BIOLOGICAL CONTROL
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successful management of a pest (including insects, mites, weeds and plant diseases) by means of another living organism (parasitoids, predators and pathogens) that is encouraged and disseminated by man is called biological control.

Biological control is a bioeffector-method of controlling pests (including insects, mites, weeds and plant diseases) using other living organisms. It relies on predation, parasitism, herbivory, or other natural mechanisms, but typically also involves an active human management role.
Techniques in biological control:

1. Introduction or classical biological control:
   • Deliberate introduction and establishment of natural enemies to a new locality where they did not occur/originate
   • If successfully established, they continue to control the pest population

2. Augmentation:
   • Rearing and releasing of natural enemies to supplement the numbers of naturally occurring natural enemies
   • There are two approaches to augmentation
     a. Inoculative releases:
        • Large number of natural enemies are released only once during the season
        • Expected to reproduce and increase its population for that growing season
        • Control is expected from the progeny and subsequent generations
     b. Inundative releases:
        • Mass multiplication and periodic release of natural enemies when pest populations approach damaging levels
        • Natural enemies are not expected to reproduce and increase in numbers
        • Control is achieved through the released individuals
        • Additional releases are only made when pest populations approach damaging levels
3. Conservation:

- To protect natural enemies that are already present in an area
- Actions to preserve and release of natural enemies by environmental manipulations or alter production practices
- Non use of those pest control measures that destroy natural enemies

Important conservation measures are:

- Use selective insecticide which is safe to natural enemies.
- Avoidance of cultural practices which are harmful to natural enemies and use favorable cultural practices
- Cultivation of varieties that favor colonization of natural enemies
- Providing alternate hosts for natural enemies.
- Preservation of inactive stages of natural enemies.
- Provide pollen and nectar for adult natural enemies
Parasite:

- An organism which is **usually much smaller than its host** and a single individual usually **doesn’t kill the host**
- Parasite may complete their entire life cycle (eg. Lice) or may involve several host species
- Which attaches itself to the body of the other living organism either externally or internally and gets nourishment and shelter at least for a shorter period if not for the entire life cycle
- The organism, which is attacked by the parasites, is called hosts

**Parasitism:** Is the phenomena of obtaining nourishment at the expense of the host to which the parasite is attached

**Parasitoid:** An insect parasite of an arthropod, parasitic **only in immature stages, destroys its host** in the process of development and **free living as an adult**

Eg: Braconid wasps
Qualities of a Successful Parasitoid in Biological Control Programme

1. Should be **adaptable** to environmental conditions in the new locality.
2. Should be able **to survive** in all habitats of the host.
3. Should be **specific** to a particular sp. of host or at least a narrowly limited range of hosts.
4. Should be able to **multiply faster** than the host.
5. Should be having **more fecundity**.
6. Life cycle must be **shorter than** that of the host.
7. Should have **high sex ratio**.
8. Should have **good searching capacity** for host.
9. Should be **amendable for mass multiplication** in the labs.
10. Should **bring down host population** within 3 years.
11. There should be **quick dispersal** of the parasitoid in the locality.
12. It should be **free from hyperparasitoids**.
Some successful examples

**Control of cottony cushion scale**, *Icerya purchasi* on fruit trees –
- predatory vedalia beetle, *Rodolia cardinalis* in Nilgiris
- imported from California in 1929 and from Egypt in 1930
- multiplied in the laboratory and Released
- Within one year the pest was effectively checked

**Suppression of Water Fern, *Salvinia molesta***, the weevil, *Cyrtobagous salviniae*,
- imported from Australia in 1982
- on water fern, *S. molesta* in a lily pond in Bangalore in 1983-84
- Within 11 months in the lily pond the salvinia plants collapsed

**Biological Control of Water Hyacinth, *Eichhornia crassipes***
- by three exotic natural enemies were introduced in India
- hydrophilic weevils – *Neochetina bruchi* and *N. eichhorniae* (Argentina)
- galumnid mite *Orthogalumna terebrantis* (South America)
- in 1982 for the biological suppression of water hyacinth
• Apple woolly aphis, *Eriosoma lanigerum* in Coonor area by *Aphelinus mali* (parasitoid)

