

- Members of genus *Lycosa* inhabit varied habitat
- Found on dry ground
- Under stones/Logs/ in crevices
- Seen in large numbers near heaps of cow dung, kept for drying

# Identification of Family Lycosidae

## Why near cow dung:

- For preying on insects like Diptera which come to lay their eggs in cow dung
- Other insects are attracted by smell.
- Seen at night chasing their prey and occasionally coming in human habitations for food search.

# Identification of Family Lycosidae

- Some members of Lycosa prefer
- Cool, moist cavities under stone, where they lie in day time.
- *Paradosa* and *Aractosa* prefer humid atmosphere
- Frequently found at the edges of ponds, lakes, rivers etc.



# Identification of Family Lycosidae

- *Paradosa birmanica.*  
*Paradosa samatrana*  
common near water source.
- When disturb, they hide under stones and soil crevices
- Run on water surface
- 
- Jump in water to chase prey

END

# Principles of Systematics

## Module# 108

# Principles of Systematics

## Identifications of Family Lycosidae

# Identification of Family Lycosidae

- *Lycosids* mainly feed on insects
- Diptera
- Lepidoptera
- Hymeniptera
- Coleoptera
- Collembola

# Identification of Family Lycosidae

- May consume young spiders of their own species
- As well as different species
- Cannibalistic/importance
- Feed at night

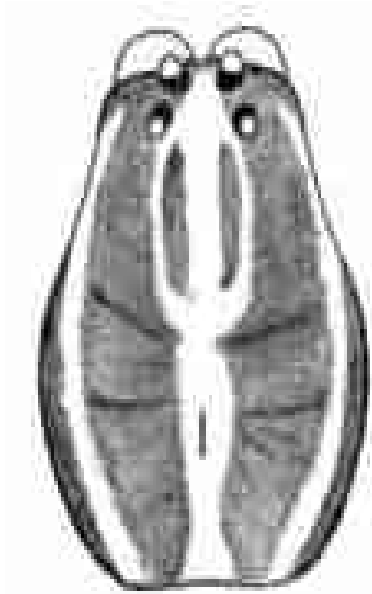
# Identification of Family Lycosidae

- The family name and common name are derived from the Greek word "lycosa" meaning "wolf" due to the spiders' hunting method of ambushing and running down its prey.
- Research has shown that the Lycosidae are important in agriculture, as they are efficient controlling agents of insect pests. They are harmless to man.

# Identification of Family Lycosidae

- Lycosids are often parasitized by wasps probably because they are free roaming and do not enjoy the protection of a web.

# Identification of Family Lycosidae



- Centre of thoracic region is provided with fovea.
- Male has enlarged swollen palp
- Female genitalia is covered externally by heavy sclerotized plate called epigynal plate

[https://www.google.com/search?q=fovea+in+lycosidae&sxsrf=ALeKk020bjj-vHKg9xn2OOMtsk0pchcuDg:1607331271899&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjEwf3Lv7vtAhXMN8AKHe2ADgMQ\\_AUoAXoECA8QAw&biw=1360&bih=600#imgsrc=---c7FIH2ulkqXM&imgdii=AlqodCv-Qo7AjM](https://www.google.com/search?q=fovea+in+lycosidae&sxsrf=ALeKk020bjj-vHKg9xn2OOMtsk0pchcuDg:1607331271899&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjEwf3Lv7vtAhXMN8AKHe2ADgMQ_AUoAXoECA8QAw&biw=1360&bih=600#imgsrc=---c7FIH2ulkqXM&imgdii=AlqodCv-Qo7AjM)



# Identification of Family Lycosidae

- Centre of thoracic region is provided with fovea.
- Male has enlarged swollen papl
- Female genitalia is covered externally by heavy sclerotized plate called epigynal plate
- Structure of genitalia is species specific.

# Principles of Systematics

## Module# 109

# Principles of Systematics

## Sampling Methods

# Sampling Methods

- Probability Sampling
- Non-Probability Sampling

# Sampling Methods

## Probability Sampling

- Random Sampling
- Systematic Sampling
- Stratified sampling
- Cluster Sampling
- Multistage Sampling



# Sampling Methods

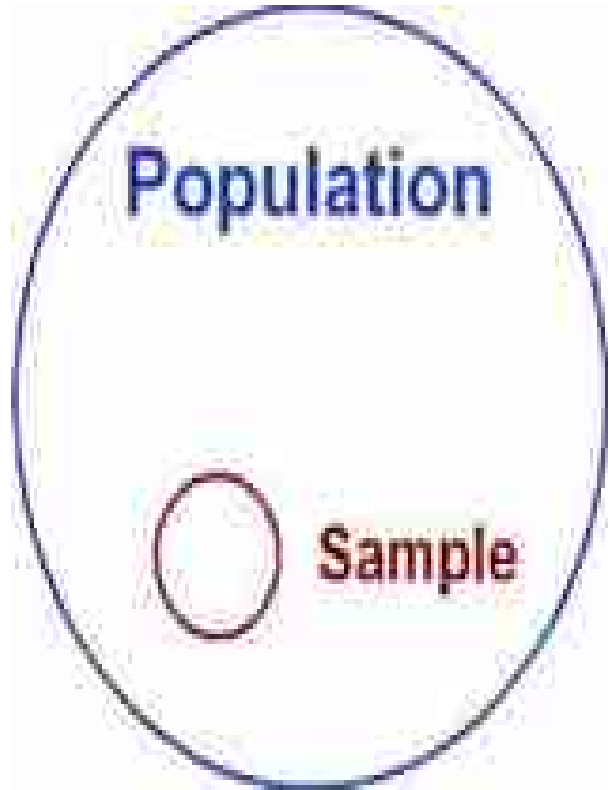
## Non-Probability Sampling

- Purposive sampling
- Quota Sampling

# Sampling Methods

- **Sampling:** It is the process of selecting a representative group from the population. The target population may be as broad as all humans but it may be a smaller group as people who are diabetics or only the teenagers.

# Sampling Methods



- **Sample:** A sample is a group of units selected from a population by a defined procedure or simply a part of a statistical population.
- The sample should be representative of the general population. 5-10% portion of the sample size of total



# Sampling Methods

- **Population:**  
Population is the total group of individuals from which the sample might be drawn.
- All members of population possess the same basic and defined characteristics, but varying in amount or quality from one member to another. For

**END**

# Principles of Systematics

## Module# 110

# Principles of Systematics

## Random Sampling

# Random Sampling

- If every individual of target population has an equal chance of selection then it will be called random sampling. Simple random sampling is the easiest form of probability sampling.
- No biasness and expert opinion is required in this method.

**END**

# Random Sampling

- All the researcher needs to do is assure that all the members of the population are included in the list and then randomly select the desired number of subjects.

## Examples:

- Selection of plants from rice fields
- Selection of students from class
- When carrying out a survey, it would be impractical to study a whole population.

# Principles of Systematics

## Module# 111

# Principles of Systematics

## Systematic Sampling

# Systematic Sampling

- In this sampling method first sample from the population is taken randomly but after that samples are selected systematically at a regular interval.

## Examples:

- Shopping centre
- Selection of plants
- Selection of soil sample

**END**



# Principles of Systematics

## Module# 112

# Principles of Systematics

## Stratified Sampling

# Principles of Systematics

## Module# 113

# Principles of Systematics

## Cluster Sampling

# Cluster Sampling

- It is a sampling technique where the entire population is divided into groups, or clusters and a random sample of these clusters are selected.
- Members of one cluster have similarity with each other and also with other clusters; minor differences can be there between different clusters.
- Individual selection from each cluster is random.

# Cluster Sampling

- Cluster of plants for study
- Cluster of animals

**END**

# Cluster Sampling

- It is a sampling technique where the entire population is divided into groups, or clusters and a random sample of these clusters are selected.
- Members of one cluster have similarity with each other and also with other clusters; minor differences can be there between

**END**

# Principles of Systematics

## Module# 114



# Principles of Systematics

## Multistage Sampling

# Multistage Sampling

- It is a complicated form of cluster sampling. In this type of sampling we divide our population into groups (clusters) and each group is further divided into sub-groups in such a way that each lower group is adjusted into a higher group.

# Multistage Sampling

- For example in a survey of tuberculosis prevalence in world, if we divide whole world into continents, then select 10 countries from each continent randomly, then 10 districts from each country, 10 cities from each district, 10 villages from each city and finally 10 families from each villages randomly. This type of sampling is multistage sampling.

**END**

# Principles of Systematics

## Module# 115

# Principles of Systematics

## Non-Probability sampling

# Non-Probability Sampling

- **Quota sampling:** In this type of sampling we divide the population into different groups or strata based on some specific criterion but selection of individual from each group is not random.

# Non-Probability Sampling

- **Purposive sampling:** In this technique researcher selects sample based on their knowledge and professional judgment. Purposive sampling can also be known as judgmental, selective or subjective sampling. For example purchase of car from market based on expert opinion or selection of staff for biology teaching in a college by a panel of subject experts.

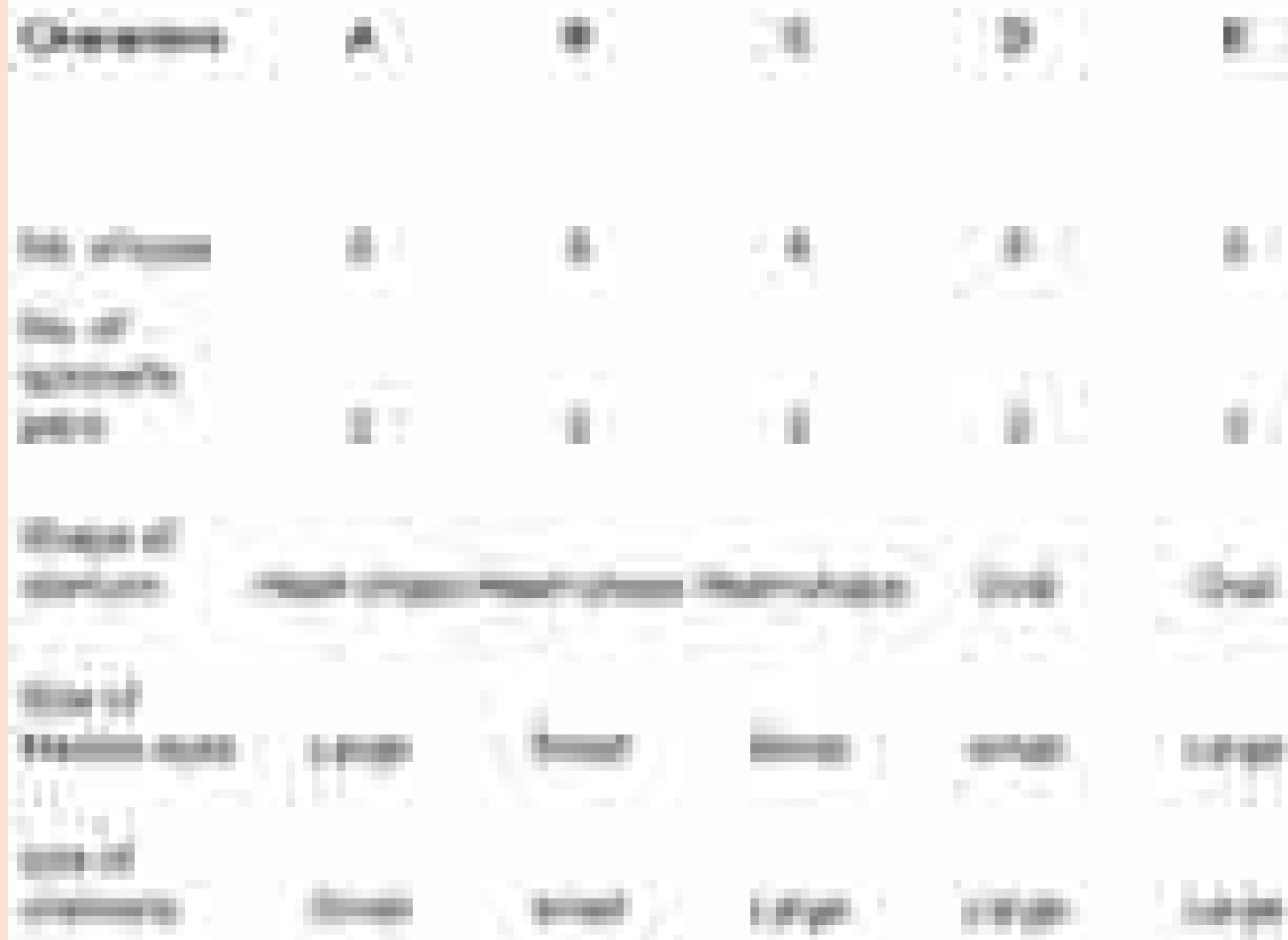
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## Module# 116 Construction of Phenogram

