

Non-Genetic Variations

Seasonal Variations of individuals

- Same animal may have different appearance in different parts of the year
- In arctic and sub-arctic birds there may be change from white winter dress to normal colour summer dress.

Non-Genetic Variations



Rock ptarmigans (*Lagopus muta*)

- Gray and brown upper parts in summer
- White plumage in winter

https://www.google.com/search?q=ptarmigan&sxsrf=ALeKk015nxwTbGZOdxCyoPYsK-TETw_DOA:1603517715139&source=lnms&tbn=isch&sa=X&ved=2ahUKEwjH3bT-wMzsAhVoQEEAHabtBjEQ_AUoAXoECCcQAw&biw=1360&bih=600#imgrc=sK318okbBMjJi

Principles of Systematics

Module# 41

Principles of Systematics

Individual Variations

Individual Variations



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European Starling (seasonal variation)

- Freshly molted bird of October is covered with white spots and all feathers show whitish margins
- In winter edges of feathers wear off

Individual Variations

European Starling



- In spring (beginning of breeding season) whole bird is glossy black without the mold of single feather

<https://www.google.com/search?q=european+starling+in+spring%2C+glossy+black&tbm=isch&ved=2ahUKEwi6xauzsAhVC-4UKHZh3BakQ2-cCegQIABAA&oq=european+starling+in>

Individual Variations



https://www.google.com/search?q=bicycles+anyana+in+wet+season&tbm=isch&ved=2ahUKEwjQsK3DxszsAhULcxoKHfjYAKMQ2-cCegQIABAA&oq=bicycles+anyana+in+wet+season&gs_lcp=CgNpbWcQAzoECCMQJzoHCAAQsQMqqzoECAAQzoFCAAQsQM6AggAOgYIABAIEB5QyY0uWN6XL2CLmi9oAHAAeACAAegDiAGKRJIBCDItMjEuOC4xmAEAoAEBqgELZ3dzLXdpei1pbWfAAQE&sclient=img&ei=4cKTX5C8Novmafixg5gK&bih=600&biw=1360&hl=en#imgsrc=zxMXuCnjPwLPSM

Seasonal variations of consecutive generations

- Seasonal plasticity
- These variations are called polyphenism.
- African butterfly *Bicyclus anynana*
- Eyespots on margins (ventral side)---- in wet season
- Very small or No eyespot ---Dry season

Principles of Systematics

Module# 42

Principles of Systematics

Social Variations

Social Variations

- In social insects there are definite groups of individuals in a colony.
- Each type of individual in a colony perform specific function.
- For examples in a colony of Honey bee:
- Queen, males (drones) and workers, soldiers

Social Variations

Social variations

- **workers:** All workers are females, product of fertilized eggs.
- They are in majority in the colony.
- May be from 10000 to 50,000 per colony.
- development.
- Projection of colony, food collection, feeding of queen, take care of young ones, cleaning of hive etc

END

Principles of Systematics

Module# 43

Principles of Systematics

Social Variations

Social Variations

Social variation in ants

- Ants live in complex social colonies.
- **Queen:** founder and leader of the colony.
- Primary goal is to populate colony .
- Lay thousands of eggs
- Queen chambers are deep within the colony for protection.
- Long life in some species upto 30 years.

Social Variations

Social variation in ants

- **Drones:** Only function is to fertilize female
- Die after fertilization
- Rarely encountered outside the colony
- **Workers:** Foraging and protection
- Sometime: queen lay eggs, winged male and females-**Alates or reproductive.**

Social Variations

Social variation in ants

- After maturation leave the colony in swarms.
- Establish new colony

END

Principles of Systematics

Module# 44

Principles of Systematics

Ecological Variations

Ecological Variations

- A. Habitat Variation
- B. Variations induced by climatic conditions
- C. Host determined variations
- D. Density dependent variations
- E. Allometric variations
- F. Neurogenic color variations

Ecological Variations

A. Habitat variation

- Populations of single species in different habitat are visibly different.

Oyster in still water

- Round or broader

Oyster in strong currents

- Narrow, elongated and usually straight

Ecological Variations

A. Habitat variation

Oyster in clean water on pebble

- Lower valve is deep and more or less sharply ribbed to acquire strength
- Not needed attachment is with perfectly flat surface

Oyster in muddy area

- Valves are less commonly ribbed

END

Principles of Systematics

Module# 45

Principles of Systematics

Ecological Variations

Ecological Variations

B. Variations induced by climatic conditions

- Animals with phenotypic plasticity
- Variations with temperature, draught, cold etc.

