ISSN No:-2456-2165

Sampling Methodology to Study Terrestrial Arthropods Biodiversity

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Abstract:- For effective management and Judicial use of the earth's resources Knowledge of biodiversity is important. In the Animal Kingdom terrestrial arthropods are the most diverse groups, and important contributors to biodiversity. Insects and their relatives are critical components of terrestrial ecosystems and are often considered ecosystem engineers. Arthropods play crucial role in the evolution of biotic community and its maintenance. They act as pollinators of flowering plants, consumers and recyclers for decomposing organic materials, and they are the important part of food chains and food webs of vertebrates and invertebrates. They provide enormous ecosystem services. For the study of arthropod diversity statistically valid samples can be captured in short durations. The insects have been used as indicators of restoration success and ecosystem functionality because they respond to environmental change rapidly. A large number of methods are available for the collection and sampling of arthropods residing in different habitats. The efficiency and effectiveness of these methods varies as per location. This study deals with active and passive sampling methods and offers general guidelines for planning a study of arthropod biodiversity. it includes attention to long-term planning as per the choice of taxonomic groups, and the sampling resources required for sorting and identification. A general index must include, at a minimum, Malaise, flight-intercept and pan traps, aerial netting, aspirators as well as behavioural extractors such as Berlese funnels.

Keywords:- *Biodiversity, Arthropod, Sampling, Malaise, Traps.*

I. INTRODUCTION

Phylum arthropod includes most successfully adapted group of organisms found almost in every kind of habitat and comprising of insects, spiders, mites and their relatives. Insects alone constitute 55% of all animal species studied till date (Barrowclough 1992). Most of the arthropods are easy to observe in their natural habitats as they are comparatively larger in size. The species which are smaller in size and also that are exceptionally difficult to sample need to be preserved and must be kept in perfect condition for their correct identification. In the field microscope or hand lens can be used to study minute anatomical details of collected specimens. Proper knowledge about arthropods could serve to better understand economic and applied importance of these organisms. The scientific name of an organism provides all known information about its life history, morphology, behavior and its potential threat or usefulness to human welfare. The ecosystem services provided by the arthropods help to increase ecosystem productiveness and sustainability by increasing the yield of required crops. It also reduces the dependence on weedicides, pesticides and other harmful chemicals. Substitute farming practices may pose unfavorable effects on some economically important arthropods. For the study of arthropod diversity and their potential use the collection, sampling and identification is of uttermost importance. According to Schauff ME (2001) collection of specific taxon for a specific purpose always requires a particular protocol which should be followed. A combination of direct and indirect methods can be used for the sampling of insects and their relatives. The direct methods utilize spotting as the main data whereas indirect method depends on assessment of indirect evidences of marks in a pre- established sampling unit. Collection and sampling methods for the study of arthropods are diverse as being a vast phylum (Ghosh and Sengupta 1982). New Tools and techniques are still being needed to be developed. The paper covers the common collection techniques and methods for various groups of arthropods and also specifies some tips and hints for accuracy. The two basic elements of any collection event are the sample and the data which includes relevant information concerning the sample. Both these elements are equally important. Diverse variety of traps and nets are in common use for the collection of different insect as per their habits and habitat.

II. COLLECTION

- *Depending upon taxon of interest to be studied for desired observations sampling tools and techniques varies. Arthropods Collection can be categorized as:*

- *General Collection:*
  In case of general collection all the samples are of equal interest. There is no specific target species.

- *Targeted Collection:*
  In this case a species specific target is set for sampling.

- *Casual Collection:*
  Casual collection is done in a particular area of interest to document the presence or identify the arthropod species.

- *Formal Collection:*
  Specimens are collected as per the specific protocol designed for required outcomes. Here the collection of specimens is intentional.

- *Qualitative Collection:*

Here the population size is not taken in to consideration, only the presence or absence of a particular species or group is considered.

- *Quantitative Collection:*

One or many of the parameters of the collection is held constant, such as area, time, season, etc. The collected samples can be compared among one another.

III. EQUIPMENTS FOR ARTHROPODS COLLECTION

Different types of equipment and methodology are adopted for the collection of arthropods as per their habits and habitat. Equipment includes:

➢ *Nets*

The nets used to collect insects and arthropods are basically of three types - Sweep nets, Aerial nets, and Aquatic nets. Each net is designed specifically in accordance with the environment from where the samples are to be collected. A net consist of three parts, the handle, the hoop, and the bag.

