The amazing life history strategies of parasitoids

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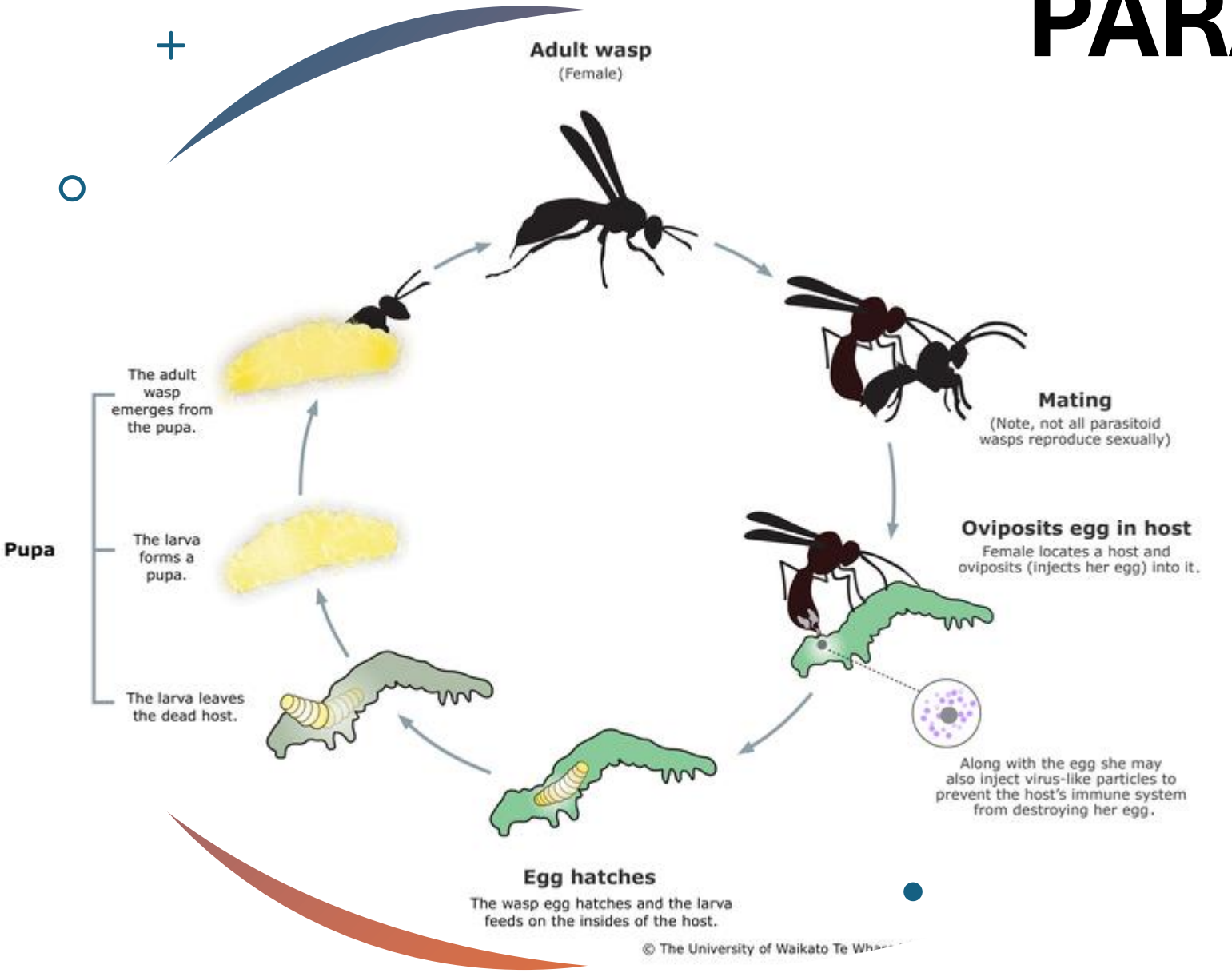
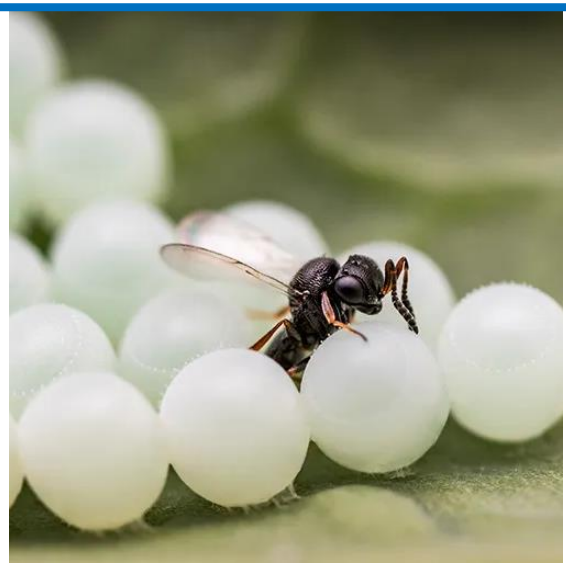
PARASITOIDS

