Friendly Foes: The Bio-control Agents

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ABSTRACT

The bio-control agents are those organisms that manage the pest population in natural way and keep them below the economic threshold and are thus applied by the agency of man. This process is known as bio-control or biological control. They are foes to the pests and are thus beneficial and a friend for us. There are many pathogens (Bacillus thuringiensis, Bt cotton), parasites (parasitoids, ex. Parasitic wasps, tachinid flies) and predators (ex. Gambusia fish against mosquito larvae) that can be applied as bio-control agents. Many are being used as effective pest control agent in Europe and United States of America. There is lots of potential in this field and more explorations and researches need to be done in an agricultural country like India.

There are many kinds of creatures or living beings that co-inhabit with us on our beautiful planet. Many of them are harmful for us while many are not. In fact there are a plenty that directly or indirectly benefit us or are friendly to us. Out of the harmful ones are the pests that are nuisance, cause health hazards and damage our crops, store grains and livestock. They are carriers of many diseases or cause diseases directly. To manage and control them chemical pesticides have been used since long. These chemicals have proved to be harmful for our ecosystem and us in the long run. So as an option there are a number of organisms, that are able to pathogenise, parasitize and predate upon them. They are known as natural enemies that keep the population of their prey under check and thus are natural foes that are friendly to us. This process occurring in nature is termed as natural control. When these natural enemies are deployed by the agency of man to manage pest population the process is called biological control or bio-control and these natural enemies are termed as bio-control agents.

These bio-control agents or our friendly foes are effective against a number of pests be they insects, weeds or other harmful creatures. These may be categorized as 1. Pathogens, 2. Parasites and parasitoids and 3. Predators. Description of each category of natural enemies is as follows:

1. Pathogens: The microorganisms that infect and kill their hosts are known as pathogens e.g. bacteria, virus, fungi, protozoans, nematodes etc. They are also potent natural enemies that could be harnessed to become good bio-control agents. We need good entomo-pathogens that can infect and kill insect pests. But microorganisms are damaged by ultra violet radiations so their applicatory formulations must be made safe against it.

Under prolonged high humid conditions or dense pest populations pathogens flourish and drastically reduce populations of caterpillars, some aphids, mites and some invertebrates. Under favorable environmental conditions there are naturally occurring disease outbreaks that keep pest populations under check. But now some beneficial pathogens are commercially available as microbial or biological pesticides e.g. Bacillus thuringiensis (Bt), entomopathogenic nematodes, granulosis viruses etc. Members of several groups such as bacteria, virus, fungi and protists are good insect pathogens as given follows:

**Bacteria:** There are many pathogenic bacteria belonging to the cocobacilli group that are harmful to the insects. Genus Bacillus is particularly very important to be employed as bio-control agents, e.g., Bt, B. sphaericus etc. They are highly host specific. There are several strains of Bt that have been isolated, mass produced and sold as pest control agents. They have been used by gardeners and farmers as effective measure against butterflies and moth caterpillars. Currently few strains of Bt has been formulated that show activity against mosquito larvae and certain beetles. There is only one drawback these are not effective in fumigation and on
contact rather must be eaten by the target pests. They do not kill immediately but show effect in about 48 hours as the toxin paralyses the gut and hinders metabolic processes. The target larvae may appear healthy after application of Bt but it would stop feeding and is unable to cause damage.

There is difference in insecticidal properties of different subspecies of Bt and they affect different groups of insects. Every year more and more types of Bt are discovered in nature. *B. thuringiensis* subspecies *kurstaki* (Btk) is the most commonly used type of Bt and is available as spray, dust, granules to be applied as per the need of the hour. It is most effective against lepidopterous larvae. *B. thuringiensis* subspecies *aizawai* is very effective against wax moths. *B. thuringiensis* subspecies *tenedronis* (Btt) also known as Bt ssp san diego or Bt ssp morrisoni is effective against certain beetles’ young stage and in few cases adults also. Currently it is in use against Colorado potato beetle larvae and elm leaf beetle. *B. thuringiensis* subspecies *israelensis* (Bti) is effective against the larvae of certain flies, mosquitoes and gnats. Different formulations of Bti are available to be applied as need arises.

*Bacillus sphaericus* has been found to be effective against *Culex* larvae and other mosquito larvae that Bti could not affect. Other bacteria such as *Paenibacillus papillae* and *P. lentimorbus* are also being used against Japanese beetle.

**Viruses:** These are highly host specific thus has good potential to be used ad bio-control agents. But they may not be effective when multiple pests are to be controlled. Researches are going on to generate more effective viruses though some are commercially available and are being used in Integrated Pest Management (IPM) Programs. Nuclear or Cytoplasmic Polyhedrosis Virus (NPV or CPV) is effective against forest pests such as tussock and gypsy moths, spruce budworm and pine saw flies. Granulosis virus is effective against butterflies and moths larvae and pupae. *Cydia pomonella* is effective in apple orchards against larvae of the codling moth. Some non-inclusion viruses such as *Entomopox* virus has also potential to be utilized as effective bio-control agent.