- *Aerial Nets:*

Aerial nets are used for the collection and sampling of flying insects such as dragonflies, mayflies, true flies, butterflies, bees, wasps and moths. Aerial nets are built light, with long thin handles, flexible hoops and a soft bag with a large mesh size. These are best suited for collecting delicate specimens, such as mayflies or butterflies. Specimens collected in aerial nets are taken from the net with the hands or directly transferred to a killing jar. The shape and size of aerial net can be adjusted as per the user's demands, desired sampling, and the availability of material. Insects and mites can be trapped by sweeping the net along the sand, through the vegetation, seaweeds or tree trunks. After sweeping a swing with force collects the samples in the bottom of the bag which can be secured (Dresner 1970, Rogers & Smith 1977, Noyes 1982). Nets can be used for specialized collection. These nets can be fixed on vehicles. (Peck and Cook 1992).

- *Sweep Nets (Beat Nets):*

These are used to sample insects from vegetation by sweeping. The traps have short handle and inflexible loop. The collection bag is made with light canvas cloth having small mesh. These are very strong. The specimens collected in the sweep net using are picked with an aspirator and treated as per the objectives of study.

- *Aquatic Nets:*

These are used for the collection of samples from aquatic environments which ranges from lakes, rivers, ponds, streams and abandoned tires, tree holes and puddles, etc. The aquatic nets have long handle and wide hoops. Aquatic samples are best sorted using a white pan**.**

➢ *Traps*

A trap is a device designed to catch or restrain insects. In a trap lures, baits, or other attractants can be used (Martin 1977, Peterson 1964, Southwood 1979).

- *Light Traps:*

Light traps are commonly used tools for collecting insects, especially nocturnal ones that are attracted to light sources. These traps are used by entomologists, researchers, and insect lovers to study insect populations and biodiversity. There are various types of light traps designed to attract and capture insects. Types of light traps are:

- *Incandescent Light Traps:*

These traps use traditional incandescent bulbs as a light source. Insects are attracted to the warm, visible light produced by these bulbs. Once they approach the light, they are captured using a variety of methods, such as funnel traps, nets, or sticky surfaces.

- *Ultraviolet (UV) Light Traps:*

These traps use ultraviolet light sources to attract insects. Many insects are highly sensitive to UV light, which is outside the range of human vision. When insects are drawn to the UV light source, they are funneled into a collection container. Mercury vapor lamps and black light fluorescent tubes are often used as UV light sources.

- *LED Light Traps:*

LED lights have high energy efficiency and adjustable wavelengths. Collector can use LEDs that emit specific wavelengths to target particular groups of insects. LED light traps easy to handle.

- *Blacklight Traps:*

Blacklight traps use special fluorescent tubes that emit ultraviolet or near-ultraviolet light. These traps are useful for attracting a wide range of insects, including moths, beetles, and flies. The insects can be collected in a variety of ways, such as falling into a collection container or being directed into a net.

- *Mercury Vapor Light Traps:*

These traps use high-intensity mercury vapor lamps to attract insects from a long distance. They are effective for attracting large numbers of moths, beetles, and other night-flying insects.

- *Pitfall Traps with Light Attraction:*

Pitfall traps can be combined with light sources to capture ground-dwelling and nocturnal insects. The light attracts insects to the trap, where they fall into a container buried in the ground.

When setting up a light trap for insect collection, it's essential to consider the specific objectives of the study, the targeted species, and the environmental conditions. Traps should be checked regularly and additional methods may be used to preserve captured specimens.

- *Light sheet Trap:*

Light sheet traps, also called as light traps or moth traps and are commonly used for the collection of nocturnal species like moths and other flying insects. These traps take advantage of insects' natural attraction to light sources and provide a means to capture and study them.

➢ *Components of A Light Sheet Trap:*

- *Light Source:*

A bright light source is placed within the trap. Commonly, UV, white, or black light bulbs are used, as they are attract wide range of insects.

- *Reflective Surface:*

The interior of the trap is typically lined with a reflective material like aluminum foil or white paint. This helps to maximize the visibility of the light source from various angles.

- *Funnel or Barrier:*

To guide insects towards the light source, a funnel or barrier is often used. It can be a simple funnel-shaped cone or a more complex design that funnels insects towards the collection area.

- *Collection Container:*

Below the light source, there is a collection container. Insects attracted to the light source fall into this container and are trapped. Insects present on light sheets can be easily collected with the help of aspirators. Diverse types of arthropods tend to come to the trap at different times during night.