Ecological Variations



https://www.google.com/search?q=apanteles+flaviconchae&tbm=isch&ved=2ahUKEwjkg7Ob_czsAhUD8IUkHQs4BLsQ2-

C. Host determined variations

- Braconid wasp, *Apanteles flaviconchae* spin white cocoons if reared from blue green caterpillars of *Choliase philodice*
- Golden cocoons if reared from yellow green caterpillars of same species.

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Module# 46

Principles of Systematics

Ecological Variations

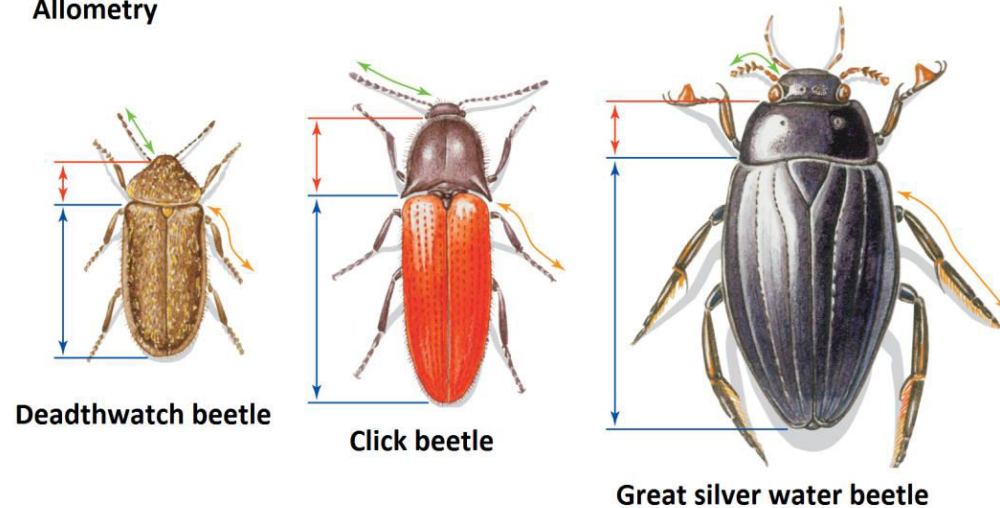
Ecological Variations

D. Density-Dependent variations

- When newly hatched nymphs of locust are reared under crowded conditions----Gregarious phase
- Less crowded condition---
Transitional phase
- Separate rearing---Solitary phase
- These phase differ in anatomy, colour and behavioral characteristics----distinct species

Ecological Variations

Allometry



<https://www.google.com/search?q=allometric+variations&tbm=isch&ved=2ahUKEwjirbyKg83sAhXC4YUKHRKVBOwQ2-cCegQIABAA&oq=allometric+variations&gs>

E. Allometric variation

- Allometry results in misappropriate size of some structure in relation to rest of the body.
- This results in animals of different sizes----Allometric variability

Ecological Variations



<https://www.google.com/search?q=chameleon&sxsrf=ALeKk03w9hngHVfxaApti0b4bszoZ9g->

F. Neurogenic variation

- It is colour change in response to environment.
- Chameleons have Chromatophores in three layers below their transparent skin.
- Xanthophores (Yellow) and erythrophores (red) in upper layer
- Iridophores or guanophores (blue or white) 2nd layer
- Melanophores (dark colour) in deep layer

Ecological Variations



F. Neurogenic variation

- Chameleons change their colours in response to temperature and to camouflage.

<https://www.google.com/search?q=chameleon&sxsrf=ALeKk03w9hngHVfxaApti0b4bszoZ9g->

Principles of Systematics

Module# 47

Principles of Systematics

Traumatic Variations

Traumatic Variations

- **Teratology** is the study of abnormalities of physical development.
- **Taratogen** are the toxic substances which cause abnormal development.
- Mercury, alcohol, lead, thalidomide
- Teratological variations are common in animals.