• Control of shoot borers of sugarcane, cotton bollworms, stem borers of paddy and sorghum with the egg parasitoid, *Trichogramma australicum* 50,000/ha/week for 4-5 weeks from one month after planting

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Centrococcus isolitus on brinjal; Pulvinaria psidi on guava and sapota; Meconellicoccus hirsutus on grape and Pseudococcus carymbatus on citrus suppressed by *Cryptolaemus montrouzieri*
Parasites can be grouped as furnished below

I. Depending upon the **nature of host**,  

1. Zoophagous - that attack animals (cattle pests)  
2. Phytophagous - that attack plants (crop pests)  
3. Entomophagous - that attack insects (parasites)  
4. Entomophagous insects - parasitoids  

II. Based on the specialization of the **site of parasitisation**  

1. **Ectoparasites**: Attack its host from the outside of the body  
   - Mother parasite lays its eggs on the body of the host  
   - Eggs are hatched the larvae feed on the host by remaining outside only  
   *Eg: Head louse; Epiricana melanolenca, Epipyrops sp. Sugarcane fly*  

2. **Endoparasites**: they enters into body of the host and feeds from inside  
   - Mother parasite either lays its eggs inside the tissues of the host or on the food material of the host to gain entry inside  
   *Eg: Braconids & Icheneunmonids, Apanteles flavipes on jowar stemboker larvae*
III. Specialization based on the **stage of the host**

Eg. Host: Coconut black headed caterpillar, Opisina arenosella

**TAMGESTT**

1. Egg parasite: *Trichogramma australicum*
2. Early larval parasite – *Apanteles taragama*
3. Mid larval parasite – *(Micro)* *Bracon hektor*
4. Prepupal parasite – *Gonizus nephantidis*
5. Prepupal parasite – *Elasmus nephantidis*
6. Pupal parasite – *Stomatoceros sulcatiscutellum, Trichospilus pupivora, Testrastichus israeli*

IV. Depending upon the **duration of attack**

1. **Transitory parasite**: spends a few stages of its life in one host
   - other stages on some other species of hosts or as a free living organism Eg. *Braconids and Ichneumonids*

2. **Permanent parasite**: spends all the stages of its life on the same host Eg. Head louse
V. Depending upon degree of parasitization

1. **Obligatory parasites**: which can live only as a parasite and cannot live freely Eg. Bird lice, Head louse

2. **Facultative parasite**: which can live away from the host at least for a shorter period Eg. Fleas

VI. Depending upon the food habits

1. **Polyphagous**: develops on number of widely different host species
   
   Eg. Bracon sp. Apanteles sp on lepidopteran caterpillars

2. **Oligophagous**: which has very few hosts but all the hosts are closely related
   
   Eg. Isotema javensis on sugarcane and sorghum borers

3. **Monophagous**: which has only one host sp. and can’t survive in another sp. i.e. host specific
   
   Eg. Gonizus nephantidis on Opisina arenosella
Kinds of Parasitism

1. Simple parasitism: Irrespective of number of eggs laid only one parasitoid attacks the host

   Eg. Apanteles taragameae on the larvae of Opisina arenosella, Goniozus nephantids

2. Super parasitism: parasitisation of a single host by more larvae of single species that can mature in the host

   Eg. Apanteles glomeratus on Pieris brassica, Trichospilus pupivora on Opisina arenosella

3. Multiple parasitism: simultaneous parasitization of host individual by two or more different species of primary parasites at the same time

   Eg: Trichogramma, Telenomous and Tetrastichus attack eggs of paddy stem borer Scirpophaga incertulas

   Super parasitism and multiple parasitism are regarded as undesirable situations as much reproductive capacity is wasted