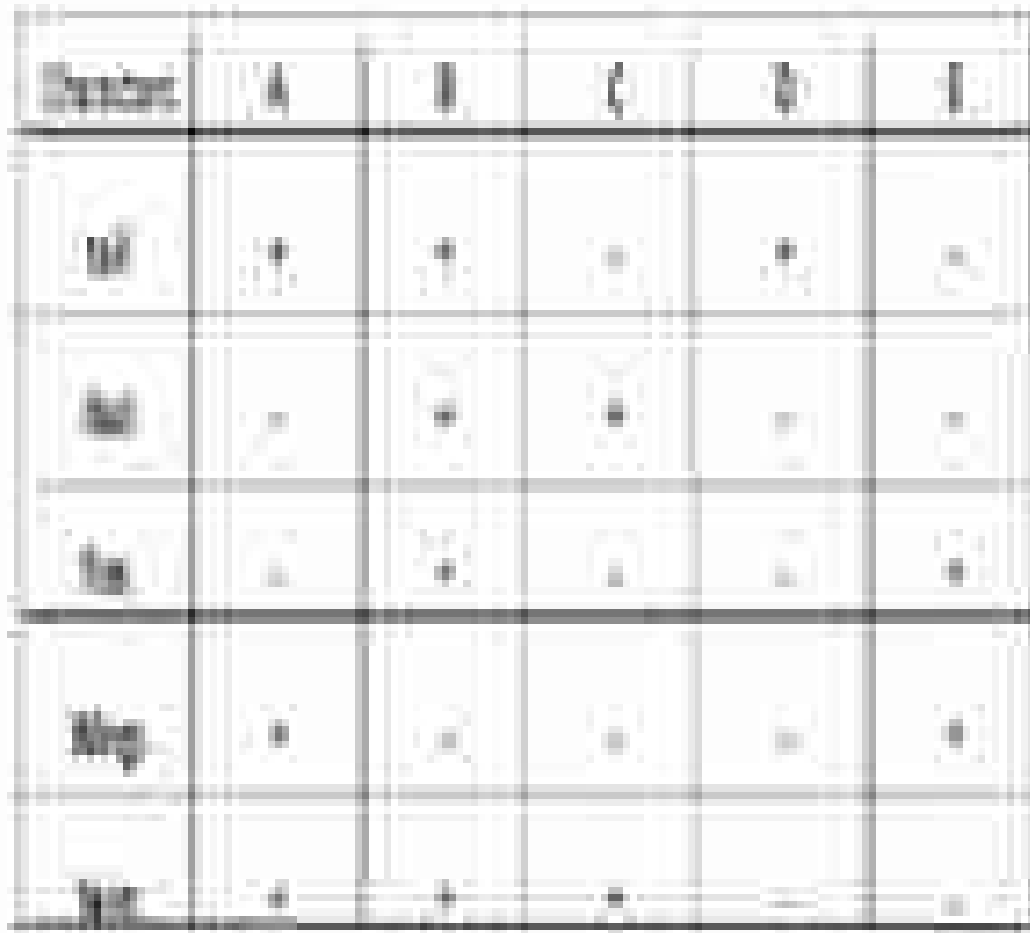
- A tree diagram depicting taxonomic relationships among organisms based on overall similarity of many characteristics without regard to evolutionary history



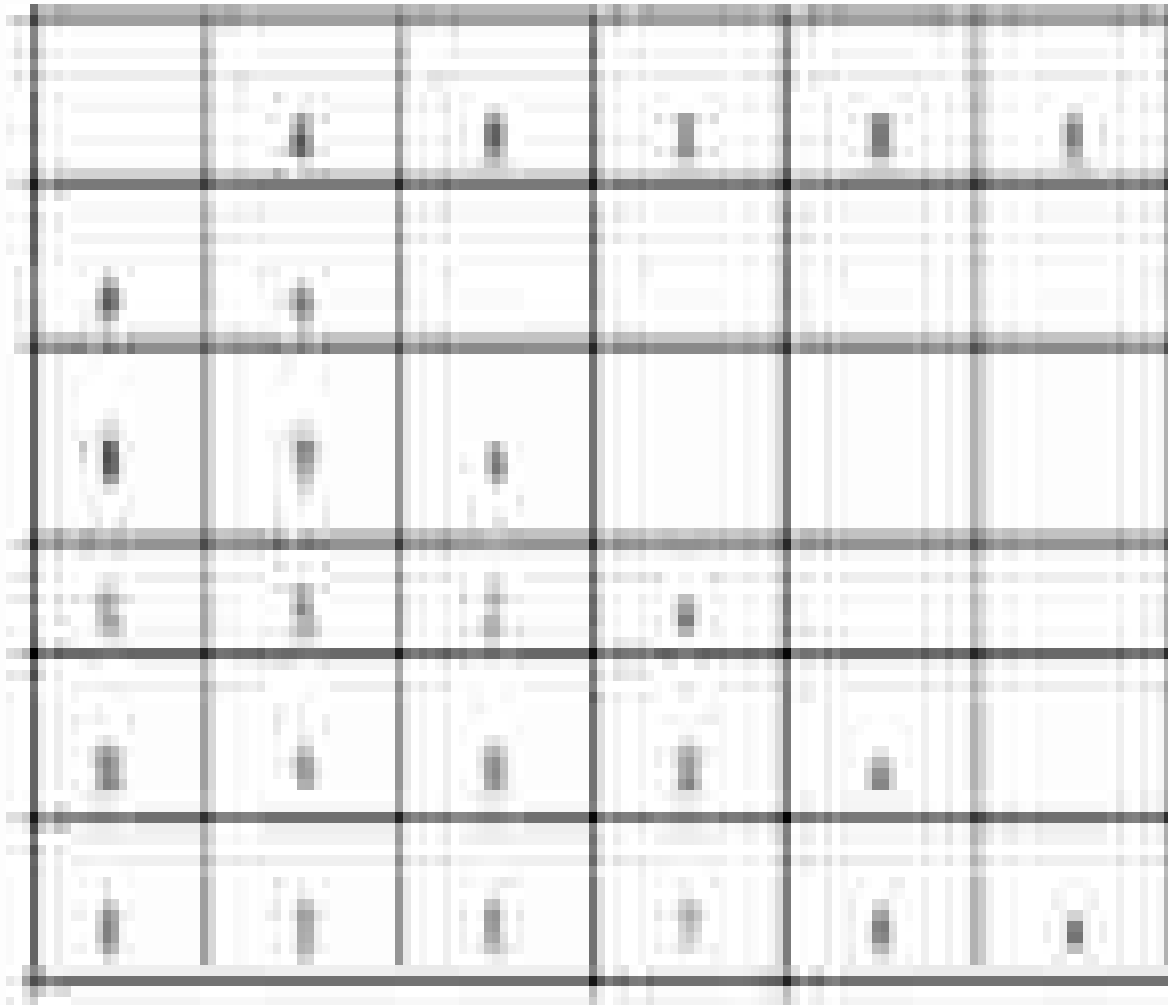
# Construction of Phenogram



# Construction of Phenogram



# Construction of Phenogram



# Construction of Phenogram

## Rules

- Start from lowest value
- Try to make maximum separate clusters
- Do not repeat
- In case of same number multiple time, you can choose any combination
- Value of previous similarity should be

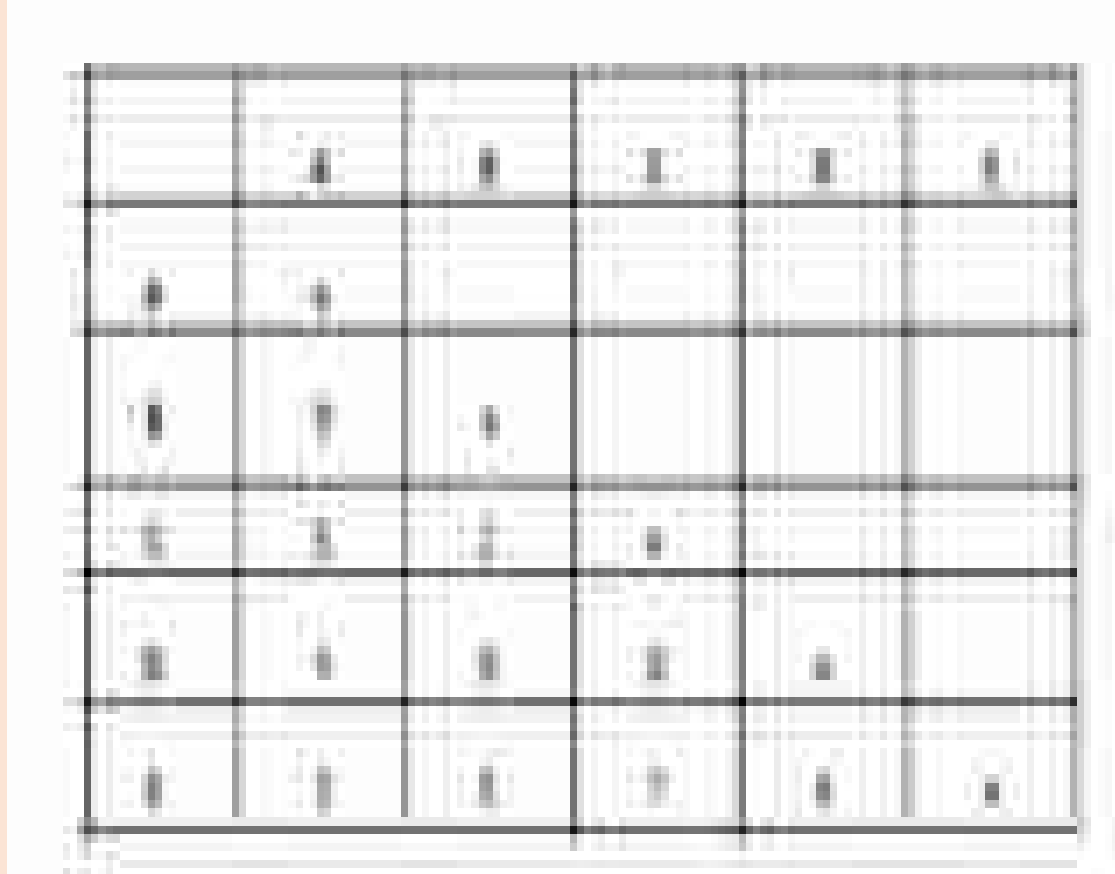
# Construction of Phenogram

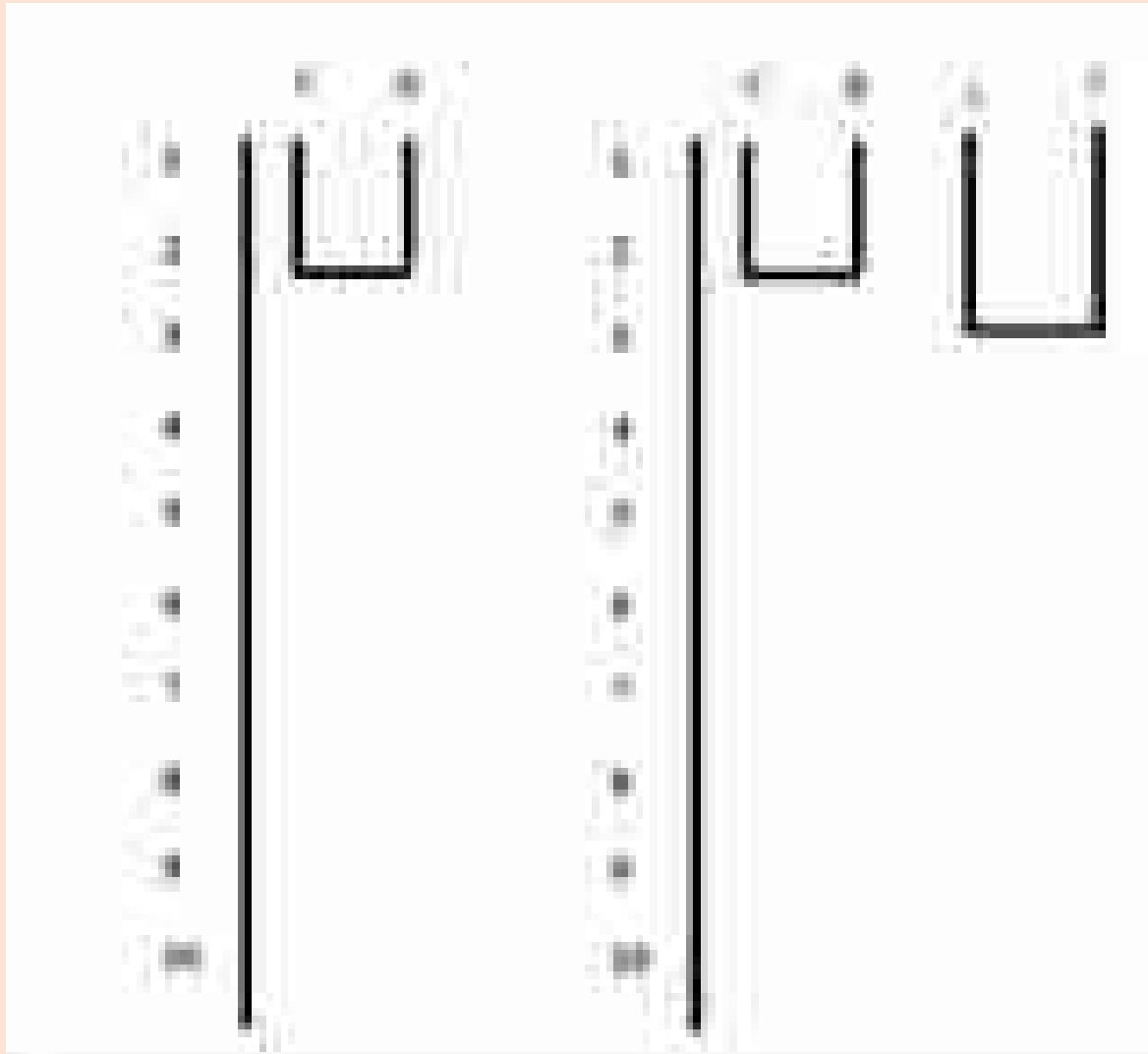
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higher than afterwards