Traumatic Variations

- In those forms which undergo metamorphosis injury to an earlier stage may produce abnormalities which are not easily recognized.
- Important if abnormality is in characters of taxonomic importance.
- Modification in wing pattern

END

Principles of Systematics

Module# 48

Principles of Systematics

Post-Mortem Variations

Post-Mortem Variations



<https://www.google.com/search?q=twelve+wire+bird+of+paradise&sxsrf=ALeKk00Z6PMYPqESiQ3ZTFbrIC6T6hsR6Q:1603611950298&tbm=isch&source>

- It is impossible to prevent post-mortem changes in some animals.
- Deep yellow plumage of twelve wire bird of paradise----white

Post-Mortem Variations



<https://www.google.com/search?q=Chinese+jay+bird%2C+green&tbm=isch&ved=2ahUKEwiMgpaQocsAhUCYBoKHRVPDI0Q2->

- Chinese jay plumage changes from green to blue in collection
- Wasps over-expressed to cyanide turn bright red
- Insects
- Spiders

Principles of Systematics

Module# 49

Principles of Systematics

Genetic Variation

Genetic Variations

- Difference in the individual members of a population
- Genetic variations are important for survival and adaptation of species
- Evolution
- Natural selection

Causes of evolution

- Mutations
- Genetic recombination
- Genetic drift
- Migration

Genetic Variations

- Population s with small variation
- Population with large variability among individual
- Variability in characters
- Variability biological fitness

Major causes variability

- Mutations
- Genetic recombination
- Mutations are not always bad
(Sickle cell disease—present
Malaria) END

END

Principles of Systematics

Module# 50

Principles of Systematics

Types of Genetic Variation

Type of Genetic Variation

Sexual Dimorphism

Many of the variants in a population are sex-associated.

- They may be sex limited (express themselves in one sex only) or otherwise associated with one sex or the others
- Primary Sex differences (PSD)
Difference in primary sex organs such as gonads genitalia etc.)
- When two sexes are similar morphologically—PSD helpful

Type of Genetic Variation

Sexual Dimorphism

- Secondly Sex differences (SSD)
- Striking differences in male in females e.g bird of paradise, humming bird and ducks
- Due to differences different sexes were considered different species until painstaking works by naturalist established their relationship.
- Celebrated case of King parrot, *Eclectus roratus* (Muller)

Type of Genetic Variation



https://www.google.com/search?q=King+parrot+Eclectus+roratus+,+male+female&sxsrf=ALeKk02h0vVHJDTAOjHTEAE5PQB iERJ9_Q:1604040706059&source=lnms&tbm=isch&sa=X&ved=2ahUKEwirmfWj3dvsAhXBDGMBHZgZCBEQ_AUoAXoECBkQAw&biw=1360&bih=657#imgsrc=kLDkWlLeXUZ6cM

King parrot *Eclectus roratus* (Muller) of Papuan region

- Male is green with orange bill
- Female is red and blue with black bill.
- Described in 1776, two
considered different for nearly
100 years
- Until naturalist proved
conclusively in 1873 that they
belonged together.