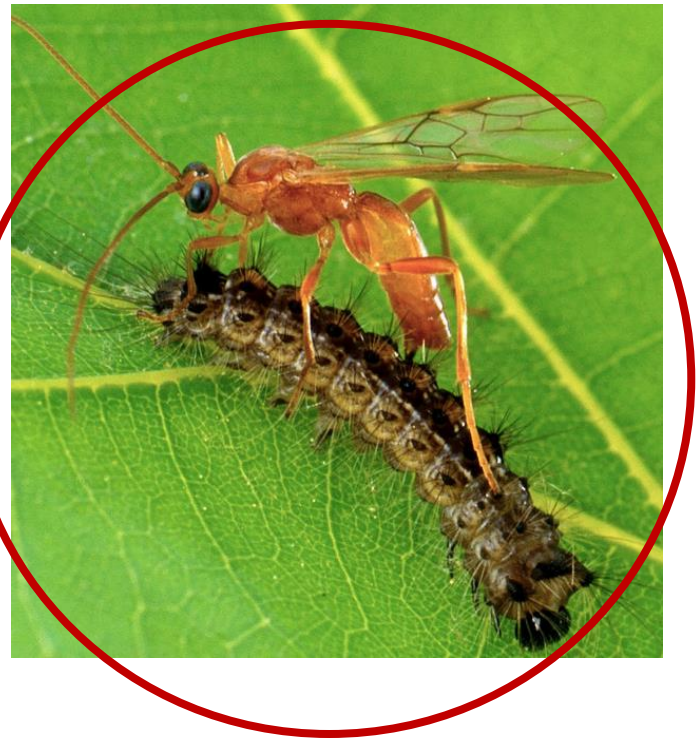


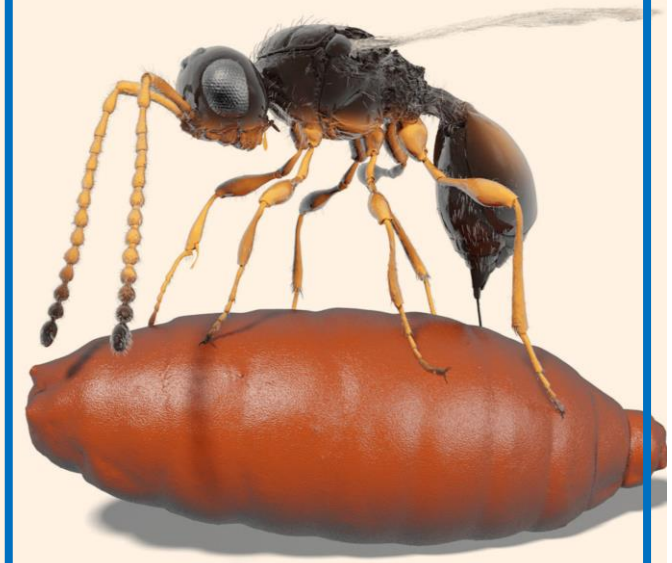
- Adult female lays her eggs *on, in* or occasionally *near* the body of the host.
- The eggs hatch and the developing parasitoid larvae consume the host, eventually killing it.
- Of the estimated 4-8 millions species of insects, 1.5 - 2 million are parasitoids!
- Coined by Reuter at the beginning of the century.
- Has independently developed in Coleoptera, Diptera, Lepidoptera, Trichoptera, Neuroptera,& Strepstiptera

PARASITOIDS

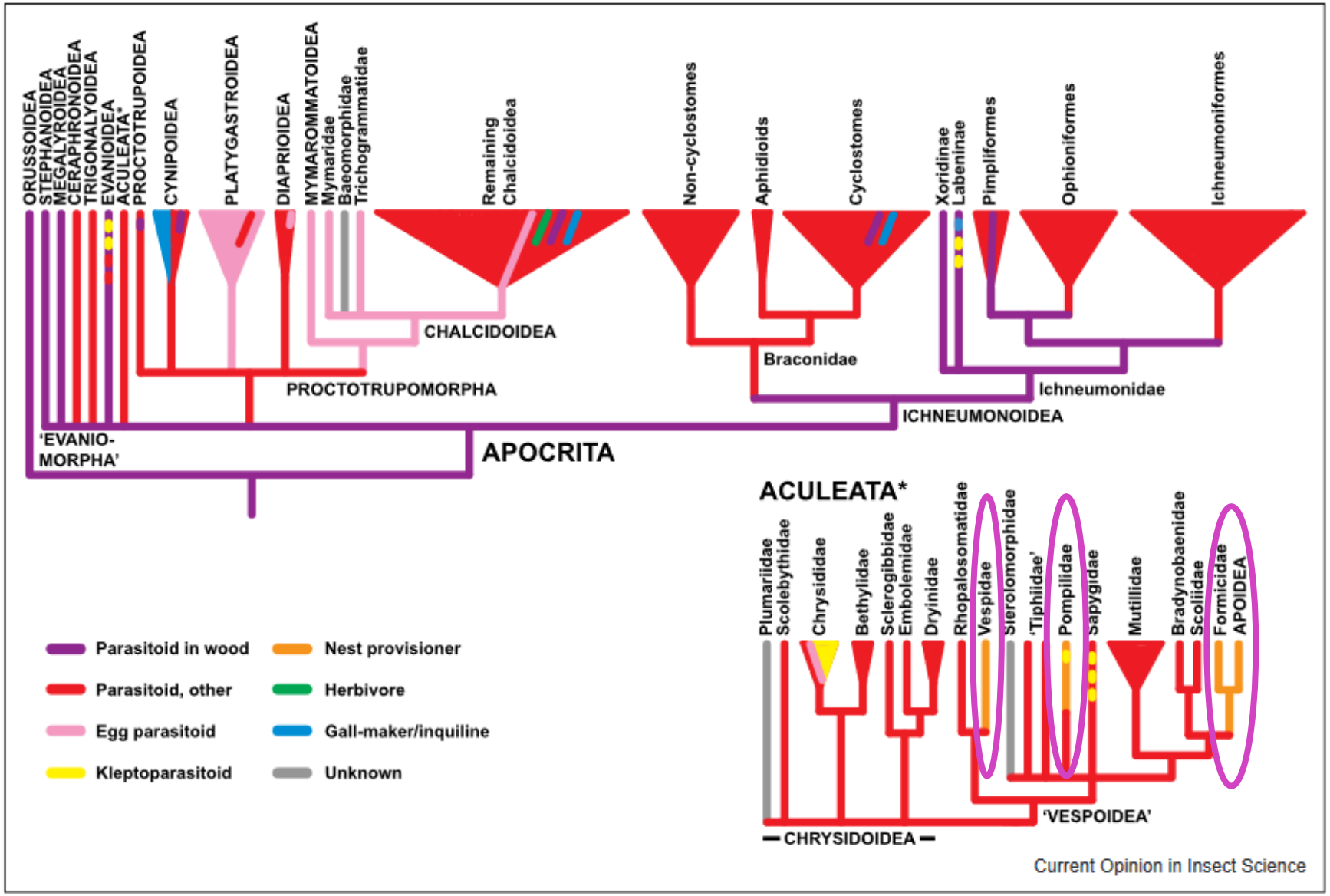
- The most common parasitoids are in the category that attack larval or nymphal stages.
- Egg and pupal parasitoids are also fairly common.
- Adult parasitoids are the least common type.