# Construction of Phenogram

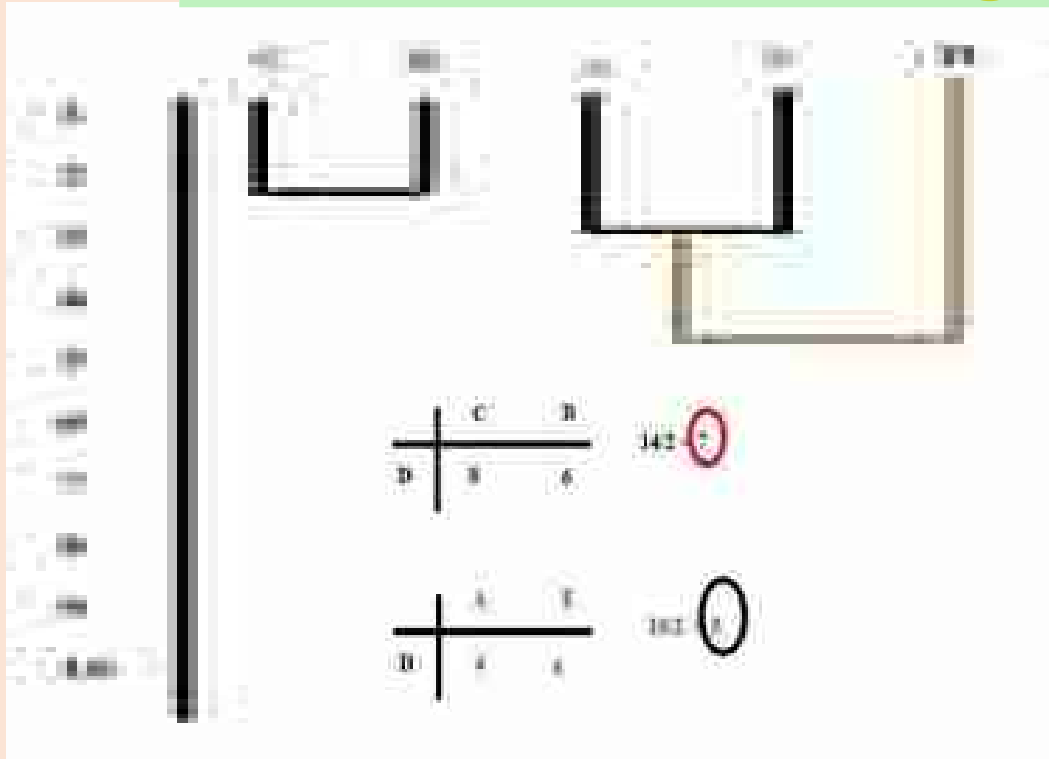
## Module# 117 Construction of Phenogram