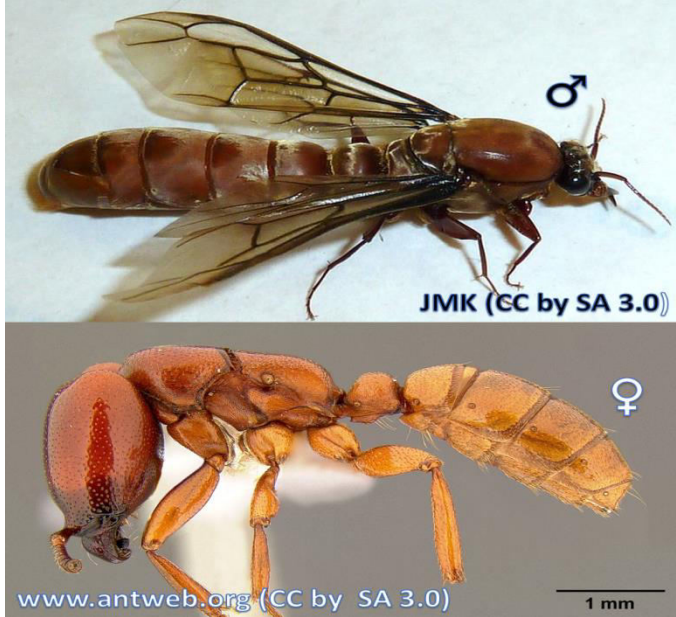
Principles of Systematics

Module# 51

Principles of Systematics

Types of Genetic Variation

Type of Genetic Variation



https://www.google.com/search?q=African+Ant+Dorylus+male+females&tbm=isch&ved=2ahUKEwiajc-y39vsAhUU_RoKHbZ2CW0Q2-cCegQIABAA&oq=African+Ant+Dorylus+male+females&gs_lcp=CgNpbWcQA1DywQFY1egBYJ_qAWgAcAB4AIAB_QOIAfQa kgELMC4xLjkuMi4wLjGYAQcGAAQgqAQtd3Mtd2l6LWltZ8AB AQ&sclient=img&ei=ObqbX9qMLpT6a7btpegG&bih=657&biw=1360#imgsrc=-C_HA25vlwfHRM&imgdii=kDy2tGctcC0wiM

Sexual Dimorphism

Striking sexual dimorphism in Hymenoptera.

- Males of African Ant *Dorylus* are so unlike others ants that they were not recognized as ants and considered belong to different family.
- In certain families of wasps small wingless females and large winged males are so different that some taxonomists use different nomenclature for both.

Type of Genetic Variation

Sexual Dimorphism

Some time males and females are so different that it is very difficult to decide which male belong to which female:

- Field study by ecologist
- Which male is attracted to which female

END

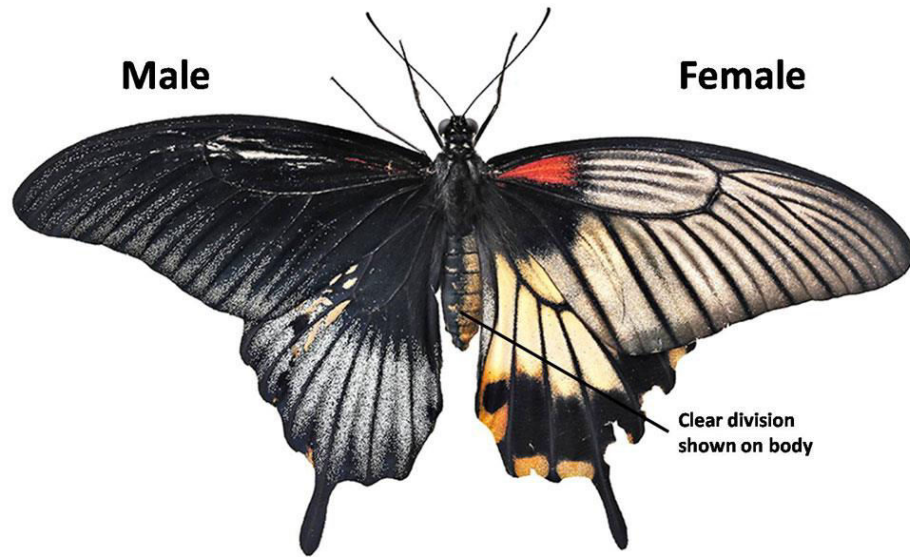
Principles of Systematics

Module# 52

Principles of Systematics

Types of Genetic Variation

Type of Genetic Variation



Great Mormon (*Papilio memnon*)

Gynandromorphs and intersexes

Individuals that show male characters in one part and female characters in other parts of body.

- Two halves of the body may be of opposite sexes.
- The division may be transverse or the sex characters may be scattered in mosaic.
- In later case symmetrical variants may be produced.
- Produced due to unequal distribution of chromosomes/SC

https://www.google.com/search?q=gynandromorph+of+papilio+adardanus&tbm=isch&ved=2ahUKEwiGuK-l5tvsAhWO0YUKHdbFCn4Q2-cCegQIABAA&oq=gynandromorph+of+papilio+adardanus&gs_lcp=CgNpbWcQAzoECAAQZoCCABQoa0BWImWAmC8mQJoAHAAeAGAAYYJiAGNPpIBEDAUmi4xMS4yLjAuMS4yLjKYAQCgAQGgAQtnD3Mtd2l6LWltZ8ABAQ&sclient=img&ei=dcGbX8apAY6jIwTWi6vwBw&bih=657&biw=1360#imgsrc=sCA1PSyDaBTaiM

