Environmental Entomology (Ent-703) Credit Hours 2(2-0)

Lecture # 4 Delivered by Dr.Hassan Yasoob

Topic- Interactions of Various groups of Insects with Biological, Chemical and Physical Constituents of the Environment

Many insects are considered to be pests by humans. However, insects are also very important for numerous reasons.

Insects can be found in every environment on Earth. While a select few insects, such as the Arctic Wooly Bear Moth, live in the harsh Arctic climate, the majority of insects are found in the warm and moist tropics. Insects have adapted to a broad range of habitats, successfully finding their own niche, because they will eat almost any substance that has nutritional value.

Insects are crucial components of many ecosystems, where they perform many important functions. They aerate the soil, **pollinate** blossoms, and control insect and plant pests. Many insects, especially beetles, are scavengers, feeding on dead animals and fallen trees, thereby recycling nutrients back into the soil. As **decomposers**, insects help create top soil, the nutrient-rich layer of soil that helps plants grow. Burrowing bugs, such as ants and beetles, dig tunnels that provide channels for water, benefiting plants. Bees, wasps, butterflies, and ants **pollinate** flowering plants. Gardeners love the big-eyed bug and praying mantis because they control the size of certain insect populations, such as aphids and caterpillars, which feed on new plant growth. Finally, all insects fertilize the soil with the nutrients from their droppings.

Insects as Food

Insects, of course, are not just eaten by people. Insects are the sole food source for many amphibians, reptiles, birds, and mammals, making their roles in food chains and food webs extremely important. It is possible that food webs could collapse if insect populations decline.

In some parts of the world, insects are used for food by humans. Insects are a rich source of protein, vitamins, and minerals, and are prized as delicacies in many third-world countries. In fact, it is difficult to find an insect that is not eaten in one form or another by people. Among the most popular are cicadas, locusts, mantises, grubs, caterpillars, crickets, ants, and wasps. Many people support this idea to provide a source of protein in human nutrition. From South America to Japan, people eat roasted insects, like grasshoppers or beetles.

Insects in Medicine Insects have also been used in medicine. In the past, fly larvae (**maggots**) were used to treat wounds to prevent or stop gangrene. Gangrene is caused by infection of dead

flesh. Maggots only eat dead flesh, so when they are placed on the dead flesh of humans, they actually clean the wound and can prevent infection. Some hospitals still use this type of treatment.

Summary

- In the environment, some insects pollinate flowering plants.
- Insects produce useful substances, such as honey, wax, lacquer, and silk.
- Insects are food sources in some parts of the world.

Review

1. Where are the majority of insects found?
2. Name two ways in which insects are important to the ecosystem.
3. Give three examples of insects that act as pollinators.
4. List three products produced by insects.
5. Give an example of how insects are used in medicine?

Factors influencing on Insects Population Growth

a) Biotic factors or density dependent factors.

b) Abiotic factors or density independent factors.

(a)Biotic factors

1) Competition :

For at least part of the lifetime the members of an insect species are likely to be competing with one another or with members of another species for limited resources like food, mates, suitable site for oviposition or pupation. Such competition operates whenever the population is increasing and the resources are limited.

a) Intraspecific competition:

When members of population of the same species compete for resources we call it intraspecific competition. Examples are as follows

- Cannibalism in American bollworm larvae
- Cannibalism in later stage grubs of Chrysopid
- Crowding in aphids result in alate (winged) form for migration
- Reduction in fecundity (egg laying) in rice weevil, *Sitophilus oryzae* during overcrowding
- Crowding in honeybees leads to swarming

b) Interspecific competition.

This is the competition occurring between members of two or more species. Two or more competing species with identical requirements cannot coexist in a same place for a long time. The elimination of one species by another as a result of interspecific competition has come to be known as the **competitive exclusion principle or Gause's principle**.

- For example when flour beetles *Tribolium castaneum* and *Tribolium confusum* were grown in the same jar of flour, one species eliminates the other. Under high temperature and RH conditions T. castaneum eliminates T.confusum and vice versa under low temperature and RH conditions.
- Accidental introduction of oriental fruit fly *Dacus dorsalis* into Hawai eliminated Mediterranean fruit fly *Ceratitis capitata.*

2) Predators and Parasites

Predators : Predators are free living organisms that feed on other animals, their prey, devouring them completely and rapidly.

- Predators may attack immatures and adults.
- More than one individual of prey required for predator to reach maturity
- Major insect predators are birds, fish, amphibians, reptiles, mammals and arthropods

Parasites: An organism that is dependent for some essential metabolic factor on another throughout its all life stages, which is always larger than itself

- A parasite weakens or kills the host while feeding
- Many parasites on asingle host
- Requires only one part of one host to reach maturity

Eg. Virus, fungi, bacteria, protozoa, nematodes and other arthropods.

Parasitoid: An insect parasite of an arthropod that is parasitic in its immature stage

killing the host in the process of development and adults are free living.
Interactions between predator and prey are different from the parasite host relationship in that the predator and prey maintain equilibrium more dynamically than the parasite and its host.
The parasites I n general when the rate of parasitism is high, cause death and result in elimination of hosts. But the predator never eliminates the prey completely.