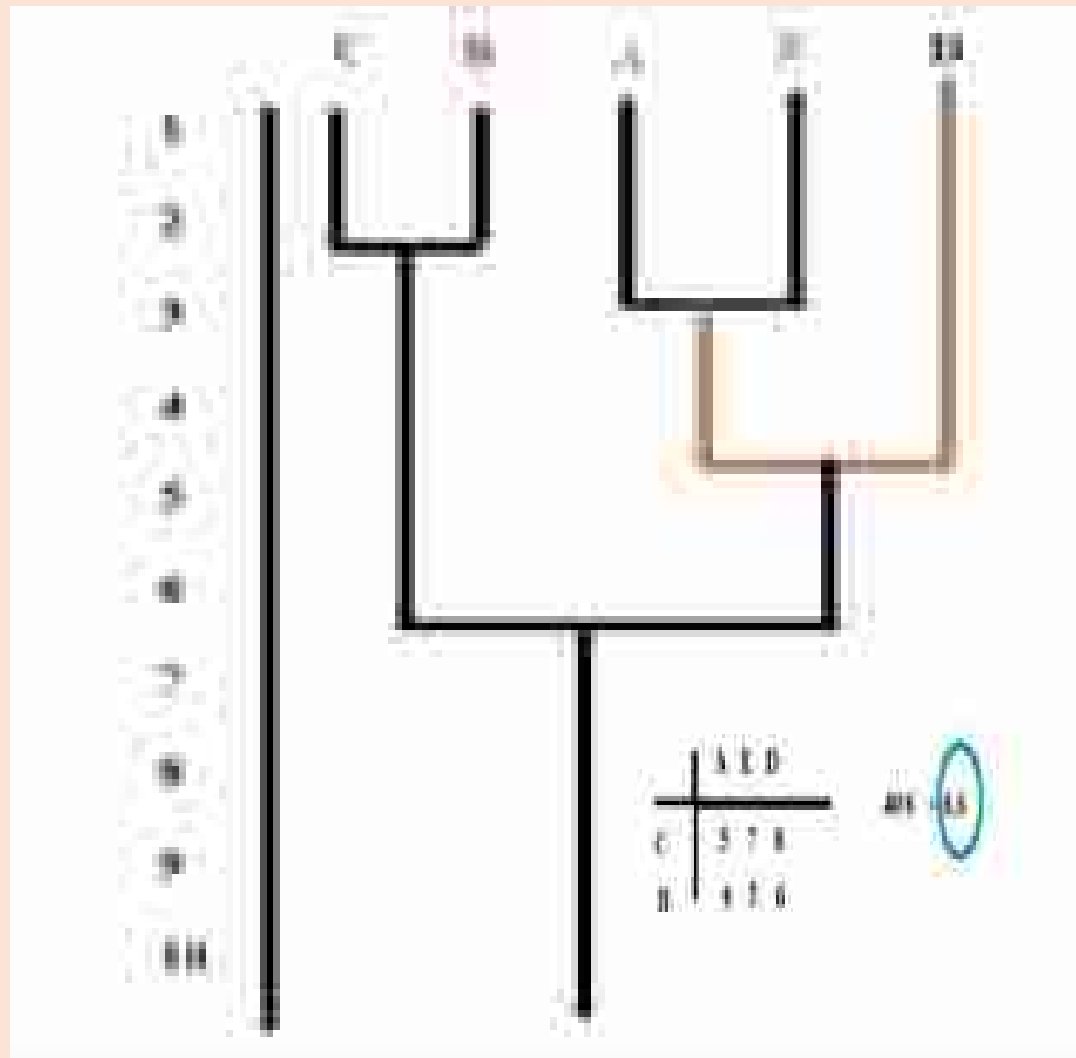


# Construction of Phenogram

# Construction of Phenogram

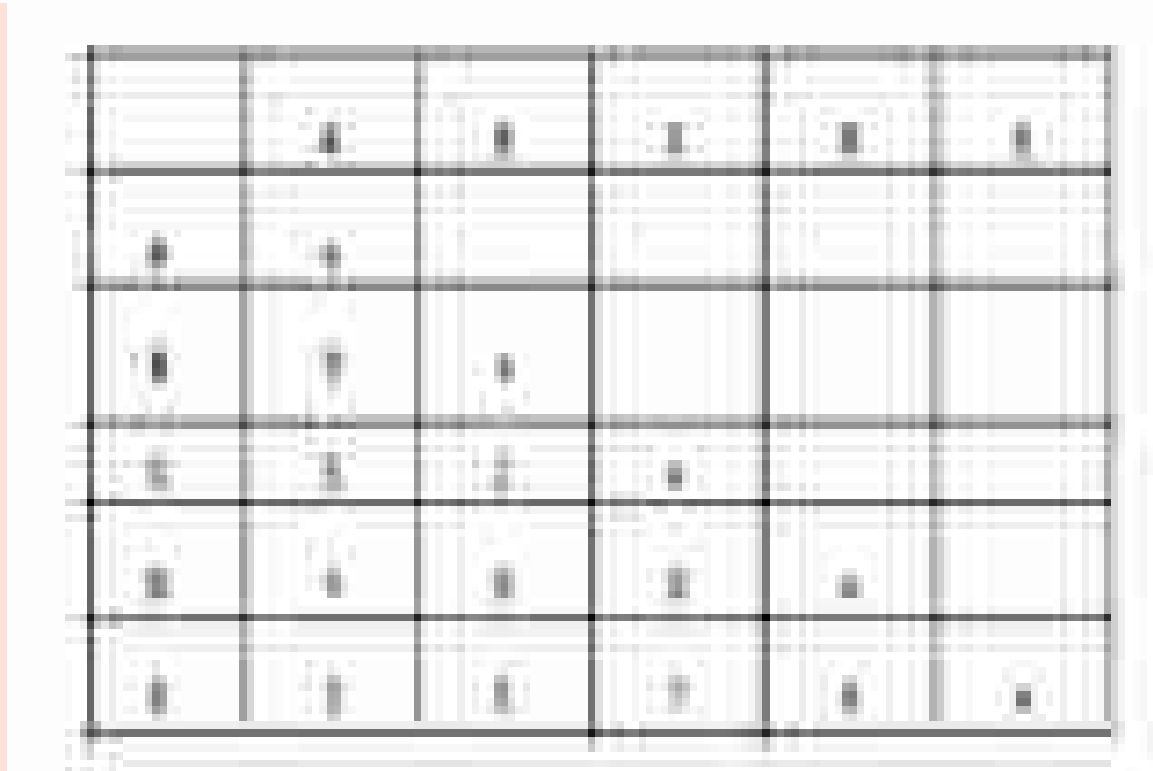


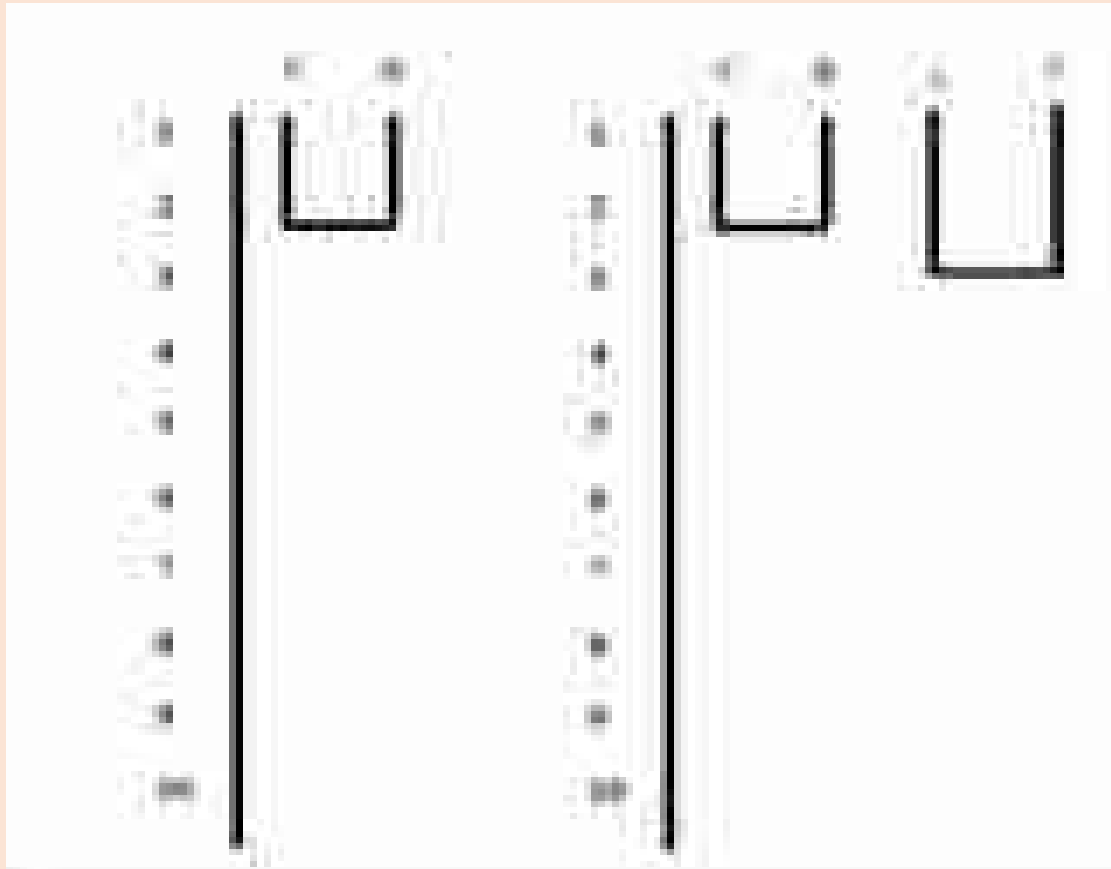




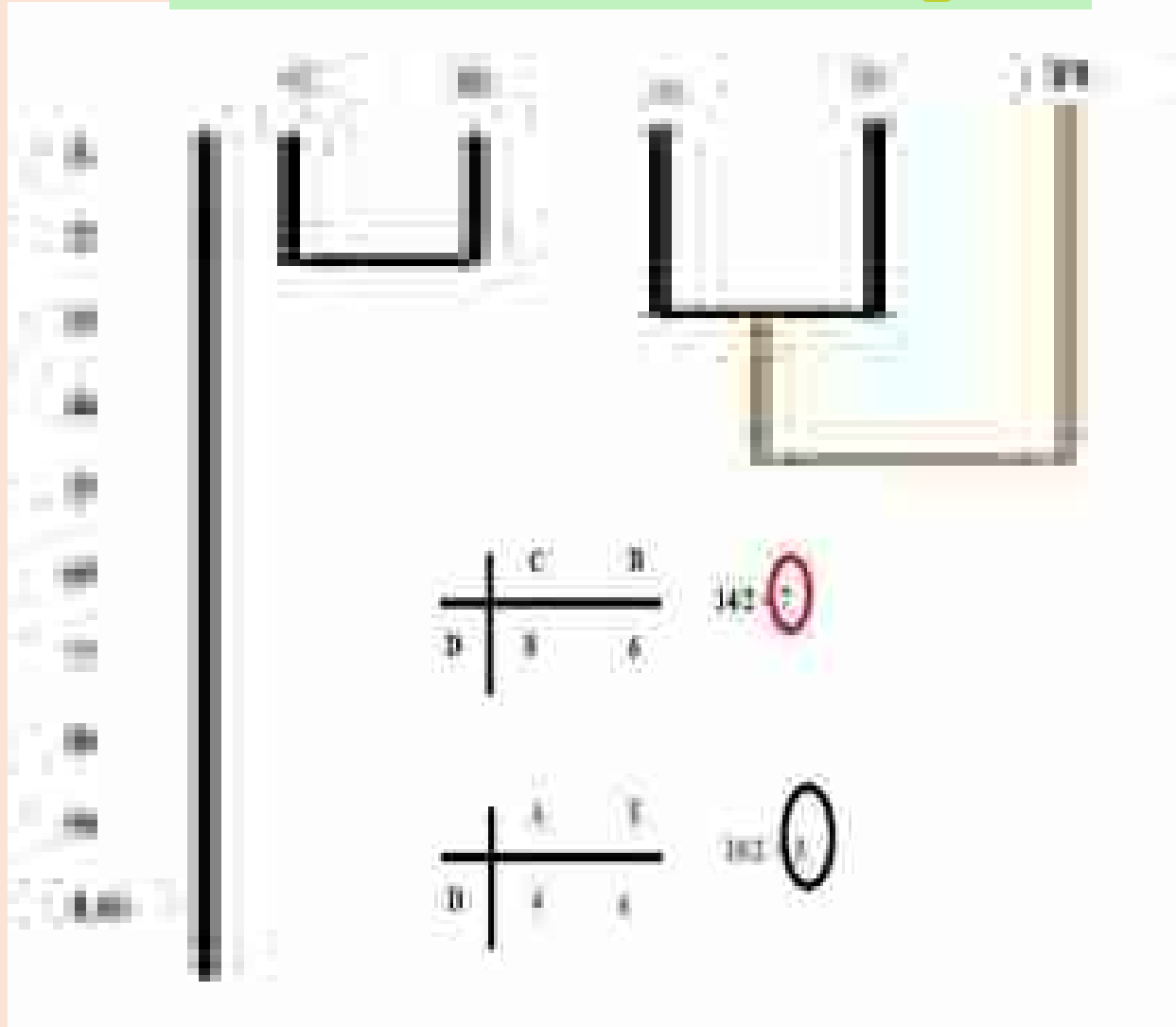
# Construction of Phenogram

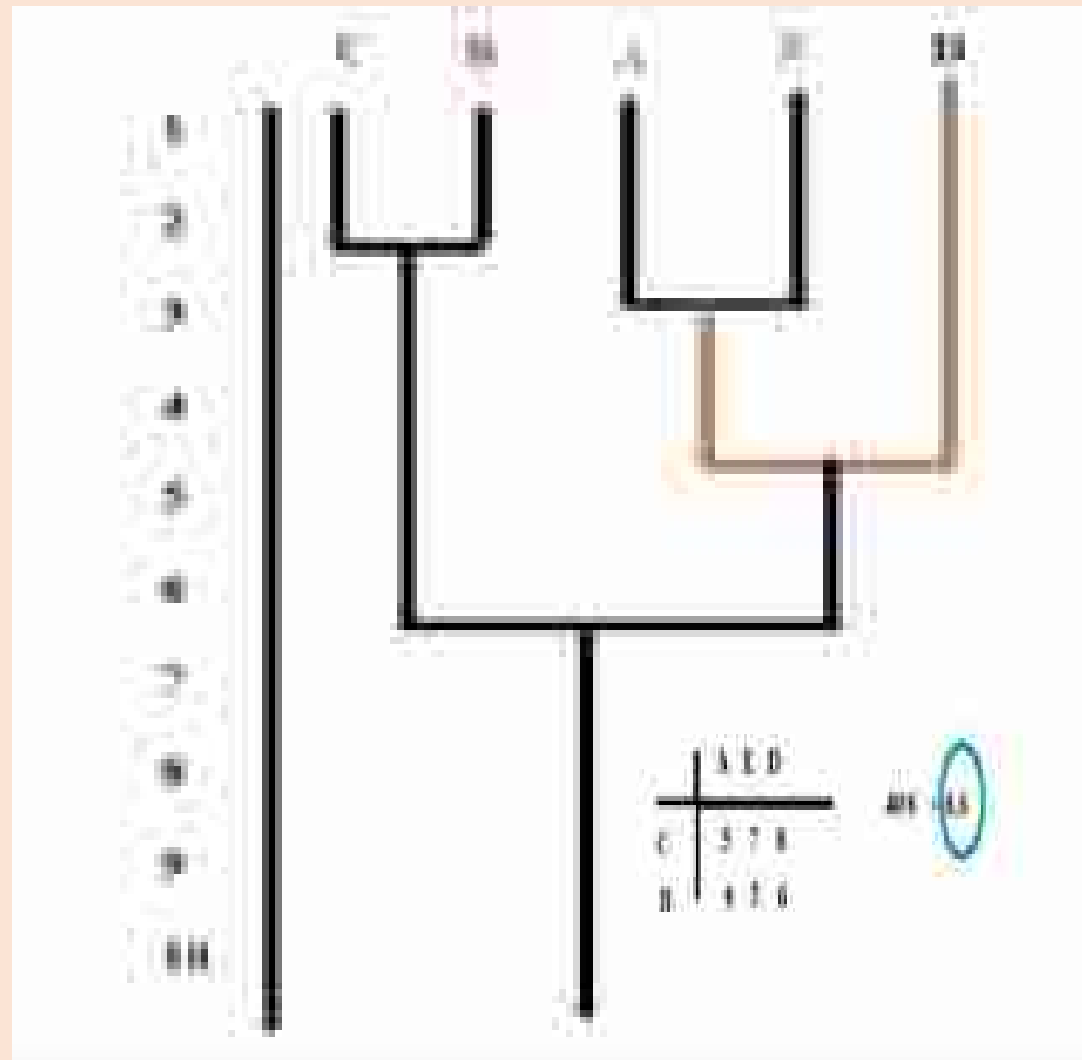
## Module# 118 Construction of Phenogram





# Construction of Phenogram





# Construction of Phenogram

## Module# 119 Describing a New Species

- Describing new species is not something that is done by non-taxonomists.
- To describe a new species, you need to have the appropriate

credentials, experience,  
and knowledge to do so.

- Assuming you have all

# Describing a New Species

- Carrying out the necessary measurements (scales, size, morphological characteristics, etc.) needed in a description.



- Record location, habitat, and other info such as DNA

## Describing a New Species

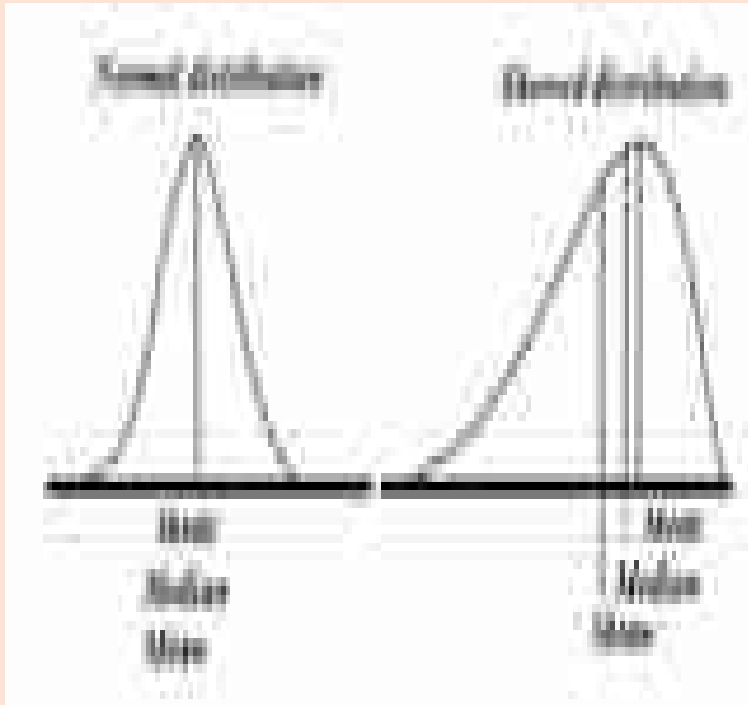
- Evidence of comparative studies demonstrating that your species is indeed new or undescribed (this can

take a long time to do properly.

- Finding the right journal for publishing your description.
- Zootaxa, ZooKeys

**END**

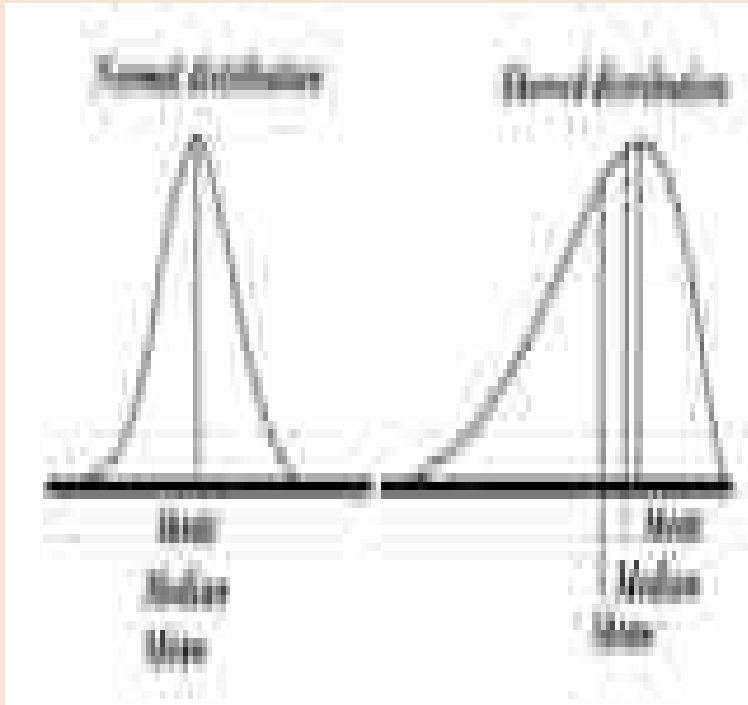
## Module# 120 Normal and Skewed Data



- In normal data values of means, median mode are equal but this not the case for asymmetric or skewed data.
- Normal data follow a bell shape curve. In skewed

distribution one tail is  
larger than other as in  
above figure.