Type of Genetic Variation



https://www.google.com/search?q=intersexes,+Example:+Lymantria&hl=en&sxsrf=ALeKk01diF3YZHp0xEbXUCJVibS92jJ0-w:1604043782080&source=lnms&tbm=isch&sa=X&ved=2ahUKEwi_udbe6NvsAhXiA2MBHQRuCRYQ_AUoAXoECAsQAw&biw=1360&bih=657#imgrc=_xPgprPy1k57CM&imgdii=Uia9hvBTpb27TM

Intersexes

Blending of male female characters.
body. Intersexes are produced due to:

- Upset in balance between male-tendency and female-tendency genes
- May result from irregularities in fertilization or mitosis
- Physiological disturbances associated with parasitism.
- Example: Gipsy moth, Lymantria

Principles of Systematics

Module# 53

Principles of Systematics

Types of Genetic Variation

Type of Genetic Variation



https://www.google.com/search?q=agemic+generation+gall+wasp&hl=en&sxsrf=ALeKk02oVJis8aalDyE2Y0wVwXJoadWcQ:1604054434479&source=lnms&tbn=isch&sa=X&ved=2ahUKEwiTu5G2kNzsAhXVh1wKHZ_ZBjoQ_AUoAXoECBkQAw&biw=1360&bih=657#imgrc=SO7OXhMqVG7A9M

Reproductively different generations

- In many insects there is an alternation of generations that is very confusing to the taxonomist.
- In cynips (gall wasp) agemic generation is different from bisexual one.
- In aphids parthenogenetic wingless females are different from winged females of sexual generation.

Type of Genetic Variation



https://www.google.com/search?q=Slugs,+Arion&hl=en&sxsrf=AleKk02zw1UrLr9HBnEK7giReGZMJt64pA:1604055019292&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiOuv_MktzsAhWjnVwKHTUaB1MQ_AUoAXoECCUQAw&biw=1360&bih=657#imgsrc=AKvOHe8xqdKJVM

Sexual and uniparental strains

- In some species of slugs (Arion) several strains are found which differ in their sexuality.
- Sexually reproducing strains are highly polymorphic in their enzymes
- While self fertilizing hermaphroditic strains are highly homozygous.

Type of Genetic Variation

Discontinuous variation (Polymorphism)

- Certain members of population have certain conspicuous characters.
- Such discontinuous individual variations is called polymorphism.
- Frequently controlled by single gene.
- Follow simple Mendelian inheritance.

Type of Genetic Variation



- Spotting in lady beetles
- Industrial melanism in moths
- Understanding of polymorphism is helpful to taxonomists.
- More than 100 birds species names were given to morphs.

https://www.google.com/search?q=laddy+beeles%2C+spotted&tbm=isch&ved=2ahUKEwi0gs_PktzsAhVRlxoKHdwxAYwQ2-

Principles of Systematics

Module# 54

Principles of Systematics

Types of Genetic Variation

Type of Genetic Variation

Continuous variations

- Most common type of individual variations is due to slight genetic differences among individuals.
- No two individuals (except monozygotic twins) in a population of sexually reproducing animals are exactly alike
- Morphologically or genetically
- Small difference/special techniques.

Type of Genetic Variation

Continuous variations

- Each characters may show a different degree of variability within a single population.
- Different degree of variability among related species.
- Why one species is highly variable while another is NOT?
- Answer this question required lot of background knowledge and research.

Type of Genetic Variation

Continuous variations

- Some early taxonomists vastly underrated individual variations in many genera of animals.
- Species of the snail genus *Melania* (fresh water and brackish water) have been described largely on the basis of shell characters as presence or absence of spines and diagonal versus spiral ribs.
- Revision showed 114 species were just because of individual variation.

Principles of Systematics

Module# 55

Principles of Systematics

Systematic Collection

Systematic Collection

Systematic collection

Systematic collection is a method of collecting valuable biological specimens and preserving them along with specimen documentations such as labels and notations. It possess various attributes:

- Raw material of classification
- Document earth's biodiversity
- Initially additional specimens of species—duplicates-exchange purpose

Systematic Collection

Systematic collection

- As there is variability in members of species
- Adequate sample of every population should be collected and preserved.

What is adequate?

- More material is needed in species with strong individual and geographical variation than in uniform species.

Systematic Collection

Objective of study?

Simple study or genetic variability

- When population analysis is attempted dealing with size, proportions, coloration, or polymorphism large samples from numerous locations are needed.
- For example in fishes where each population of a species may vary in some metric characters (fin ray, vertebrae), a single specimen per locality would tell us little.