Abiotic factors on insect population

(1)Physical factors (2) Nutritional factors (3) Host associated factors

(1)Physical factors

- Temperature, light, wind, soil conditions influence development, longevity, reproduction and fecundity of insects
- Population density fluctuates depending on weather
- Extreme weather causes mortality of pests

Temperature

- Insects are poikilothermic - do not have mechanism to regulate body temperature
- Body temperature depends on environmental conditions

Preferred or Optimum temperature is the temperature at which normal physiological activities take place - insects survive at this temperature.
w Upper lethal limit - 40-50oC (even upto 60oC survival in some stored product insects)
Lower lethal limit - Below freezing point e.g. snow fleas
The total heat required for completion of physiological processes in life - history is a constant - thermal constant.
At low temperature (winter) insect takes more days to complete a stage (larval or pupal stage)
At high temperature (summer) it takes less than to complete a stage.
Some insects when exposed to extremes of temperature
Undergo - Aestivation (during summer) or Hibernation (during winter)
During this period, there is a temporary developmental arrest, metabolic activities suspended. When temperature is favourable, they resume activity.
Eggs undergo aestivation in summer
Larva, pupa commonly undergo hibernation in winter

Influence of temperature on fecundity (egg laying)

Grasshopper lays 20-30 times more eggs at 32oC compared to 22oC
Oviposition of bed bug inhibited at 8-10oC
Other effects of temperature

- **Early shoot borer of sugarcane attacks more high temp.**
- Larval period of sugarcane internode borer
very short 16-24 days in summer
prolonged 141-171 days in winter
- Swarm migration of locust occurs at 17-20oC

MOISTURE/HUMIDITY
- Moisture required for metabolic reactions and transportation of salts in insects
- War layer of cuticle prevents water loss
- Other adaptations - Morphological, physiological prevent moisture loss in insects
- Moisture scarcity leads to dehydration and death of insects - but very rare
- Excessive moisture can be harmful in following ways
i. Affects normal development and activity of insects
ii. Encourages disease causing pathogens on insects
Examples
- White halo fungus *Verticillium lecanii* on coffee green scale *Coccus viridis*
requires high RH for multiplication and spread
- High RH induces BPH in rice and aphids in other crops
- Termites prefer high humidity 90-95% RH
- Low RH in rainfed groundnut crop induces leaf mines incidence

Light

The following properties of light influence insect life
i. Intensity and illumination
ii. Quality or wavelength
iii. Duration or Photo period

Photoperiodism

The response of organisms to environmental rhythms of light and darkness

Photo period

Each daily cycle inclusive of a period of illumination followed by a period of darkness
- Photo period influences induction of diapause (a resting stage) in most of the insects e.g. Long day during embryonic development causes adult to lay diapausing eggs in *Bombyx mori*.
- Seasonal dimorphism occurs in aphids due to change in photo period
- Short day - Sexual forms
- Long day - Asexual - Parthenogenetic forms
- Some insects are active in night - Nocturnal
Some are active during the day - diurnal
Some active during dawn and dusk - Crepuscular
- Fruit flies lays eggs in dark
- Lepidopterans like cotton bollworm, Red hairy caterpillar (RHC) oviposit in **dark**

Rainfall

- Rainfall is essential for adult emergence of cutworms and RHC
- Heavy rain washes aphids, diamond back moth (DBM)

Intermittent low rain increases BPH and thrips

Wind

- Interferes with feeding, mating, oviposition
- Wind aids in dispersal of insects
- Aphids, mites (Eriophyid mites also) disperse through wind
- Helicoverpa flies upto 90 km with the aid of winds

Topgraphy

Mountains, lakes, sea, etc. act as physical barrier for spread of insects

Soil Type

Wire worm, multiplies in clay soil with poor drainage

White grubs and cut worm - multiply in loose soil with good drainage

Water Current

Standing water aids in multiplication of mosquitoes

Running water is preferred by Odonata and Caddis flies

(2)NUTRITIONAL FACTORS

Insects heterotrophic - cannot synthesize their own food

- depend on plants for food

The quantity and quality of food/nutrition plays important role in survival, longevity, distribution, reproduction and speed of development

a. Quantity of food

- Short supply of food causes intranspecific and interspecific competition
- Also affects parasitoids and predators of insects hosts whose food is of short supply

b. Quality of food

- This depends on nutritional availability of plants
- Crop varieties/species differ in nutritional status which affects insects

(3)Host plant associated factors

Antixenosis or non preference

Host plant **not preferred** by insects for feeding, oviposition or shelter due to morphological characters like thorns, wax, hairyness, etc. or done to presence of some chemicals (called allelochemicals)

Antibiosis

This refers to adverse effect of the host plant on biology (survival, dept, reprdn.) of insects and their progeny due to

- Presence of toxic substance in plant
- Absence of essential substances
- Presence of enzymes which affect digestion of insects

Example

DIMBOA in corn leaves affects European corn borer *Ostrinia nubilalis*

Gossypol in cotton affects *H. armigera* and *S. litura*

Tolerance

Ability of host plant to withstand insect population sufficient to damage susceptible plants

- No adverse effect on insect infestation
- Tolerance by plant vigour, regrowth of damaged tissues, etc.