EVOLUTIONARY HISTORY OF PARASITOID HYMENOPTERA



Parasitoid strategies

- **Ectoparasitoid**- feeds on the host from the outside.

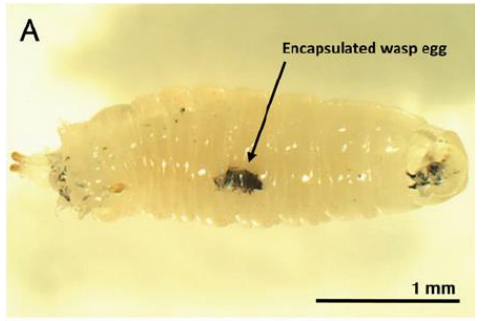
- **Endoparasitoid**- lives within their host's body

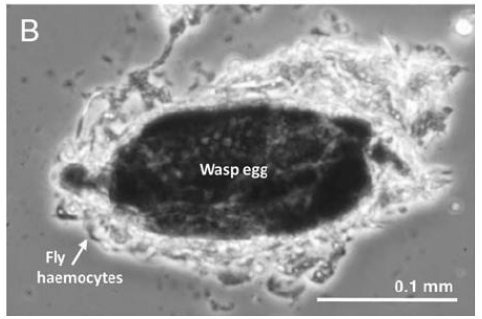
First challenge: *BREATHING*

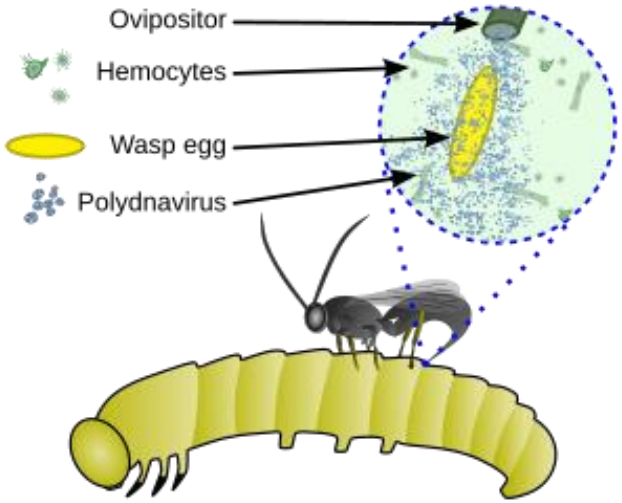
- **Ectoparasitoid**: uses standard tracheal system to get air
- **Endoparasitoid**: use the dissolved oxygen floating around in the haemolymph (insect's blood) or hacks into the tracheal system.

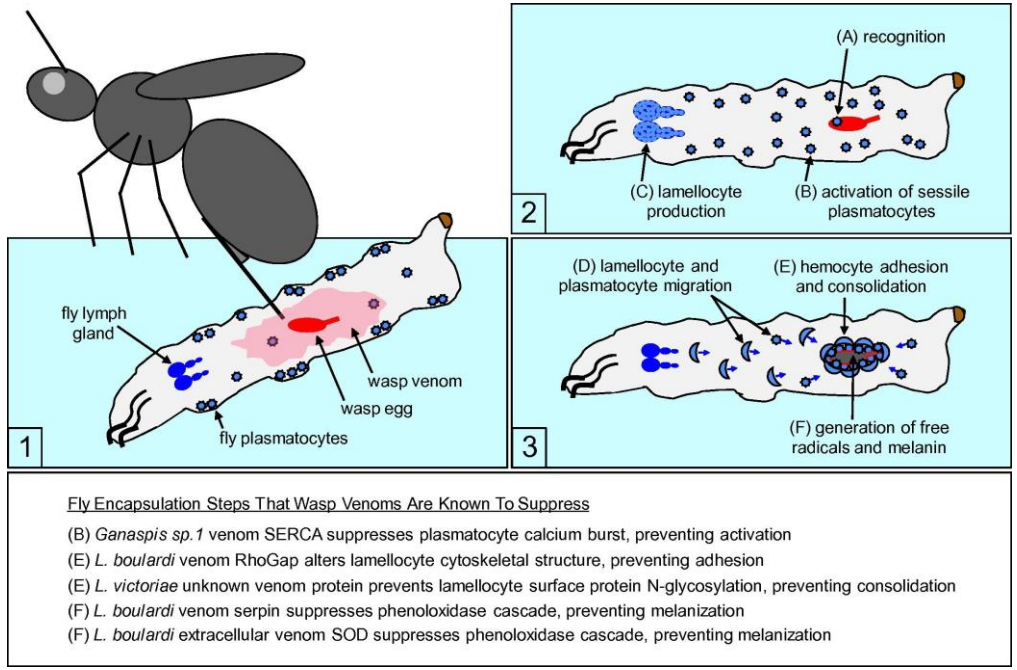
Second challenge: *RESISTANCE TO HOST'S IMMUNE SYSTEM*

- **Passive**: parasitoids camouflage so they are not recognized as foreign or insert their eggs in specific organs away from circulating hemocytes.
- **Active**: injection of toxins at oviposition, injection of viruses









KILLING THE HOST

Idiobiont

- Host killed or paralyzed permanently; development terminated with venom injected during oviposition; host immediately consumed by the larva.
- Typically attacks a host life stage that is immobile.
- They tend to be generalists.