Systematic Collection

- Facilitate the process of researching relationships among and within different groups of organisms biodiversity
- We can use systematics to find out how insects are related to the rest of the invertebrates.

Systematic Collection

Preservation of collection samples

The collected samples are preserved by;

- Wet method and
- Dry method

Systematic Collection

Wet method

- Wet method of preservation involves the use of liquid preservatives to prevent deterioration.
- Chemicals like alcohols, formalin etc. are commonly used for specimen preservation. Animals belonging to phylum porifera, annelida, nematoda are mostly preserved by wet method.

Systematic Collection

Dry method

- In this method, specimens are preserved in dry state is a traditional method to place several kinds of insects in a box for an indefinite period allowing them to become dry.
- Not advisable for soft bodied insects.
- The process of pinning insect specimens is a dry method to preserve and display collections.

END

Principles of Systematics

Module# 56

Principles of Systematics

Systematic Collection

Systematic Collection

Importance of systematic collection

- Safe storage of historical material such as fossils
- Rarely found specimens
- Specimens of geographically inaccessible areas
- Extinct species specimens to place in museums for documentation
- Provide permanent record of faunas and floras from natural catastrophes

Systematic Collection

Importance of systematic collection

- Help in the verification of original data or for renewed study from new knowledge and technique
- The systematic method assumes the size of the population is available
- Aid in identification of organisms through comparison
- Teaching/Public Outreach:
stimulate interest in earth's

Systematic Collection

- Facilitate the process of researching relationships among and within different groups of organisms biodiversity
- We can use systematics to find out how insects are related to the rest of the invertebrates.

END

Principles of Systematics

Module# 57

Principles of Systematics

Collection Methods

Collection Methods

Collection methods

There are various collection methods to collect specimens

- Black light trap
- Sweep net
- Suction device
- De-Vac
- Pit fall method
- Aspirator
- Beating sheet
- Trawling
- Dipper
- Hand picking

Collection Methods

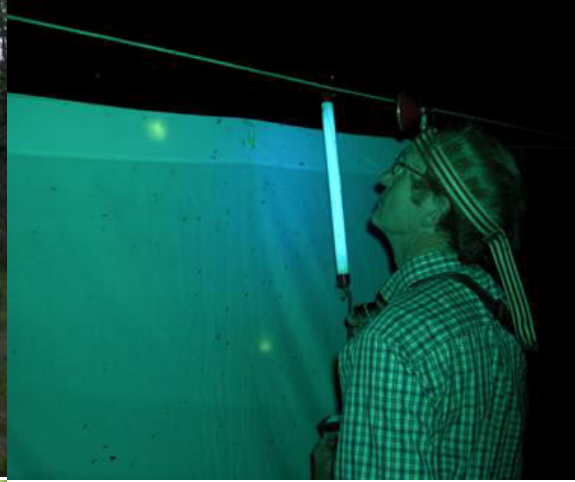


<http://mississippientomologicalmuseum.org.msstate.edu/images/traps/blacklight.sheet>.

Black light trap

- Entomologists often collect night flying insects using a black light and sheet.
- The black light is suspended in front of a white sheet.
- Insects attracted to ultraviolet light fly toward the light, and alight on the sheet.

Collection Methods



Black light trap

- **A:** Tying the rope between two trees
- **B:** Sheet and light are hung
- **C:** A quiet night of collecting



<https://mississippientomologicalmuseum.org.msstate.edu/collecting.preparation.methods/Blacklight.traps.htm>

Collection Methods



<https://ffs.ipm-info.org/wp-content/uploads/2015/05/Collecting-insects-with-a-sweep-net>.

Sweep Net

- Sweep nets are used to collect arthropods from long grass and other types of vegetation.
- This net is with round mouth and canvas bag fixed with a long rod.
- Its advantages lie in its simplicity and speed, and its ability to collect relatively dispersed insect species on top of the vegetation.
- It cannot be used on very short vegetation.