4. Hyper parasitism: When a parasite itself is parasitized by another parasite

   Eg. Goniozus nephantidis is parasitized by Tetrastichus israeli, Most of the Bethylids and Braconids are hyper parasites
Primary parasite: A parasite attacking an insect which itself is not a parasite (Beneficial to man)

Secondary parasite: A hyperparasite attacking a primary parasite (Harmful to man)

Tertiary parasite: A hyperparasite attacking a secondary parasite (Beneficial to man)

Quaternary parasite: A hyperparasite attacking tertiary parasite (Harmful to man)

A primary parasitoid becomes harmful in case of productive insects like silkworms, Bombyx mori and lac insect Kerria lacca
Predators and Predatism

A predator is one which catches and devours smaller or more helpless creatures by killing them in getting a single meal

- It is a free living organism through out its life
- normally larger than prey
- requires more than one prey to develop

Insect predator qualities

1. generally feeds on many different species of prey - **polyphagous nature**
2. relatively large compared to its prey, which it **seizes and devours quickly**
3. consumes **large number of prey** in its life time Eg: coccinellid predator larva consume 100s of aphids
4. kill and consume their prey quickly, usually via **extra oral digestion**
5. very efficient in **search** of their prey and capacity for **swift movements**
6. develop **separately from their prey** and may live in the same habitat or adjacent habitats
7. Structural adaptation with **well developed sense organs** to locate the prey
8. **carnivorous in both its immature and adult stages**
9. May have **cryptic colourations** and **deceptive markings**

Eg. Preying mantids and Robber flies
Predatism: Based on the degree of use fullness to man,

1. **Entirely predatory**, Eg. lace wings, tiger beetles, lady bird beetles except Henosepilachna genus

2. **Mainly predator but occasionally harmful** Eg. Odonata and mantids occasionally attack honey bees

3. **Mainly harmful but partly predatory** Eg. Cockroach feeds on termites

4. **Mainly scavenging and partly predatory** Eg. Earwigs feed on dead decaying organic matter and also fly maggots

5. **Variable feeding habits of predator**, eg: Tettigonidae: omnivorous and carnivorous but damage crop by lying eggs

6. **Stinging predators**
   - nests are constructed and stocked with prey
   - Prey have been stung and paralyzed by the mother insect
   - the eggs are laid on prey and then scaled up
   - Larvae emerging from the egg feed on paralyzed but not yet died prey

   Eg. **Spider wasps**
<table>
<thead>
<tr>
<th>Predator</th>
<th>Parasite</th>
</tr>
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<tbody>
<tr>
<td>Very <strong>active</strong></td>
<td>Sluggish</td>
</tr>
<tr>
<td><strong>Generalized feeders</strong> excepting lady bird beetles and hover flies which show some specificity to pray</td>
<td><strong>Host specific</strong> in many cases the range of host species attacked is very much limited</td>
</tr>
<tr>
<td>Sense organs and mouth parts are well developed</td>
<td>Except <strong>ovipositor</strong> others are underdeveloped</td>
</tr>
<tr>
<td>Stronger, larger and usually more intelligent than the prey</td>
<td>Smaller and not markedly more intelligent than the host</td>
</tr>
<tr>
<td><strong>Habitat is independent</strong> of that of its prey</td>
<td>Habitat and environment is made and determined by that of the host</td>
</tr>
<tr>
<td><strong>Long</strong> life cycle</td>
<td><strong>Short</strong> life cycle</td>
</tr>
<tr>
<td>Attack on the prey is casual and not well planned</td>
<td>Planning is more evident</td>
</tr>
<tr>
<td>Seizes and devours the prey rapidly</td>
<td>Lives on or in the body of the host killing it slowly</td>
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<tr>
<td>Attack on prey is for obtaining food for the attacking predator itself</td>
<td>It is for provision of food for the offspring</td>
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<tr>
<td>A single predator may <strong>attack several hosts</strong> in a short period</td>
<td>A parasite usually completes development in a <strong>single host</strong> in most cases</td>
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