Trissolcus japonicus

Koinobiont

- Host may be temporarily paralyzed during oviposition;
- The host continues to develop and is only killed when the parasitoid reaches maturity.

Cotesia congregata

Social preference

Solitary

One egg laid on/in the host and the size of the emerging wasp matches the size of the host.

Social preference

Gregarious

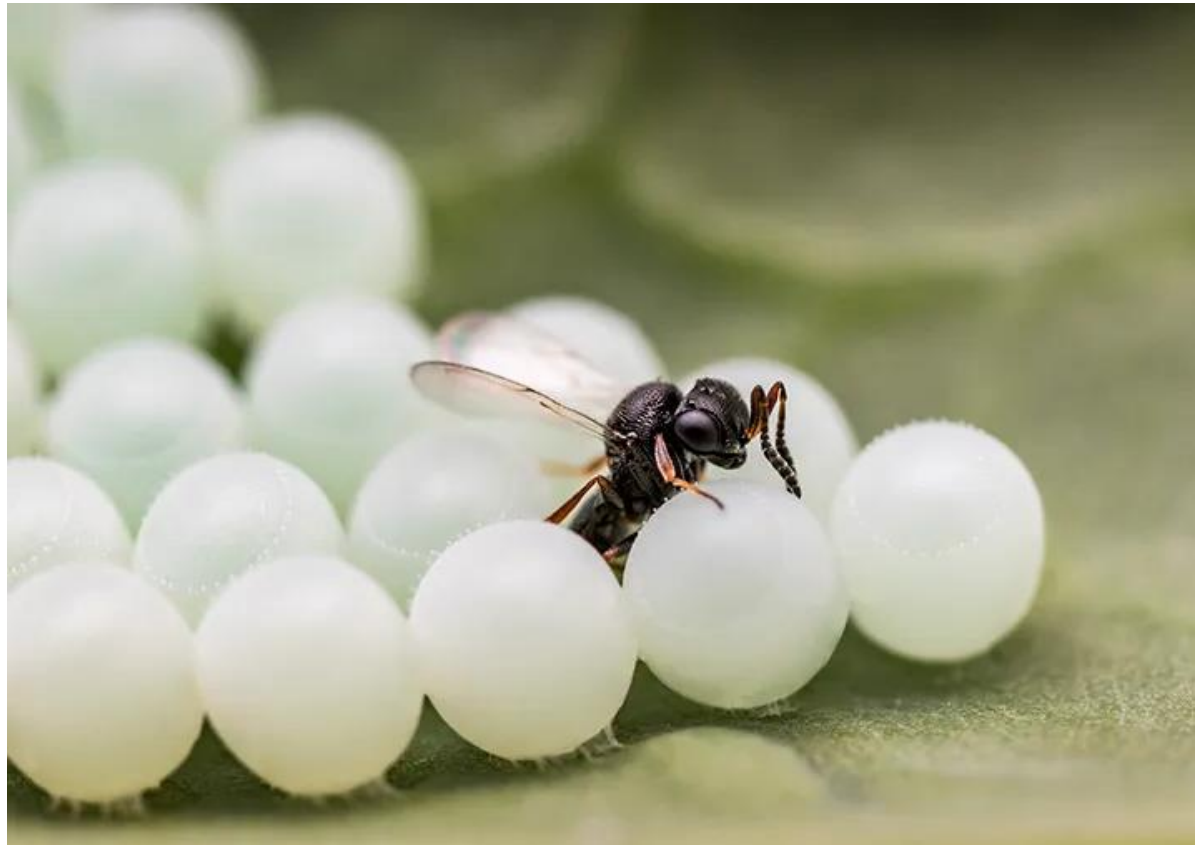
A large host yields more than one parasitoid wasp, this can be achieved either by:

- Multiple eggs are laid on/in the host
- Polyembryony (multiple embryos develop from a single egg that divides repeatedly after oviposition).