Collection Methods



Suction device/De-Vac

- Used for collection of arthropods from vegetation, long grasses, forest, orchards etc.
- Engine operated.
- Large scale insect collection.

https://www.google.com/search?q=suction+device+for+insect+collection%2F+devac&tbm=isch&ved=2ahUKEwikjtP_hN7sAhUKahoKHTraDt0Q2

Principles of Systematics

Module# 58

Principles of Systematics

Collection Methods

Collection Methods



https://upload.wikimedia.org/wikipedia/commons/b/b2/Barber_pitfall_trap

Pit Fall Method

- In this method, the insect falls into a pit, a container that is buried in the soil.
- The pitfall trap catches ground-dwelling insects.
- Glass jar is buried in soil with its rims at the level of ground.
- Filled with formalin/alcohol
- Detergent drops to break surface tension
- May be covered

Collection Methods

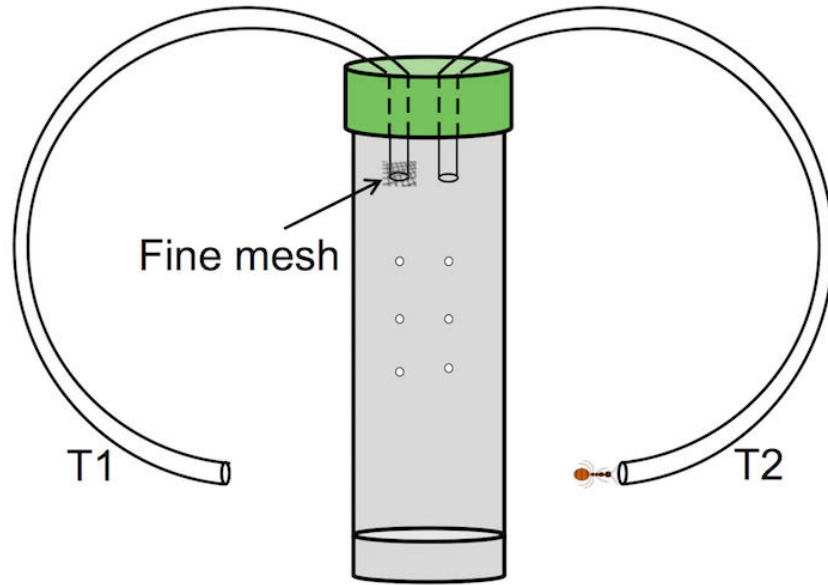


Aspirator

- Small insects or insects in hard to reach places, can be collected using an aspirator.
- The aspirator is a vial with two pieces of tubing, one with a fine screen material over it.
- By sucking on one tube, you draw the insect into the vial through the other.

<https://bioquipinc.com/wp-content/uploads/2017/05/%C3%92Pooter%C3%93-Style-Aspirator-4>

Collection Methods



Aspirator

- The screen/fine mesh prevents the insect or anything else unpleasant from getting drawn into your mouth.

<https://www.google.com/search?q=aspirator%2C+i nsect+colection&tbm=isch&ved=2ahUKEwiNwOKFi N7sAhUI7xoKHS47DLQQ2-cCegQIABAA#imgrc=7omrJPNCN0eAqM>

Principles of Systematics

Module# 59

Principles of Systematics

Collection Methods

Collection Methods



<http://www.nzffa.org.nz/images/design/beatingbig.jpg>

Beating Sheet

- To study insects that live on branches and leaves, like caterpillars, a beating sheet is a tool to use.
- Stretch a white or light-colored sheet below the tree branches. With a pole or stick, beat the branches above.
- Insects feeding on the foliage and twigs will fall down onto the sheet, where they can be collected.

Collection Methods



<https://bharatabharati.files.wordpress.com/2015/03/bottom-trawling.jpg?w=460&h=260>

Trawling

- Trawling is a method of fishing that involves pulling a fishing net through the water behind one or more boats.
- The boats that are used for trawling are called trawlers or draggers
- In Trawling baited fishing lines are drawn through the water.
- Trawling is commonly used as a scientific sampling, or survey method for marine specimens.

Collection Methods



<https://www.researchgate.net/profile/Richard-Nisbett/publication/265226839/figure/download/fig15/AS:669421387382787@1536613904116/Dipper-for-the-collection-of-mosquito-larvae-41.jpg>

Dipper

- The most commonly used larval collection method is the "standard dipper."
- Estimates of **larval** density can be carried out by counting the number of mosquito **larvae** per **dip**, using a standard 1-pint **dipper**.
- A minimum of three to five dips should be completed at each site.