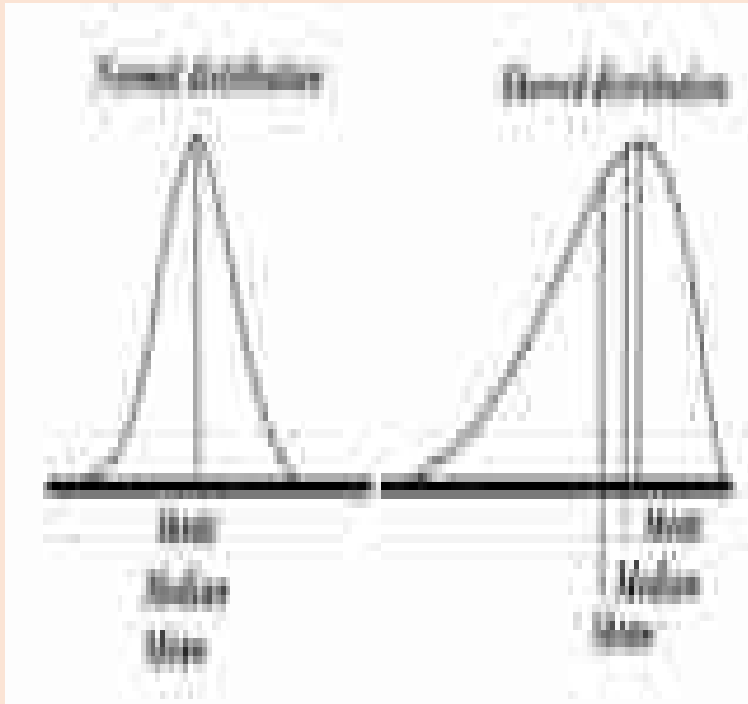
## Normal and Skewed Data



- In normal data most of the individual values are close to the mean of the data. However, in skewed that the difference between individual values and mean values is higher.

- Extreme values are almost negligible in normal data but higher

# Normal and Skewed Data



- Values of standard deviation are less for normal data compared to skewed data.
- Measure of central tendency for normal data

is mean but it is median  
for skewed data.

## Module# 121 Parametric Vs Non-Parametric Tests

- Parametric tests are used for Normal data
  - T-test
  - Z-test
  - F-test



- ANOVA
- Regression
- Correlation

## Parametric Vs Non-Parametric Tests

- Non-parametric tests for skewed data.
- Wilcoxon Signed Rank Test

- Mann Whitney U Test
- Kruskal-Wallis test
- Principal Component Test
- Friedman Tests

# Parametric Vs Non-Parametric Tests

| Parametric Test                                   | Non Parametric Test                                |
|---------------------------------------------------|----------------------------------------------------|
| 1. Data is quantitative and continuous.           | 1. Data is qualitative or discrete.                |
| 2. Data is normally distributed.                  | 2. Data is not normally distributed.               |
| 3. Data is measured on a ratio or interval scale. | 3. Data is measured on a nominal or ordinal scale. |
| 4. Data is measured on a continuous scale.        | 4. Data is measured on a discrete scale.           |

- For measuring the degree of association between two quantitative variables, **Pearson's coefficient of correlation** is used in the parametric test, while **Spearman's rank correlation** is used in the nonparametric test.

## Module# 122 Types of data Distribution

- Normal Distribution
- Binomial Distribution
- Poison Distribution

# Types of data Distribution

- **Normal Distribution**
- Data which is normally distributed and follow the normal curve is called normal data. It can be continuous and discrete in value.
- **Binomial Distribution**
- Data in which there are only two outcomes from an event and numbers of events are

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## Types of data Distribution

predecided is called binomial distribution. For example in five test match series, outcomes of each match are two i.e. to win or lose. Outcome of the event is a discrete number.

- **Poisson Distribution**
- The data distribution in which total numbers are not predetermined and some time there number can reach to infinite. These events

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## Types of data Distribution

occur in nature rarely. Outcome of such events is complete discrete value not in decimal points. For example number of deaths in

Lahore per hour. Number of deaths can be infinite if some unusual event occurs.

END

# Module# 123 Measure of Central Tendency and Measure of Variability

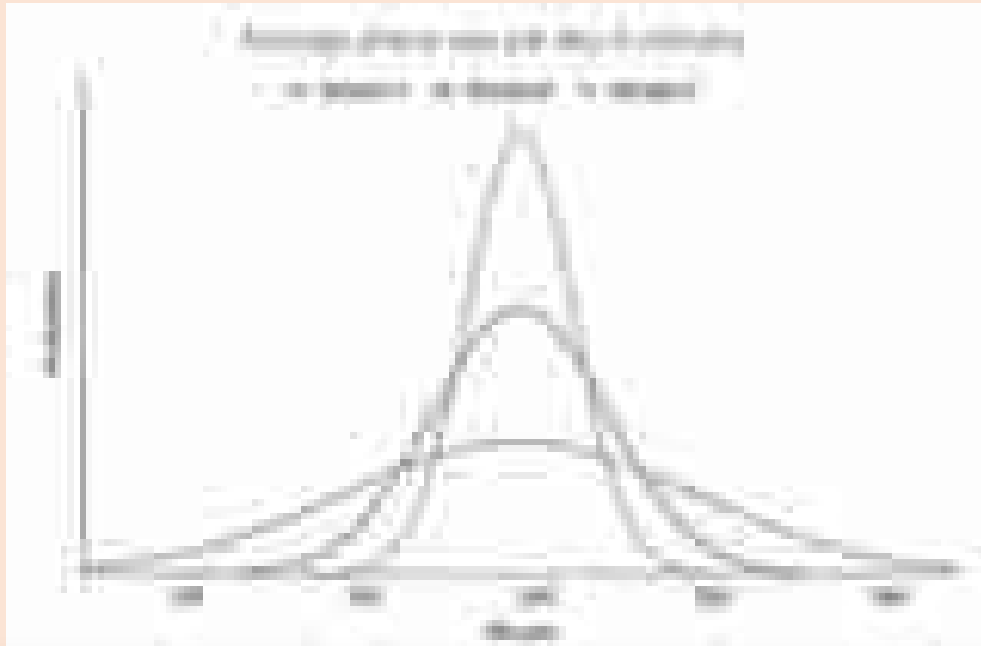
## Measure of central tendency

- It provide information about average value of a data set.
- Mean, Median and Mode are commonly used measures of central tendency.



- Data set has only one and only one Mean.
- Value of mean is influenced by all <sup>BS</sup> **ZOOLOGY** observations in the data set.

# Measure of Central Tendency and Measure of Variability



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## Measure of variability

- Mean deviation
- Variance
- Standard deviation
- Standard error of mean

- Range

BS ZOOLOGY • Less vs high value

## Module# 124 Z-test

- Z-test is used to compare the means of two samples when sample size is greater than 30 ( $n > 30$ ).

$$Z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

$$Z = \frac{\bar{X} - \mu}{SE}$$

- This test like t-test assume a normal distribution of the data.

- This test is most useful when the standard deviation is known.

## Z-test

$$Z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

- Test the hypothesis that there is no difference in the calculated sample mean with given population means.

- Population mean:  $\mu = 100$ ,  $n = 55$ ,  
Sample mean:  $\bar{x} = 12$
- By putting the values in formula:  
Z-calculated = -2.7

## Z-test

$$Z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

- Critical value at 95% confidence interval for Z -test is  $\pm 1.96$ . Zcalculated is not within the acceptable range so our null hypothesis is rejected.

## Module# 125 ANOVA

- Analysis of variance (ANOVA) is a technique used to compare means of more than two samples.
- This technique can be used only for numerical data as it is a parametric test.”

# ANOVA

## Assumptions

- Number of samples must be more than two.
- Data should be normally distributed.
- Samples must be independent.

- Homogeneity of variances.

## ANOVA

### Examples

- A group of psychiatric patients are trying three different therapies: counseling, medication and biofeedback. You want to see if one therapy is better than the others.
- Students from different colleges take the same exam. You want to  **END** see if one college outperforms



the other.

## Module# 126 ANOVA

| Source of variation     | SS | DF | MS | F-value |
|-------------------------|----|----|----|---------|
| Between group variation |    |    |    |         |
| Within group variation  |    |    |    |         |
| Total                   |    |    |    |         |

# ANOVA

| Source of Variation | SS | df | MS | F-value |
|---------------------|----|----|----|---------|
| Between groups      |    |    |    |         |
| Within groups       |    |    |    |         |
| Total               |    |    |    |         |

- SS (total) [Sum of square] = (Each observation – Grand mean)<sup>2</sup>
- SS (within) = ((Each observation – Group mean)<sup>2</sup>
- SS (between) = (Group mean – Grand mean)<sup>2</sup> × Number of observation in each group
- DF (between) = Total number of Groups – 1

END

- $DF \text{ (within group)} = \text{Total number of Observations} - \text{Total number of Groups}$

## Module# 127 One-Way ANOVA

- A one-way ANOVA uses one independent variable, while a Two-way ANOVA uses two independent variables.

- As a crop researcher, you want to test the effect of three different fertilizer mixtures on crop yield. You can use a one-way ANOVA to find out if there is a difference in crop yields between the three groups.

- You are interested to compare the effectiveness of three medicines in treating cancer patients
- Comparison of four feeds on weight of fish

One-Way ANOVA

One-Way ANOVA

| Department | Age | Gender | Age |
|------------|-----|--------|-----|
| 8          | 14  | 38     | 7   |
| 10         | 14  | 118    | 9   |
| 8          | 6   | 5      | 1   |

**Grand Mean** =  $8+11+5/3 = 8$

SS (total) [Sum of square] = (Each observation – Grand mean)<sup>2</sup>

- **SS(Total)** =  $(8-8)^2 + (14-8)^2 + (38)^2 + (7-8)^2 + (10-8)^2 + (14-8)^2 + (118)^2 + (9-8)^2 + (8-8)^2 + (6-8)^2 + (5-8)^2 + (1-8)^2$

- **SS (Total) = 174**

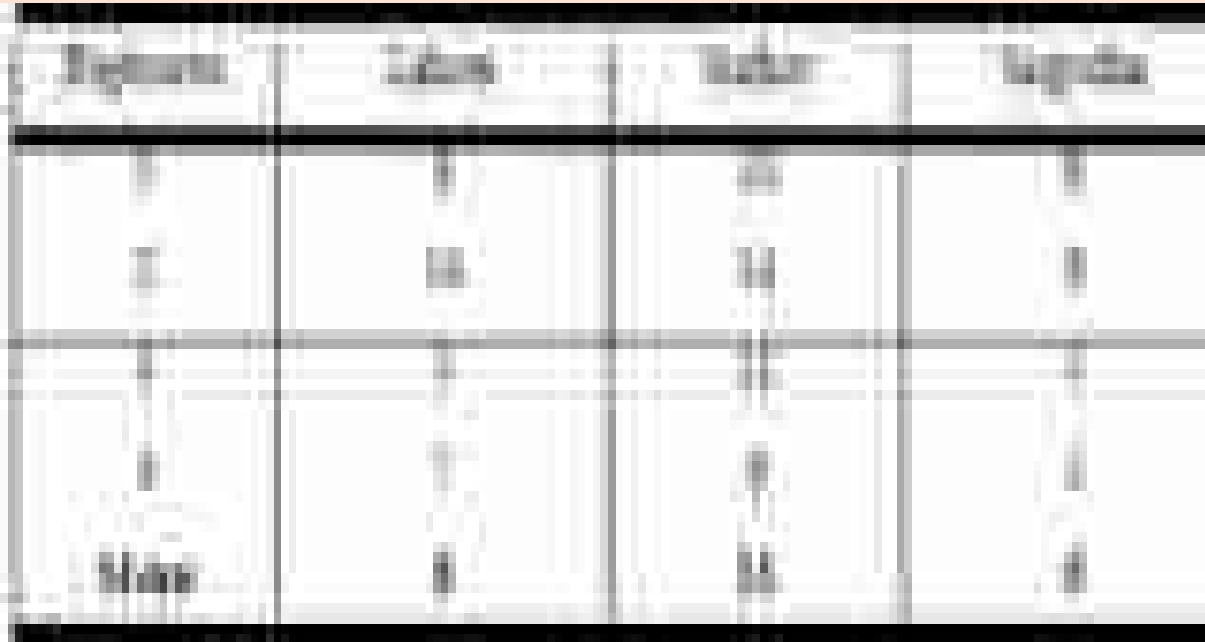


# One-Way ANOVA

| Department | College | Teacher | Subject |
|------------|---------|---------|---------|
| 1          | 1       | 1       | 1       |
| 2          | 2       | 2       | 2       |
| 3          | 3       | 3       | 3       |
| 4          | 4       | 4       | 4       |
| 5          | 5       | 5       | 5       |
| 6          | 6       | 6       | 6       |
| 7          | 7       | 7       | 7       |
| 8          | 8       | 8       | 8       |
| 9          | 9       | 9       | 9       |
| 10         | 10      | 10      | 10      |