- *Intercept Traps:*

These are also known as barrier traps or passive traps. (Merritt RW et al. 2008). Intercept traps are used to capture and collect flying and non-flying (dwelling on the ground) insects for research or monitoring purposes. These traps are designed to intercept insects as they move through their natural habitats. The intercept traps are designed as per the purpose of study including biodiversity research, pest monitoring, and studying insect behavior. Different Types of Intercept Traps are:

- *Pitfall Traps:*

These traps consist of containers buried in the ground with their rims level with the surface. Insects walking or crawling on the ground fall into the container and can be collected later. Pitfall Traps are being used for epigeic arthropods (Hoeckman D et al. 2017). Pitfall traps for collection and computing epigeic arthropods are used since 1900s (Barber HS 1931, Fichter E 1941). There are many changes in the basic design, a funnel is fixed to prevent the escape of collection, a cover used to obstruct rain and detritus from falling in to the trap, baits may be used and drift fences and barriers increase the captures. (Hansen JE 2005, Ng K et al. 2018). Dry pitfall traps are used to collect live specimens; here predatory species is often a problem (Greenslade and Greenslade 1971). To kill or keep up the collected specimens the trap is partially filled with a preservative. Water, ethylene glycol, brine, formalin, propylene glycol, alcohol, kerosene, acetic acid and chloral hydrate can be used as preservatives (Woodcock BA 2005). The activity level and abundance determines the numbers of captures (Maelfrat and Beart 1975). The samples are described in terms of “activity-abundance” or “activity-density” (Thiele H 1977). The best design of pitfall trap is “double cup design”. A hole is dug and two cups are put in the hole and soil is fixed around it up to inner cup lip level. The inner cup can be removed and emptied mean while outer cup stops the soil from falling back. To keep out debris, water and curious mammals a lifted up cover is placed over it.

- *Flight Intercept Traps:*

These are set up to intercept flying insects, such as moths and beetles. They often consist of vertical or slanted sheets or funnels that guide insects into a collecting container.

- *Malaise Traps: Malaise Traps:*

Malaise traps are used for passive insect collection. They consist of a tent-like structure made with mesh fabric with a barrier that directs insects upward into a collection container. These traps are often placed in areas where insects are likely to fly into them, and they are especially designed for capturing flying insects. They are effective for a wide variety of insects (Malaise R 1937). Most commonly used design of malaise trap is the Townes-style Malaise trap with white roof and black base (Townes HA 1972, Mathews 1983). Malaise traps have been used in a variety of environments to collect various arthropod groups (Geroff et al. 2014, Mathews and Mathews 1971, Noyes et al.1989, Bartholomew and Prowel 1905, Ngo et al. 2013, Mc Cravy et al. 2016).

- *Window Traps:*

These traps use windows or clear surfaces with a light source to attract insects, especially at night. Insects are attracted by the light and can be collected from a collection chamber.

- *Yellow Pan Traps:*

These traps use a yellow-colored container filled with soapy water. The yellow color attracts many flying insects, and they drown in the soap water.

- *Sticky Traps:*

These traps have adhesive surfaces that insects get stuck to when they come in its contact. They are often used in greenhouses or gardens to monitor or control pest populations.

- *Baited Traps:*

These traps use attractants or baits to lure insects into them. The bait can be pheromones, food, or other substances that specific insects are attracted to. The baits can be selected as per general or targeted insect’s collection. These traps can be made at home although also available in the market. The place for bait and killing and preserving agent

are two main components of this trap. Attractants such as colors or pheromones can be built in the structure of the trap, while dung, fruit, carrion, etc. are placed in a cup or compartment.

Killing agent or preservative are filled in the Collection chamber. Soap water can be used as surfactant or as killing agent. Propylene glycol (Chu HF 1949) based antifreeze (Dindal DL 1990) or pure propylene glycol can also be used as both killing and preserving agent. These traps are essential tools for arthropod collection.

The three most common traps used for the collection of bees are **vane traps, bowl traps, and Malaise traps.** Bowl traps are sometimes mentioned as "bee bowls", "Moericke traps", or "pan traps". Two common collection methods for ground dwelling arthropods are homemade Berlese–Tullgren funnels and Barber trap or pitfall trap.

➢ *Hand-Picking Method*

Insects like bugs, beetles and grasshoppers which are large enough can be collected by hand picking and placed in containers. It is a time consuming method. Some harmful insects that stings or inflict throbbing bites are difficult to collect by this method.

➢ *Other Methods:*

Other sampling methods available to study the arthropods density includes suction samplers, emergence traps, microhabitat removal and arthropod extraction and soil flooding.

- *Suction Samplers:*

The core component of a suction sampler is a pump system that generates suction or vacuum pressure. This pump can be powered by electricity, battery, or manual operation, depending on the specific model. An activated pump creates a vacuum inside the system. Water, along with suspended particles or organisms, is drawn through the inlet tube and into the collection container. These are widely used for the collection of samples from vegetation, and epigeic arthropods. The most commonly used suction sampler is the "D-vac" (Dietrick vacuum) insect net (Dietrick EJ 1961, Sunderland et al. 1995). These can be used to measure arthropod density (Topping and Sunderland 1992). The sampling within sealed enclosures is required so as to avoid entry of specimens from outside the measured sampling area (Toft et al. 1995). Suction sampler are mainly used in sampling of grassland and agro ecosystem invertebrates, including alfalfa (Pruess et al. 1977), cereals (Dewar et al. 1982, Hand SC 1986) and wheat (Elliott et al. 2006).