Copidosoma floridanum

BEHAVIORAL STRATEGIES

COMPETITION FOR RESOURCES



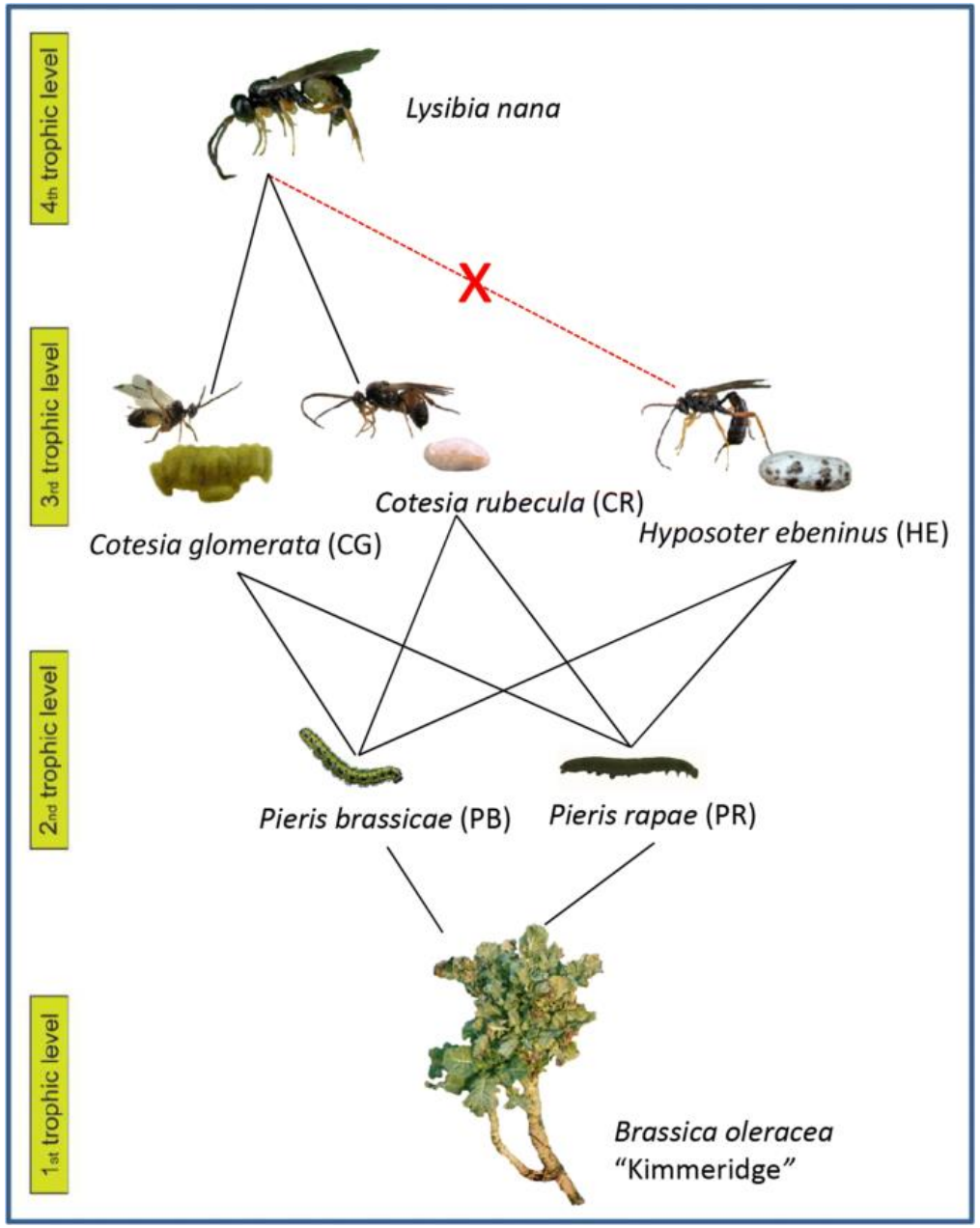
- **Host discrimination**: when parasitoid females avoid previously parasitized hosts; may be aided by chemical marks deposited by the first female.
- **Super-parasitism**: sometimes a second female will add her own eggs to the host already parasitized with an individual of the same species.
- **Multi-parasitism**: similar to above, but the first and second parasitoid eggs are from different species.
- **Self-super-parasitism**: the first female may parasitize a host that she previously attacked.

BEHAVIORAL STRATEGIES

COMPETITION

PARASITOIDS FEEDING ON OTHER PARASITOIDS

- **Hyper-parasitoidism**: where the development of the parasitoid larva is contingent on the presence in the primary host of another parasitoid; only the hyperparasitoid completes its development. It is widespread across parasitoid wasps; some genera are exclusively hyperparasitoids.
- **Obligate**: can only develop as a parasitoid of a parasitoid.
- **Facultative**: can develop on an unparasitized host or as a hyperparasitoid when it encounters a previously attacked host.



Chrysonotomyia susbelli

- A hyperparasitoid of the gall wasp *Neuroterus bussae*
- Gall wasp of southern live oak
- Reported last week!
- On Rice University campus in Houston

8 minute videoclip of hyperparasitodism

https://vimeo.com/812762042

Multiple hosts

Encarsia porteri

Female E. porteri on lepidoptera eggs. These eggs will develop as males.

Female E. porteri on whitefly pupa laying eggs that will develop as females.

Other strategies

POLYPHENISM

Different types of wasp larva develop from the same genetic material. A cast system. Larva either develop into reproductive adults or soldiers.