- **SS (within)** = ((Each observation – Group mean)<sup>2</sup>
- $SS(\text{ within }) = (8-8)^2 + (14-8)^2 + (38)^2 + (7-8)^2 + (10-11)^2 + (14-11)^2 + (11-11)^2 + (9-11)^2 + (8-5)^2 + (6-5)^2 + (5-5)^2 + (1-5)^2$
- **SS (with in)** = 102

## Module# 128 One-Way ANOVA



| Treatment | Control | Drug A | Drug B |
|-----------|---------|--------|--------|
| 8         | 118     | 5      | 8      |
| 8         | 118     | 5      | 8      |
| 8         | 118     | 5      | 8      |
| 8         | 118     | 5      | 8      |
| Mean      |         |        |        |

- **SS (between)** = (Group meanGrand mean)<sup>2</sup> × Number of observation in each group
- $SS \text{ (between)} = [(8 - 8)^2 \times 4] + [(118)^2 \times 4] + [(5-8)^2 \times 4] = 72$

## One-Way ANOVA

| Source of variation | SS | df | MS | F-value |
|---------------------|----|----|----|---------|
| Between groups      |    | 3  |    |         |
| Within groups       |    | 9  |    |         |
| Total               |    | 12 |    |         |

- **DF (between)** = Total number of groups – 1
- $DF (\text{between}) = 3 - 1 = 2$
- **DF (within group)** = Total number of observation – Total number of groups
- $DF (\text{within group}) = 12 - 3 = 9$

# One-Way ANOVA



| Source         | Sum of Squares | Degrees of Freedom | Mean Square | F-value |
|----------------|----------------|--------------------|-------------|---------|
| Between groups | 72             | 2                  | 36          | 11.33   |
| Within groups  | 102            | 9                  | 11.33       |         |
| Total          | 174            | 11                 |             |         |

## MS (between)

- It can be calculated by dividing the SS (between group) with DF (between group)
- $72/2 = 36$

## MS (within)

It can be calculated by dividing the SS (within group) with DF (within group)

- $102/9 = 11.33$

# One-Way ANOVA

| Source of Variation | SS   | df | MS   | F    |
|---------------------|------|----|------|------|
| Between groups      | 3.11 | 3  | 1.04 | 3.11 |
| Within groups       | 1.11 | 12 | 0.09 |      |
| Total               | 4.22 | 15 |      |      |

F-calculated

- 3.11

F- Tabulated

- Comparison of both
- Decision about hypothesis

## Module# 129 Two-Way ANOVA

- In two-way ANOVA there are two independent variables and one dependent variable.
- In one-way ANOVA there was only one independent variable

# Two-Way ANOVA

## Assumptions

- The population must be close to a normal distribution.
- Samples must be independent.
- Population variances must be equal.

## Two-Way ANOVA

- Groups must have equal sample sizes.
- One could use a **two-way ANOVA** to understand whether there is an interaction between gender and educational level on test anxiety amongst university students, where gender (males/females) and education level



## Two-Way ANOVA

(undergraduate/postgraduate)  
are your independent variables,  
and test anxiety is your  
dependent

- For example, a two -way ANOVA allows a company to compare worker productivity based on two independent variables, such as department and gender.

## Two-Way ANOVA

- It is utilized to observe the interaction between the two factors. It tests the effect of two factors at the same time.
- The effective life (in hours) of batteries is compared by material type (1, 2 or 3) and operating temperature: Low ( $-10^{\circ}\text{C}$ ), Medium ( $20^{\circ}\text{C}$ ) or High ( $45^{\circ}\text{C}$ ).

## Two-Way ANOVA

END

- Twelve batteries are randomly selected from each material type and are then randomly allocated to each temperature level.

## Module# 130 T-test

- T-test is appropriate whenever you want to compare the means of two samples.
- This test is used to find out whether the means of two samples are statistically different from each other or not.

## T-test

- Data should be normally distributed.
- Samples should be taken randomly from the population
- Sample size should be 30 or less than 30.
- All randomly collected samples should have the same variances

(within the limits of sampling error).

- Standard deviation may or may not be known.

## T-test

- Independent t -test/two sample ttest
- Paired t-test

## Module# 131 Independent t-test

- For two sample t -test, the two populations must be  
independent
- It is not necessary that sample size should be same for both samples.

- **Example**: Test the hypothesis that means heights (cm) of plants randomly selected from two wheat fields are same.



# Independent t-test

- For two sample t-test, the two populations must be independent
- It is not necessary that sample size should be same for both samples.

Data of Field I ( $X_1$ ) = 10, 15, 20, 25 and 30

Data of Field II ( $X_2$ ) = 4, 8, 10, 15 and 10

Null hypothesis:  $\mu_1 = \mu_2$

Alternative hypothesis is  $\mu_1 \neq \mu_2$

**Formula:**

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

# Independent t-test

- **Example**s: Test the hypothesis that means heights (cm) of plants randomly selected from two wheat fields are same.

# Independent t-test

| Group | Mean | Standard Deviation | Standard Error |
|-------|------|--------------------|----------------|
| 1     | 10.5 | 2.5                | 0.5            |
| 2     | 12.5 | 3.0                | 0.6            |
| 3     | 11.5 | 2.0                | 0.4            |
| 4     | 13.5 | 2.5                | 0.5            |
| 5     | 10.5 | 2.5                | 0.5            |
| 6     | 12.5 | 3.0                | 0.6            |
| 7     | 11.5 | 2.0                | 0.4            |
| 8     | 13.5 | 2.5                | 0.5            |
| 9     | 10.5 | 2.5                | 0.5            |
| 10    | 12.5 | 3.0                | 0.6            |
| 11    | 11.5 | 2.0                | 0.4            |
| 12    | 13.5 | 2.5                | 0.5            |
| 13    | 10.5 | 2.5                | 0.5            |
| 14    | 12.5 | 3.0                | 0.6            |
| 15    | 11.5 | 2.0                | 0.4            |
| 16    | 13.5 | 2.5                | 0.5            |
| 17    | 10.5 | 2.5                | 0.5            |
| 18    | 12.5 | 3.0                | 0.6            |
| 19    | 11.5 | 2.0                | 0.4            |
| 20    | 13.5 | 2.5                | 0.5            |

# Independent t-test

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}} = \frac{10.5 - 12.5}{\sqrt{\frac{1.5}{10} + \frac{1.5}{10}}} = -2.5$$

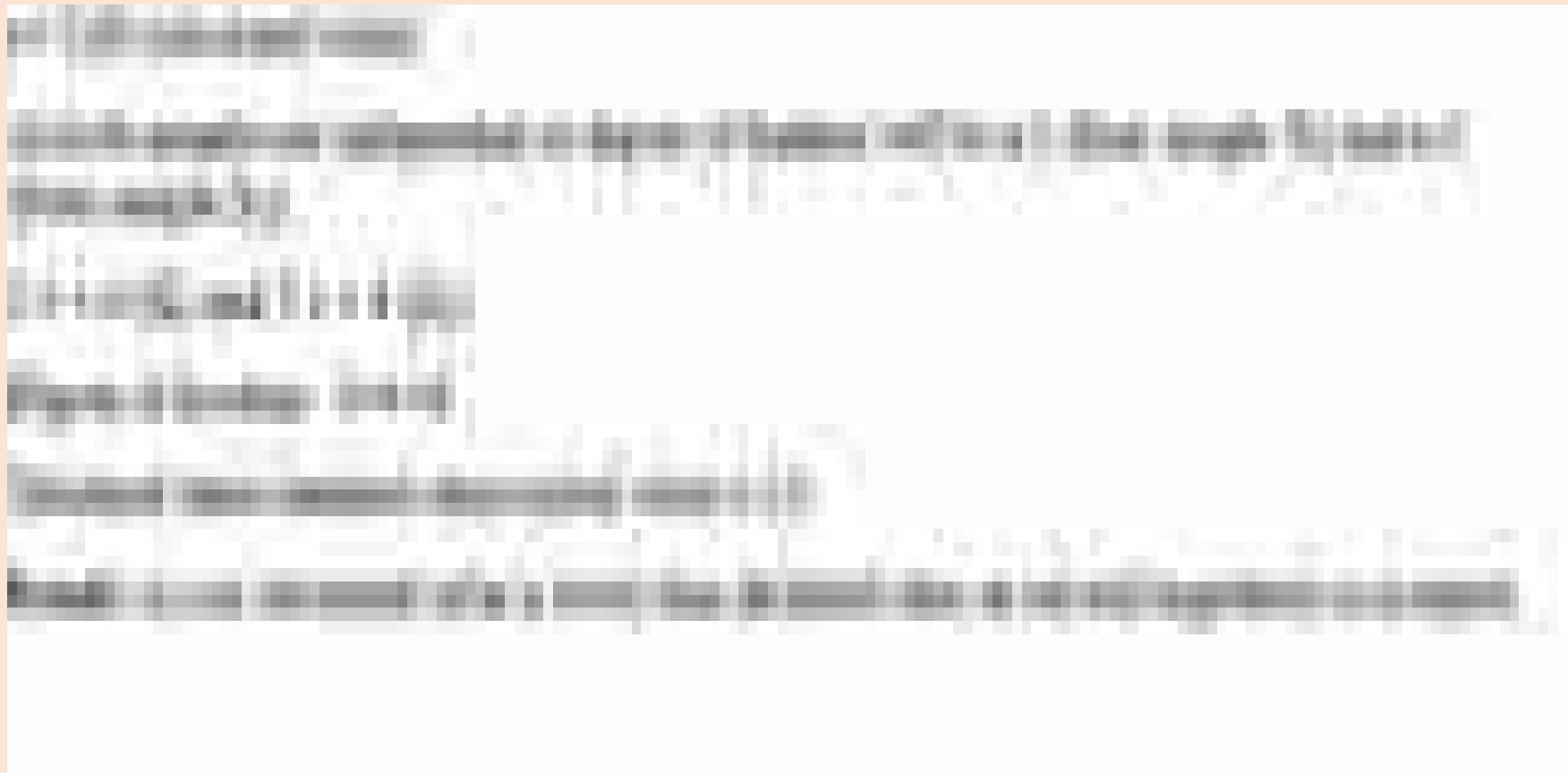
$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{10.5 - 12.5}{\sqrt{\frac{1.5}{10} + \frac{1.5}{10}}} = -2.5$$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{10.5 - 12.5}{\sqrt{\frac{1.5}{10} + \frac{1.5}{10}}} = -2.5$$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{10.5 - 12.5}{\sqrt{\frac{1.5}{10} + \frac{1.5}{10}}} = -2.5$$