- *Emergence Traps:*

These traps are commonly called as photoeclectors or eclectors, if it utilizes positive phototaxis of emerging organisms (Sunderland et al. 1995). Emergence traps are used to measure population density from a specific location. Emergence trap may include a pitfall trap within it for the collection of invertebrates moving on the ground.

- *Cryptozoan Boards:*

Also mentioned as "drop boards" are used for sampling cryptozoans that hide underneath stones and shelter under logs (Southwood TRE 1978, Brower et al.1998). These are made up of wood and are kept on the ground. While collecting samples, to avoid undesirable specimens boundaries of the board are marked. An aspirator is used for sucking up the specimens (Brower et al.1998). An enclosure can be placed around the board and its edges are buried in the soil. The specimens can be sampled at collection site, or can be collected and sorted later in the lab.

IV. SIFTERS

➢ *A sifter is a sieve like tool used to separate insects from the substrate in which they exist such as leaf litter, soil, or debris. It helps to separate the insects, some common types of sifters used for sampling are:*

- *Standard Sieve:*

Standard sieves are often used in insect collection. These are similar to the sieves used in cooking or construction but are typically smaller and have finer mesh sizes. They come in various mesh sizes to suit different types of substrates and the size of the insects being collected.

- *Berlese Funnel:*

It is a specialized device used for extracting insects from leaf litter and soil samples. It consists of a funnel attached to a light source (often an incandescent bulb) placed above a container filled with alcohol or a preservative. The heat from the light source drives the insects away from it and they fall into the alcohol at the bottom.

- *Shaker Sieve:*

A shaker sieve is designed to be shaken manually or mechanically to sift insects from the substrate. It usually consists of a mesh container that holds the substrate and a handle or mechanism for shaking it. This method is efficient for large-scale insect collection.

- *Miniature Vacuum Cleaner:*

Miniature vacuum cleaners with adjustable suction are used to collect insects from plants or substrate. Insects are collected in a chamber which can be transferred to a vial or container later.

- *Pooter:*

A Pooter, also known as an aspirator, is a hand held suction device used to gently collect small insects. It consists of two tubes connected by a mouthpiece and a bulb. One tube is placed near the insect, and through other suction is done. It is simple and effective device for collecting microscopic arthropods such as insects and mites (Azrang1976, Barnard & Mulla 1977). At the end of the suction tube filter is attached to avoid inhalation of dirt and debris.

ISSN No:-2456-2165

- *Beat Sheets:*

Beat sheets are used to collect insects from vegetation. It typically consists of a large white sheet or cloth that is placed under a plant or tree, and then the vegetation is "beaten" with a stick or other object to dislodge insects onto the sheet. Then insects are collected and preserved.

- *Collection Kit:*

It is a kind of tool kit designed to collect, preserve and study the insects. Some common items which must be present in insect collection kit are insect net, insect pinning kit, Killing jar, vials and containers, field notebook, labels, markers, magnifying glass, entomological forceps, insect containers, spreading boards, field guides for identification, safety gears as gloves, protective clothing and insect repellents etc. and camera for capturing insects in their natural habitat and for future reference. Collection Kit should consist of everything collector needs to have a successful sample collection.

It's important to note that collecting insects should be done ethically and in accordance with local regulations. Some insects may be protected, and collecting permits might be required in certain areas. Additionally, best practices for collecting and preserving insects should be followed to maintain the integrity of the specimens for scientific study.

V. CONCLUSION

Knowledge and understanding about arthropods could serve to better understand economic and applied importance of these organisms. For authentic sampling and monitoring of desired arthropods reliable tools and techniques are of utmost importance to evaluate the effects of environmental disturbances and effectiveness of conservation strategies and efforts. The insects and their relatives can be sampled by using a combination of direct and indirect methods. Before choosing a suitable sampling method it is important to consider the specific research objectives of the study, the targeted species, and the environmental conditions. Ethical guidelines should be followed for insect collection. Priority should be given to conservation and minimum disturbance to the ecosystem. The basic equipments for general arthropod collection should be simple and economical. Collection net and killing bottles are prelims for field collection. Additional tools must be selected as per sampling of desired fauna. The collector can carry additional handbag or wear a vest to store the collected specimens. (Arnett, 1985, Banks et al. 1981, Bland & Jacques 1978, Upton 1991). Different tools may be more suitable for different situations, so it is important to select the one most suitable that meets specific research goals. The collected arthropod samples must be handled with care to avoid damage especially when it is planned to preserve them for further study.

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