Copidosoma truncatellum

Other strategies

PHORESY

Cabbage white butterfly

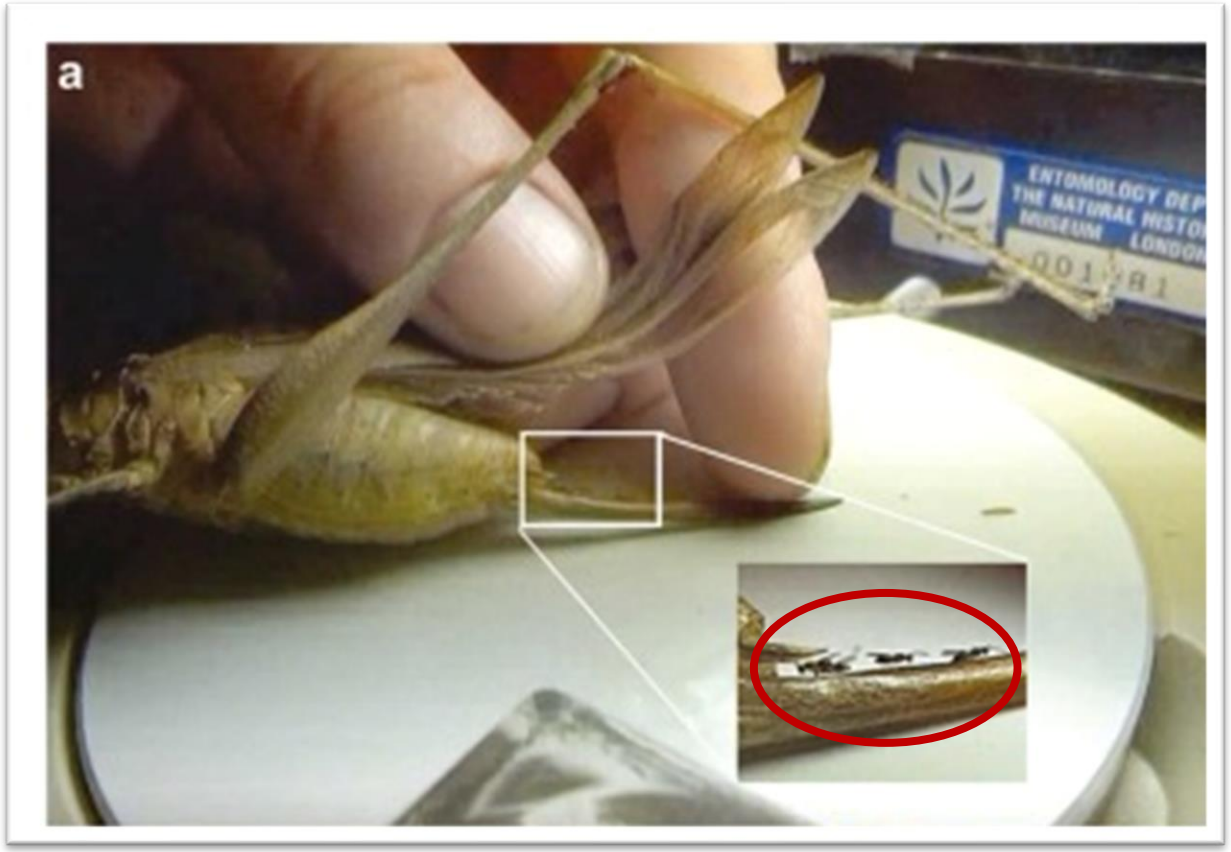
Trichogramma brassicae

One species uses another for transport, including dispersal.

Helps with:

- Locating their hosts, often the eggs of the individual on which they are traveling,
- Accessing those potential hosts while in a suitable state for oviposition

Eulophidae await oviposition by the bush cricket



Dinocampus coccinellae

Dinocampus coccinellae paralysis virus

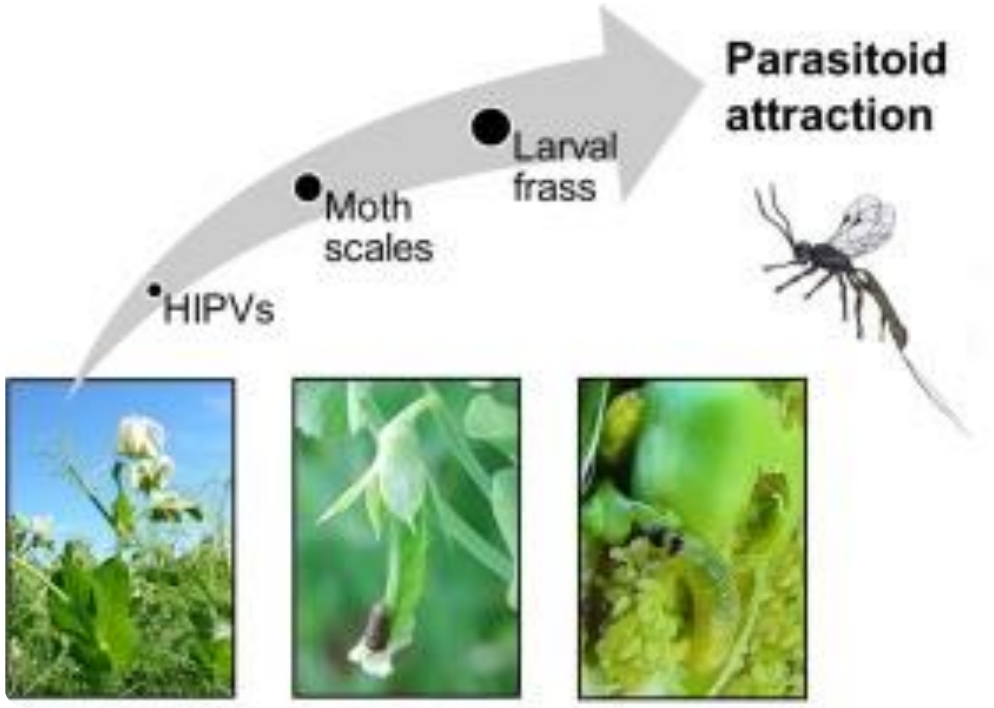
Virus symbiosis

- Endogenous viruses (bracoviruses and ichnoviruses) have evolved, probably at least twice independently in each. These viruses are transferred with the egg and help to subdue the host's immune response.
- Some viruses affect the behavior of the parasitoid's host.