# Independent t-test

Null hypothesis:  $\mu_1 = \mu_2$



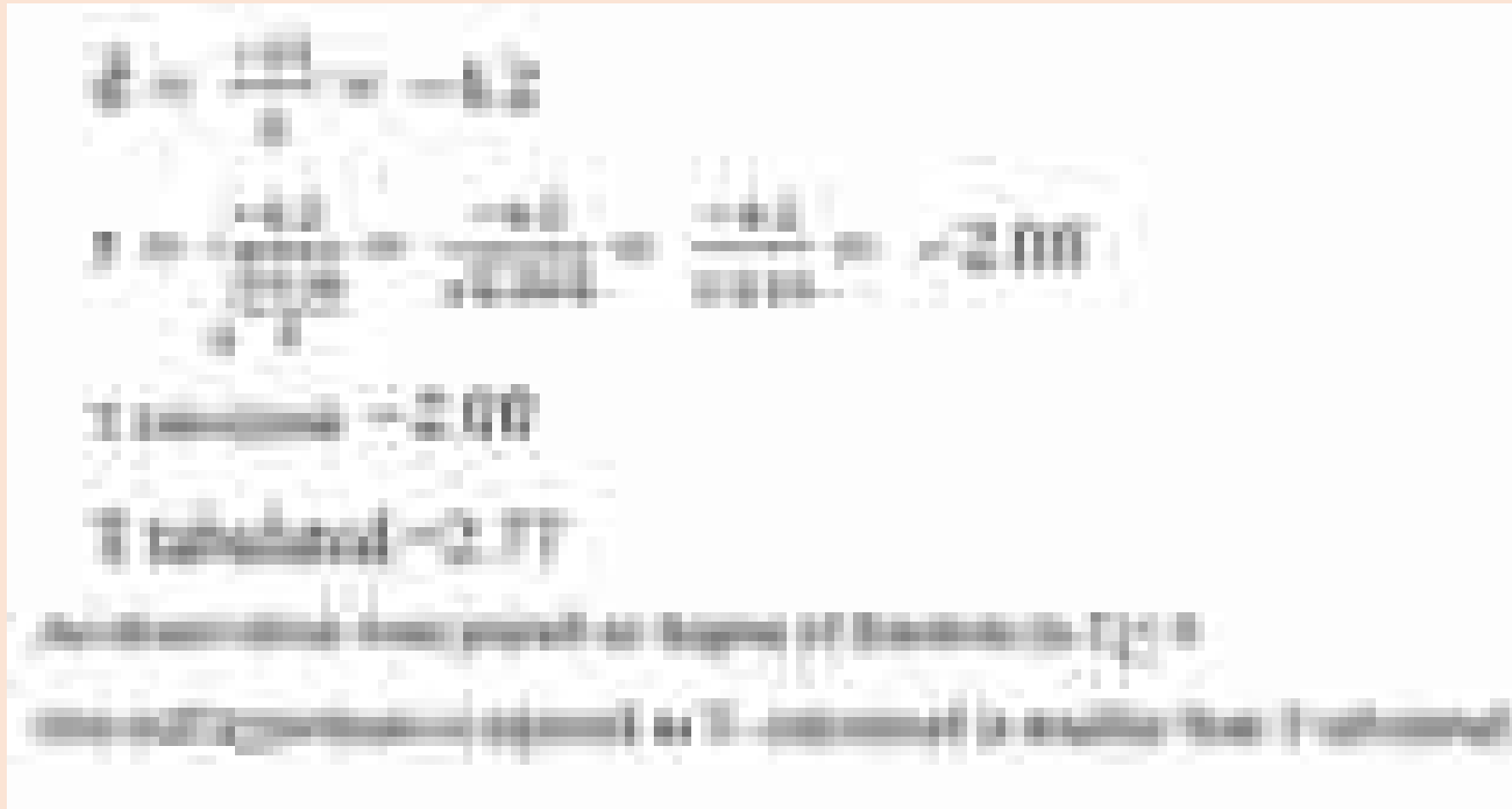
## Module# 132 Paired t-test



## Paired t-test

$$t = \frac{\bar{d}}{\sqrt{\frac{\sigma^2_d}{n}}}$$
$$\sigma^2_d = \frac{\sum (d - \bar{d})^2}{n - 1}$$
$$\frac{12 + 0 + 12 + 12 + 12}{4} = 3$$
$$\frac{99 - 12 \times 3}{4} = \frac{63}{4} = 15.75$$
$$\frac{3}{\sqrt{15.75}} = 20.34$$

## Paired t-test





# Module# 133   Standard Deviation

Data of Field I ( $X_1$ ) = 10, 15, 20, 25 and 30

Data of Field II ( $X_2$ ) = 4, 8, 10, 15 and 10

Null hypothesis:  $X_1 = X_2$

Alternative hypothesis is  $X_1 \neq X_2$

**Formula:**

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

- It is positive square root of variance.
- Standard deviation "provides a sort of average of the differences of all scores from the mean.
- It is a measure of the dispersion of scores around the mean.
- Generally, a low standard deviation means that a set of scores is not very widely dispersed around the mean.

## Standard Deviation

- While a high standard deviation indicates that the scores are more widely dispersed

$$SD = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

- Its advantage over variance is that its physical unit are same as that of individual observations

## Standard Deviation

- The standard error is also a measure of spread.

$$SE = \frac{s}{\sqrt{n}} \quad \text{or} \quad SE = \frac{SD}{\sqrt{n}}$$

- It is represented by SE.
- Higher value of SE indicates higher spread of the data.
- The difference in the standard error and standard deviation is that standard error uses sample data but standard deviations use population data.
- SE tells us that how far our sample mean deviate from

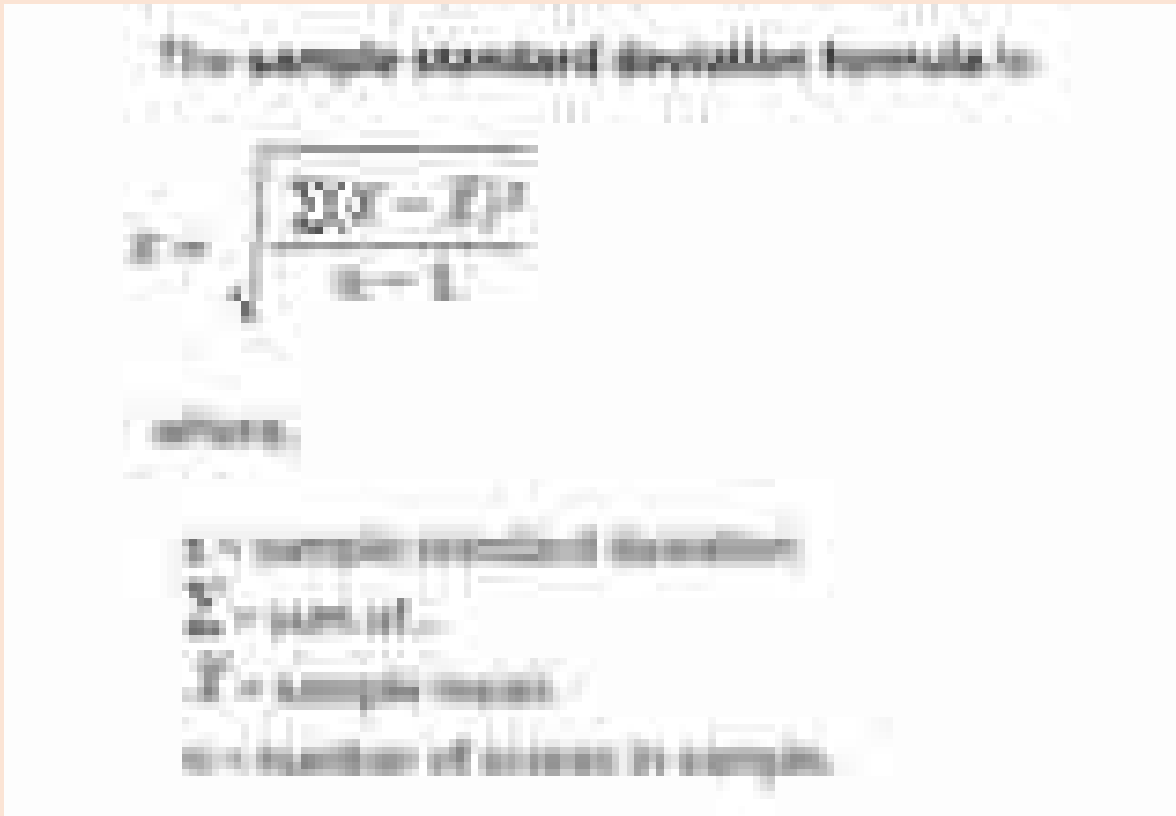
## Standard Deviation

$$SE = \frac{\sigma}{\sqrt{n}} \quad \text{or} \quad SE = \frac{SD}{\sqrt{n}}$$

population means.

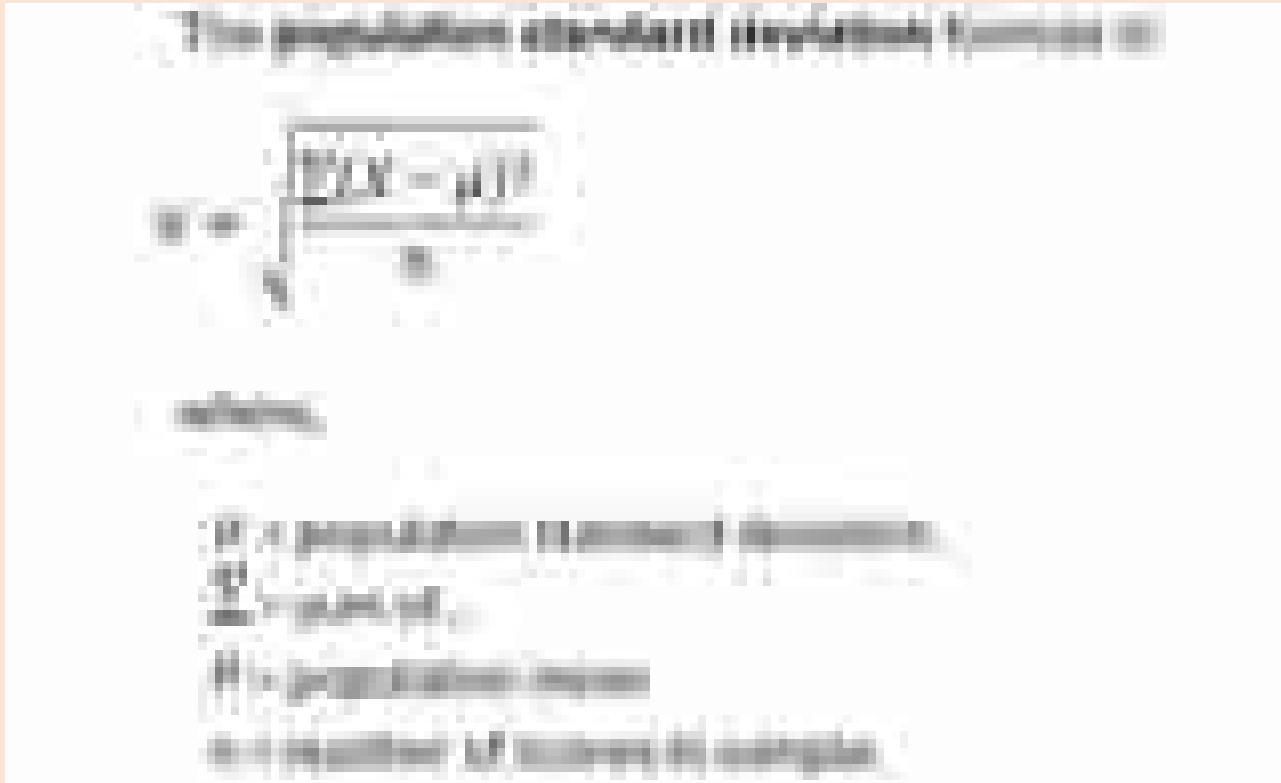
## Module# 134 Standard Deviation

- The standard deviation is a measure of the spread of scores within a set of data.
- Usually, we are interested in the standard deviation of a population.
- However, as we are often presented with data from a sample only, we can estimate the population



# Standard Deviation

standard deviation from a sample standard deviation.



- The standard deviation is a measure of the spread of scores within a set of data.

- A **sample standard deviation** is a statistic. This means that it is calculated from only some of the individuals in a **population**.