**Fungi:** Many insect pathogenic fungi have been formulated as bio-pesticides. But for their application the environmental conditions must be regulated as they favor high humidity. But the problem is that other pathogenic fungi may also get developed there. To overcome the low humid conditions oil formulations of entom-pathogenic fungi are being used. Some fungal pathogens have wide host range (e.g. *Beauveria bassiana*, *Metarhizium anisopliae*, and *Cordyceps* spp.) while others are more specific e.g., *Erynia radicans* and *Aschersonia ssp.* (Against aphids), *Entomophthora muscae* (against muscoid flies), *Lagenidium giganteum*, *Coelomomyces* spp., and *Tolypocladium* spp (against mosquito larvae) or *Nomuraea rileyi* and *Paecilomyces* spp (against butterflies and moths).

**Protists:** Commercially available microsporidian *Nosema locustae* (as the brand name Hopper Stopper) is effective against grass hoppers when applied in vast habitat. It is not much suitable in small gardens as it is slow acting. *Lagenidium giganteum* is effective against *Aedes* and *Culex* mosquito larvae. It is also commercially available.

2. **Parasites and Parasitoids:** These are those organisms which may feed and inhabit upon their target organisms termed as host. True parasites may be internal or external in host. They are highly specific but can infect only one or very few hosts. They are smaller than the host. Their both larval as well as adult stages infect the target host. They generally need only one host to reach maturity. They feed without killing. They function at low host density so are efficient. They may be either diurnal or nocturnal e.g. Mosquitoes, Lice, Bed bugs etc. They are not at all suited for bio-control.

However there are also such insects whose only larval stages infect host organisms and these are termed as **parasitoids.** Their adult stage is free living and generally vegetarian. They are of same size as host. They also need single host for maturity. They paralyze to oviposit. They are highly efficient as can function at low host density. They are highly host specific. They are nocturnal in habit. They are best suited for bio-control e.g. parasitic wasps, tachinid flies.

Tachinid flies are effective against caterpillars of butterflies and moths, saw fly young ones, bettle’s grubs and occasionally nymphs of bugs and hoppers. Bee flies and big headed flies also parasite upon insect pests. There are many wasps that also parasitise insect pests.

There are about 300 species of roundworms in about 19 families that attack insects. *Steinermera* and *Heterorhabditis* harbor symbiotic bacteria that are pathogenic to the host insect and this makes them unique among all.
3. **Predators:** These are those organisms that attack, kill and devour their prey. They can prey upon a large number of target organisms and both young ones and adults are feeders on host thus are suited to become effective bio-control agents. They are larger than prey. They need more than one prey/host to reach maturity and are not so great host specific. They function at higher host density. They are crepuscular in habit. There are many invertebrate (e.g. mantids, lady beetles etc.) as well as vertebrate (fish, birds etc.) predators which can be employed to manage pest populations. The most effective predators are given below:

**Arthropods:** Many insects and spiders are effective predators against a number of insects pests such as dragonflies, lacewings, beetles, flies, true bugs, ants, wasps, thrips, mantids etc.

Spiders have a nonselective diet thus they are relatively minor bio-control agents. There are about 4000 species of predatory spiders. Adult as well as larvae of dragon flies have a significant effect on mosquito and other flying insects populations. The lace wings specially aphid-lions are effective against aphid populations. Lady bird beetles are effective against small soft bodied insects such as aphids and scale insects. Ground beetle *Calosoma sycophanta* is quite effective against gypsy moths and has been introduced into New England. Flower flies are effective against aphids and robber flies are also beneficial predators. Damsel bugs, minute pirate bugs, big eyed bugs, ambush bugs are important predators of eggs and larvae of butterflies and moths. Fire ants and army ants are non-selective predators. Hunting wasps endow their nests with spiders, caterpillars and other small insects. Black hunter and the banded thrips predate upon spiders, mites, aphids, whiteflies and other thrips. Preying mantids are nonselective predators but are less effective bio-control agents as they are cannibalistic.

**Vertebrates:** Many fishes, frogs, toads, salamanders, lizards, snakes, turtles, birds, moles shrews, mice, bats are predatory in nature thus have potential to be employed as bio-control agents. Many cyprinoid fishes e.g *Gambusia* spp have been employed against mosquito larvae. The Giant toad *Bufo marinus* has been employed against white grubs in Puerto Rican sugarcane fields. Geckoes are employed against cockroaches and are kept as house pets for that reason in many parts of the world. Many birds such as flycatchers, warblers, swifts and vireos are exclusive insect predators.

In 1850, Mormon settlers in Utah were threatened by crickets that could have destroyed their crops. These crickets were eaten by flocks of seagulls that appeared suddenly over there. These birds had saved those settlers from expected starvation so they have erected a monument devoted to those seagulls in their memory.

Soil-dwelling small mammals predate upon white grubs and pupal stages of many flies and moths. Bats predate upon small flying insects e.g. *Myotis lucifugus* that feeds more than half its weight in insects every night.

**Future Furor**

These friendly foes may prove to be much helpful in near future if the practice of bio-control is adopted early in agriculturally rich country such as ours. Further research needs to be done about the effectiveness of other organisms as biocontrol agents while enhancing the potential of current natural control agents by means of biotechnology and bioengineering.

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