Photo: S. Rae from Scotland, UK

Coleomegilla maculata

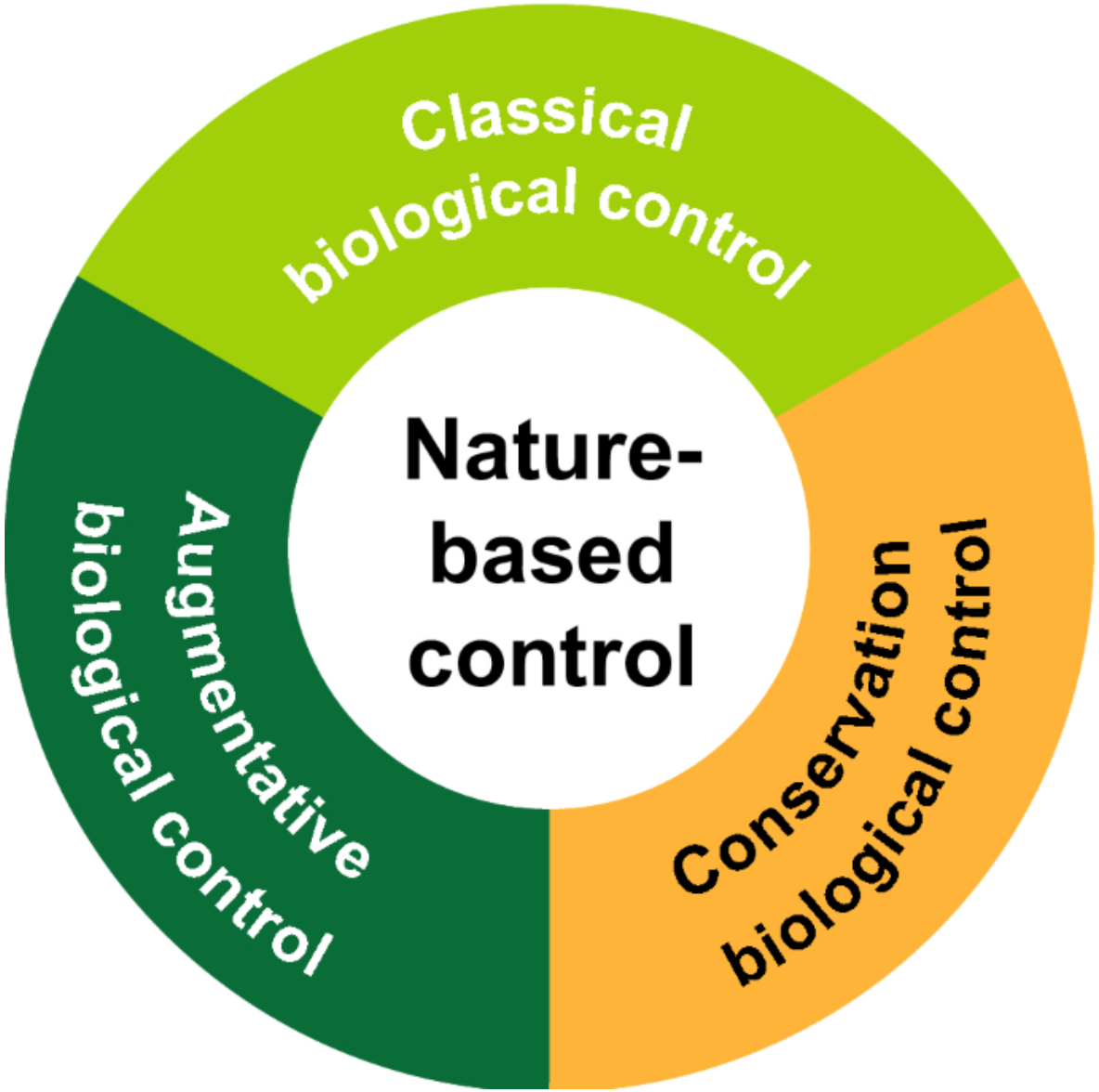
HOST LOCATION



Parasitoids are aided by several cues

- **obvious stimuli that will point to habitats or microhabitats that might contain a host (ex. green areas)**
- **herbivore induced plant volatiles**
- **host waste, saliva or mandibular secretions, silk or scales.**
- **symbiosis with other organisms who provide a clue to the host's location.**
- **host's pheromones (aggregation and sex)**
- **vision, but vibration and thermal for concealed hosts.**