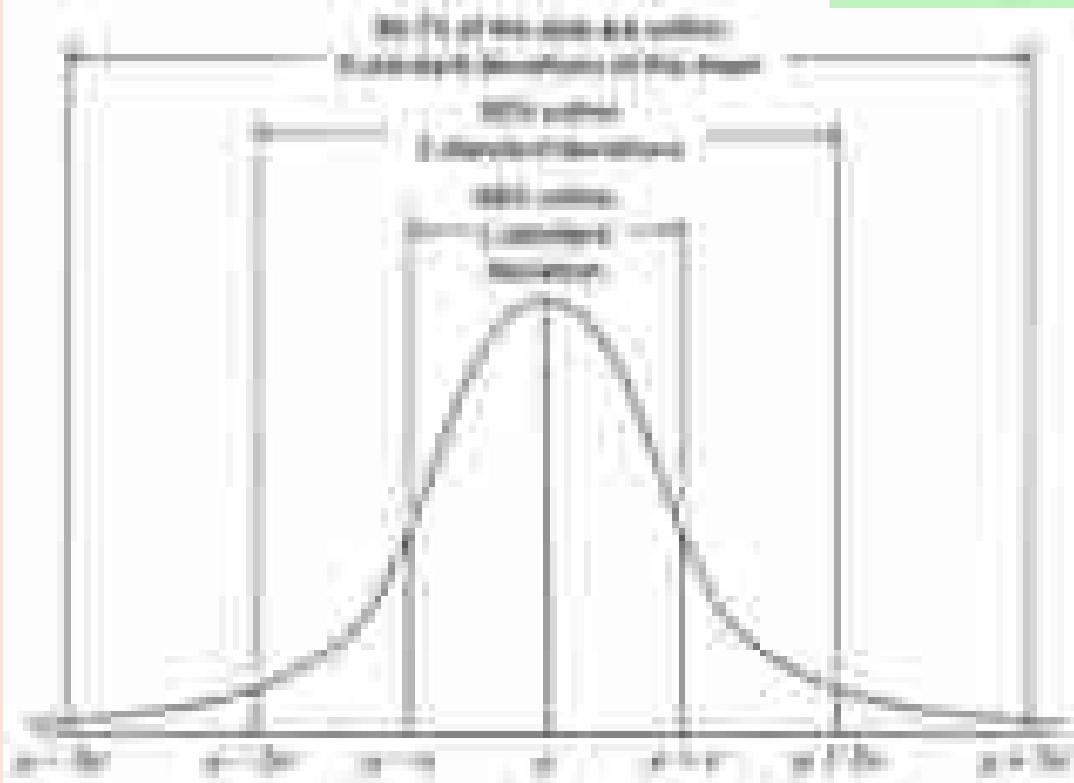
- The **population standard deviation** is a parameter, which is a fixed value calculated from every individual in



# Standard Deviation

the **population.**

# Standard Deviation



## Relationship between Variance and SD

- The **standard deviation** is the square root of the **variance**. The **standard deviation** is expressed in the same units as the mean is, whereas the **variance** is expressed in squared units,

# Standard Deviation



## Module# 135 Introduction to Spiders

- Most abundant natural predators

(Maloney et al., 2003)

Ranked 7<sup>th</sup> in animal diversity

(WSC, 2018)

- More than 46000 species
- Strictly carnivorous

## Standard Deviation

- Cause wasteful killing
- Show functional and numerical response

# Introduction to Spiders



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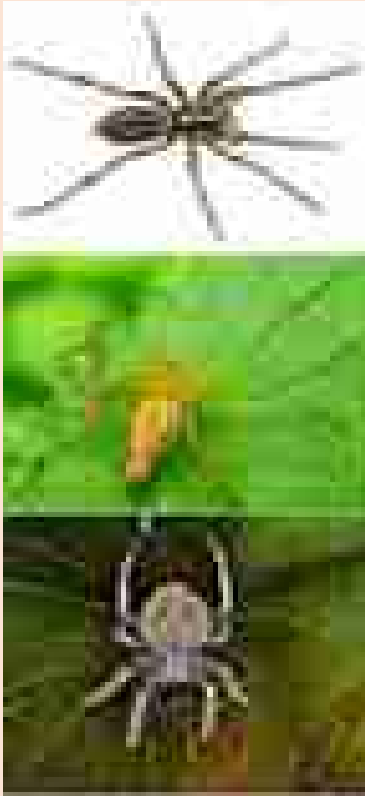
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b

- Best survivors under food shortage
- Prey switching
- Cannibalistic
- Top down effect
- Indirect killing

# Module# 136 Introduction to Spiders



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- Ground runners • Stalkers

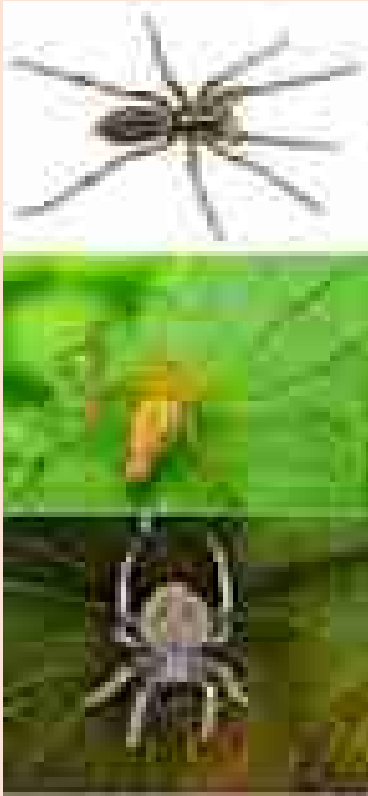
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- Web builders



# Introduction to Spiders



- Bio-control agents
- Model organism for research
- Spiders silk

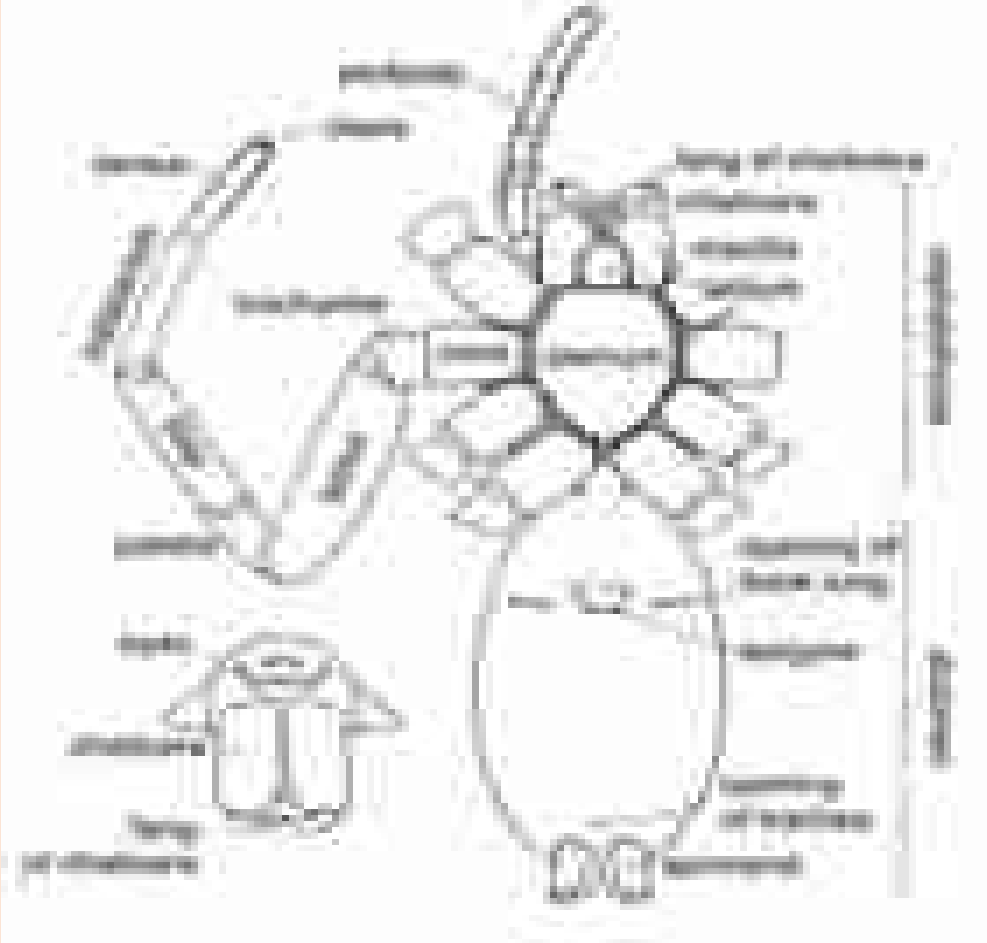
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- Spider venom peptides

## Module# 137 Morphology of spider Leg



- Spiders typically have eight walking legs (insects have six)
- They do not have antennae
- the pair of appendages in front of the legs are the pedipals(or just palps)
- Spiders' legs are made up of

# Morphology of spider Leg

[https://en.wikipedia.org/wiki/Spider\\_anatomy#/media/File:Spider\\_external\\_anatomy\\_en.png](https://en.wikipedia.org/wiki/Spider_anatomy#/media/File:Spider_external_anatomy_en.png)



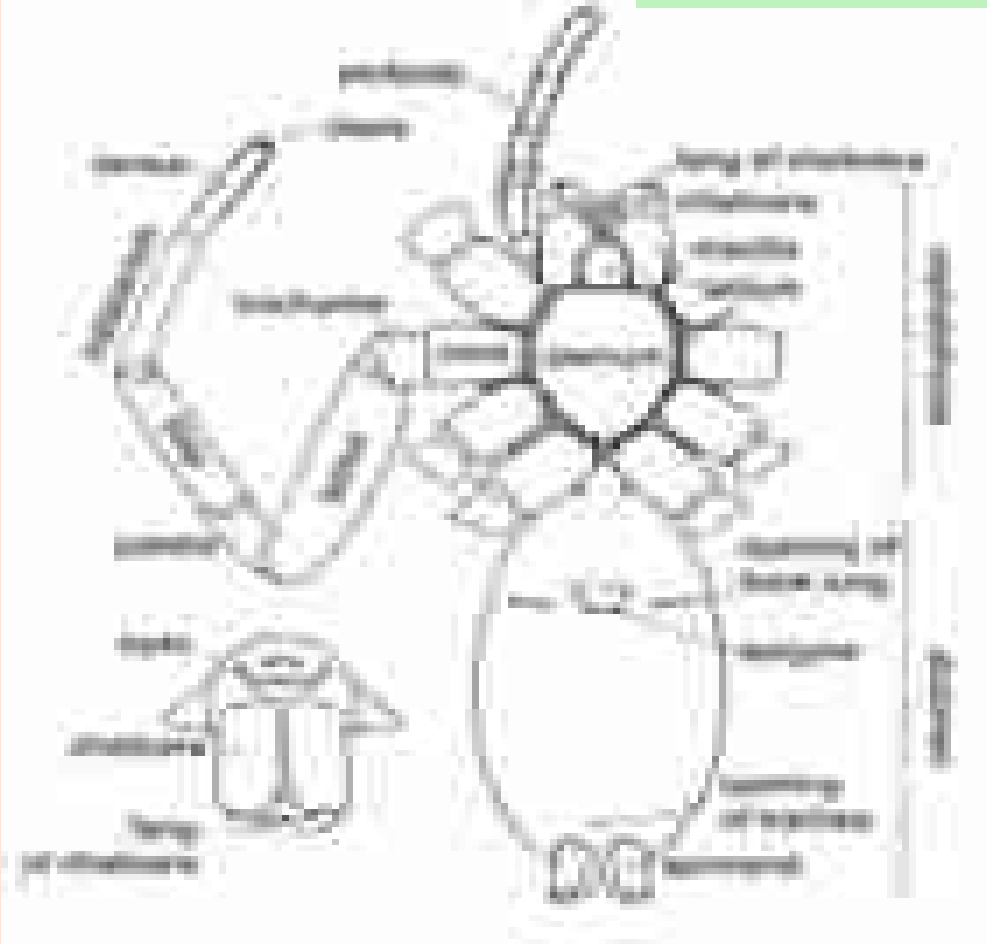
- seven segments
- The tip of the tarsus bears claws, which vary in number and size
- Spiders that spin webs typically have three claws, the middle one being small
- Hunting spiders typically have

# Morphology of spider Leg

only two claws

[https://www.google.com/search?q=claws+on+spider+legs&sxsrf=ALeKk0060j\\_KdLtgM-6hkwrG7Ye5YSDcbw:1608429989309&source=lnms&tbm=isch&sa=X&ved=2ahUKEwillalRvNvtAhVhs3EKHXUQBY4Q\\_AUoAXoECBQQAw&biw=1360&bih=657#imgrc=288GAyKO3bRCM](https://www.google.com/search?q=claws+on+spider+legs&sxsrf=ALeKk0060j_KdLtgM-6hkwrG7Ye5YSDcbw:1608429989309&source=lnms&tbm=isch&sa=X&ved=2ahUKEwillalRvNvtAhVhs3EKHXUQBY4Q_AUoAXoECBQQAw&biw=1360&bih=657#imgrc=288GAyKO3bRCM)

## Morphology of spider Leg



- Starting from the body end, these are the:
  - Coxa
  - Trochanter
  - Femur
  - Patella • Tibia

# Morphology of spider Leg

[https://en.wikipedia.org/wiki/Spider\\_anatomy#/media/File:Spider\\_external\\_anato](https://en.wikipedia.org/wiki/Spider_anatomy#/media/File:Spider_external_anato)

• Metatarsus my\_en.png •

Tarsus.

## Morphology of spider Leg



- Since they do not have antennae, spiders use specialized and **sensitive** **setae** on their legs to pick up scent, sounds, vibrations and air currents.
- Some spiders, such as



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not have claws.

the  
Australia  
crab  
spiders,  
do

## Morphology of spider Leg



palpal

- The pedipalps have only six segments: the metatarsus is missing.
- In adult males, the tarsus of each palp is modified for mating (variously called a palpal pulb, organ or copulatory bulb)

<https://www.google.com/search?q=palpal+bub+in+spiders&tbm=isch&ved=2ahUKEwjypqXYvNvtAhVLHBoKHTcdDzsQ2->

cCegQIABAA&oq=palpal+bub+in+spiders&gs\_lcp=CgNpbWcQAzoECCMQJzoICAAQsQMQgw

A

QE&sclient=img&ei=tLHeX\_L8Acu4aLe6vNgD&bih=657&biw=1360#imgsrc=HeEJxStweWNH