E.g. collection of mosquito larvae

Principles of Systematics

Module# 60

Principles of Systematics

Curation of Collection

Curation of Collection

- A **curator** is a person who manages, administers or organizes a collection for exhibition.
- A museum curator is custodian of collection of museum and is responsible for their management.
- **Curation** is process of identification and organization animal collection.

Curation of Collection

- All types of museums have at least one curator.
- A large museum may employee several curators
- Each have specialization in particular fields.
- American Museum of Natural History (AMNH), New York
- Housing of collection in fire free buildings that are dust proof
- Air-conditioned Building

Curation of Collection

Cataloging

- Museum number
- Original field number
- Scientific Name (at least generic name)
- Exact locality
- Date of collection
- Name of Collector
- Remarks
- Card systems/electronic data processing
- Exchange of materials

END

Principles of Systematics

Module# 61

Principles of Systematics

Important Properties of Taxa Names

Important Properties of Texa Names

Three important properties

- Uniqueness
- Universality
- Stability

Important Properties of Texa Names

Uniqueness

- Names of an animal gives immediate access to all known information about that taxon.
- Every names has to be unique
- If several names---clear cut method should be there to determine valid name.
- Principle of priority usually decides in case of conflict.

Important Properties of Texa Names

Universality

- Scientific communication would be very difficult if there were only vernacular names for animals.
- Specialist would have to learn the name of texa in different languages in order to communicate with each other.
- Zoologist use single language

Important Properties of Texa Names

Stability

- A name should be stable
- Any change of a well-established name is likely to produce confusion and impede information retrieval.
- Even a principle of priority can be set aside by International Commission on Zoological Nomenclature in cases where stability is threatened.

END

Principles of Systematics

Module# 62

Principles of Systematics

Type Specimen

Type Specimen

- A type is a specimen (or a group of specimens) which serves to illustrate the defining characters of a species or genus.
- A type is a specimen serve as a reference which can be used by later scholars to verify the identity of species being described.

Type Specimen

- Precise collecting locality and other relevant data on the labels of specimen.
- Sex
- Developmental stage or form to which the type is referable
- In the case of parasites, the name of host species

Type Specimen

- Name of collector
- Specimens numbered
- Altitude of the type locality or depth in meters below sea level at which the holotype was taken
- In the case of fossils species, geological horizon

Type Specimen

- Type designation or fixation should always be completed before publication
- Type designation should be clear and unambiguous
- The deposition and museum number of the type always be recorded

END

Principles of Systematics

Module# 63

Principles of Systematics

Kinds of Type Specimen

Kind of Type Specimens

Holotype

- A single specimen designated or indicated as the type by the original author at the time of publication of the original description of a species”
- If no specimen designated or indicated as the type by the original author but it is clear that only one specimen was used for description then it will be considered as Holotype.

Kind of Type Specimens

Holotype

- For a species described after 1999, holotype must be designated.

Kind of Type Specimens

Paratype

- The specimen other than the holotype, which has been used in the description.

Kind of Type Specimens

Allotype

- A specimen of opposite sex as the holotype, which has been used in the description.
- Its is often used to describe a morphological character not shown in the Holotype

Principles of Systematics

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Kinds of Type Specimen

Kind of Type Specimens

Syntype

- When description is based on two or more specimens, no holotype was designated, every specimen in a type series will be syntype

Kind of Type Specimens

Lectotype/Paralectotype

Kind of Type Specimens

Neotype

- A specimen selected as a type subsequent to the original description in the cases where the original types are known to have been destroyed or suppressed by commission

Kind of Type Specimens

Isotype

- A specimen that is a duplicate of holotype or very similar to the type specimen collected at the same time but not from same place as holotypes, paratype or syntype and not included in any of these.
- Can be used as a reference specimen if the type specimen is lost.

Kind of Type Specimens

Monotype

- When holotype of the species is the only specimen known to science, it is known as monotype.

END

Principles of Systematics

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Principles of Systematics

Type Locality

Type Locality

- Place of collection of Holotype and lectotype.
- Paratype can be from different locality to holotype.
- Specimens collected at type locality are called **Topotypes.**
- Population that occur at type locality is called **Topotypical population.**

Type Locality

- In the case of parasites, the term type host is used to indicate the host organism from which the type specimen was obtained.
- Importance of type locality

END

Principles of Systematics

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Principles of Systematics

Type Locality