BIOLOGICAL CONTROL

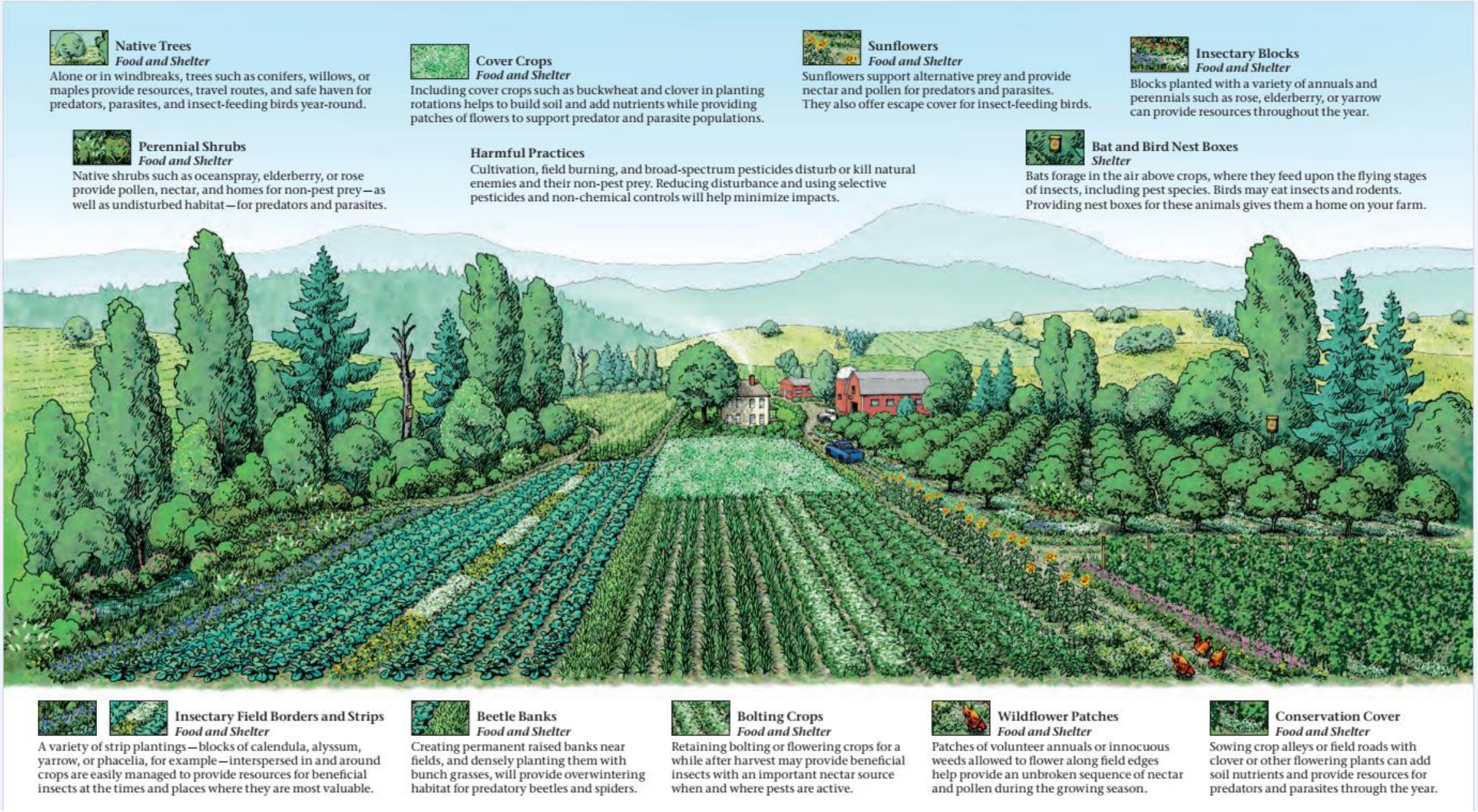


Augmentative biocontrol

- For immediate impact
- Within a single generation of a pest
- Tends to be confined to a very local scale such as an individual field orchard

- **Inoculative**: release a few at a critical time of the season
- **Inundative**: millions released all at once.

Conservation biocontrol

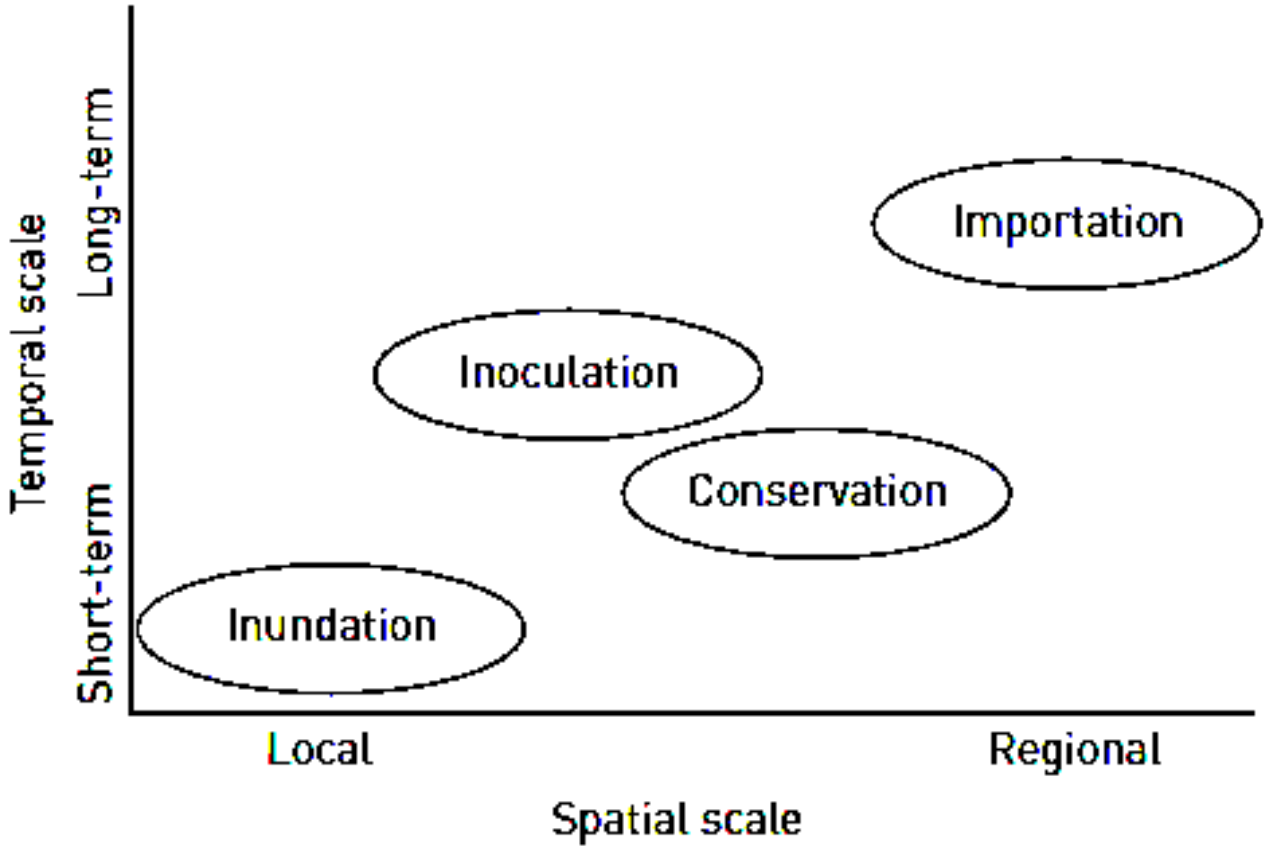


Classical biocontrol

- It involves the discovery, importation, and establishment of exotic natural enemies with the hope that they will suppress a particular organism’s population

The use of parasitoids in Biocontrol

- Conservation
- Augmentative: inoculative and inundative
- Classical or Importation



A schematic representation of the four main approaches to applied biological control to reflect the differential spatial and temporal scale of the processes involved.

THANK YOU!

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6 min videoclip on parasitoids
https://youtu.be/GCo2uCLXvhk

A good reference to start on…

- H.C.J. Godfray, Parasitoids, Editor(s): Simon Asher Levin, Encyclopedia of Biodiversity, Elsevier, 2007, Pages 1-13 (https://www.sciencedirect.com/science/article/pii/B0122268652002182)