**Types of biological pest control:**

There are three basic types of biological pest control strategies: importation (sometimes called classical biological control), augmentation and conservation:

**Importation**

Importation (or "classical biological control") involves the introduction of a pest's natural enemies to a new locale where they do not occur naturally. This is usually done by government authorities. In many instances the complex of natural enemies associated with a pest may be inadequate, a situation that can occur when a pest is accidentally introduced into a new geographic area, without its associated natural enemies. These introduced pests are referred to as exotic pests and comprise about 40% of the insect pests in the [United States](https://en.wikipedia.org/wiki/United_States).

The process of importation involves determining the origin of the introduced pest and then collecting appropriate natural enemies associated with the pest or closely related species.

Selected natural enemies are then passed through a rigorous assessment, testing and [quarantine](https://en.wikipedia.org/wiki/Quarantine) process, to ensure that they will work and that no unwanted organisms (such as hyperparasitoids) are introduced. If these procedures are passed, the selected natural enemies are mass-produced and then released. Follow-up studies are conducted to determine if the natural enemy becomes successfully established at the site of release, and to assess the long-term benefit of its presence.

To be most effective at controlling a pest, a biological control agent requires a colonizing ability which will allow it to keep pace with the spatial and temporal disruption of the habitat. Its control of the pest will also be greatest if it has temporal persistence, so that it can maintain its population even in the temporary absence of the target species, and if it is an opportunistic forager, enabling it to rapidly exploit a pest population. However an agent with such attributes is likely to be non-host specific, which is not ideal when considering its overall ecological impact, as it may have unintended effects on non-target organisms.

There are many examples of successful importation programs, including:

* [Joseph Needham](https://en.wikipedia.org/wiki/Joseph_Needham) noted a Chinese text dating from 304AD, *Records of the Plants and Trees of the Southern Regions*, by Hsi Han, which describes mandarin oranges protected by biological pest control techniques that are still in use today
* One of the earliest successes in the west was in controlling [*Icerya purchasi*](https://en.wikipedia.org/wiki/Icerya_purchasi), the [cottony cushion scale](https://en.wikipedia.org/wiki/Cottony_cushion_scale), a pest that was devastating the [California](https://en.wikipedia.org/wiki/California) citrus industry in the late 19th century. A predatory insect [*Rodolia cardinalis*](https://en.wikipedia.org/wiki/Rodolia_cardinalis) (the Vedalia Beetle), and a parasitoid fly were introduced from Australia by [Charles Valentine Riley](https://en.wikipedia.org/wiki/Charles_Valentine_Riley). Within a few years the cottony cushion scale was completely controlled by these introduced natural enemies.
* Damage from [*Hypera postica*](https://en.wikipedia.org/wiki/Hypera_postica) Gyllenhal, the alfalfa weevil, a serious introduced pest of forage, was substantially reduced by the introduction of several natural enemies. 20 years after their introduction the population of [weevils](https://en.wikipedia.org/wiki/Weevil) in the [alfalfa](https://en.wikipedia.org/wiki/Alfalfa) area treated for alfalfa weevil in the [Northeastern United States](https://en.wikipedia.org/wiki/Northeastern_United_States) was reduced by 75 percent.
* A small [wasp](https://en.wikipedia.org/wiki/Wasp), [*Trichogramma ostriniae*](https://en.wikipedia.org/w/index.php?title=Trichogramma_ostriniae&action=edit&redlink=1), was introduced from [China](https://en.wikipedia.org/wiki/China) to help control the [European corn borer](https://en.wikipedia.org/wiki/European_corn_borer) (*Ostrinia nubilalis*), one of the most destructive insects in [North America](https://en.wikipedia.org/wiki/North_America), making it a recent example of a long history of classical biological control efforts for this major pest.
* The population of [*Levuana iridescens*](https://en.wikipedia.org/wiki/Levuana_iridescens) (the Levuana moth), a serious coconut pest in [Fiji](https://en.wikipedia.org/wiki/Fiji), was brought under control by a classical biological control program in the 1920s.

Classical biological control is long lasting and inexpensive. Other than the initial costs of collection, importation, and rearing, little expense is incurred. When a natural enemy is successfully established it rarely requires additional input and it continues to kill the pest with no direct help from humans and at no cost. However importation does not always work. It is usually most effective against exotic pests and less so against native insect pests. The reasons for failure are not often known but may include the release of too few individuals, poor adaptation of the natural enemy to environmental conditions at the release location, and lack of synchrony between the [life cycle](https://en.wikipedia.org/wiki/Biological_life_cycle) of the natural enemy and host pest.,

**Augmentation:**

Augmentation involves the supplemental release of natural enemies, boosting the naturally occurring population. Relatively few natural enemies may be released at a critical time of the season (inoculative release) or millions may be released (inundative release). An example of inoculative release occurs in greenhouse production of several crops. Periodic releases of the parasitoid, [*Encarsia formosa*](https://en.wikipedia.org/wiki/Encarsia_formosa), are used to control greenhouse [whitefly](https://en.wikipedia.org/wiki/Whitefly), and the predatory mite [*Phytoseiulus persimilis*](https://en.wikipedia.org/wiki/Phytoseiulus_persimilis) is used for control of the two-spotted spider mite. Lady beetles, lacewings, or parasitoids such as those from the genus [*Trichogramma*](https://en.wikipedia.org/wiki/Trichogramma) are frequently released in large numbers (inundative release). Recommended release rates for Trichogramma in vegetable or field crops range from 5,000 to 200,000 per acre (1 to 50 per square metre) per week depending on level of pest infestation. Similarly, entomopathogenic [nematodes](https://en.wikipedia.org/wiki/Nematodes) are released at rates of millions and even billions per acre for control of certain soil-dwelling insect pests.

[](https://en.wikipedia.org/wiki/File:Lady_bugs_are_a_beneficial_insect_commonly_sold_for_biological_control_of_aphids..jpg)

The spraying of [octopamine](https://en.wikipedia.org/wiki/Octopamine_(neurotransmitter)) analogs (such as [3-FMC](https://en.wikipedia.org/wiki/3-FMC)) has been suggested as a way to boost the effectiveness of augmentation.

Octopamine, regarded as the [invertebrate](https://en.wikipedia.org/wiki/Invertebrate) counterpart of [dopamine](https://en.wikipedia.org/wiki/Dopamine) plays a role in activating the insects' flight-or-fight response. The idea behind using octopamine analogues to augment biological control is that natural enemies will be more effective in their eradication of the pest, since the pest will be behaving in an unnatural way because its flight-or-fight mechanism has been activated., Octopamine analogues are purported to have two desirable characteristics for this type of application: (1) they affect insects at very low dosages (2) they do not have a physiological effect in humans (or other vertebrates).