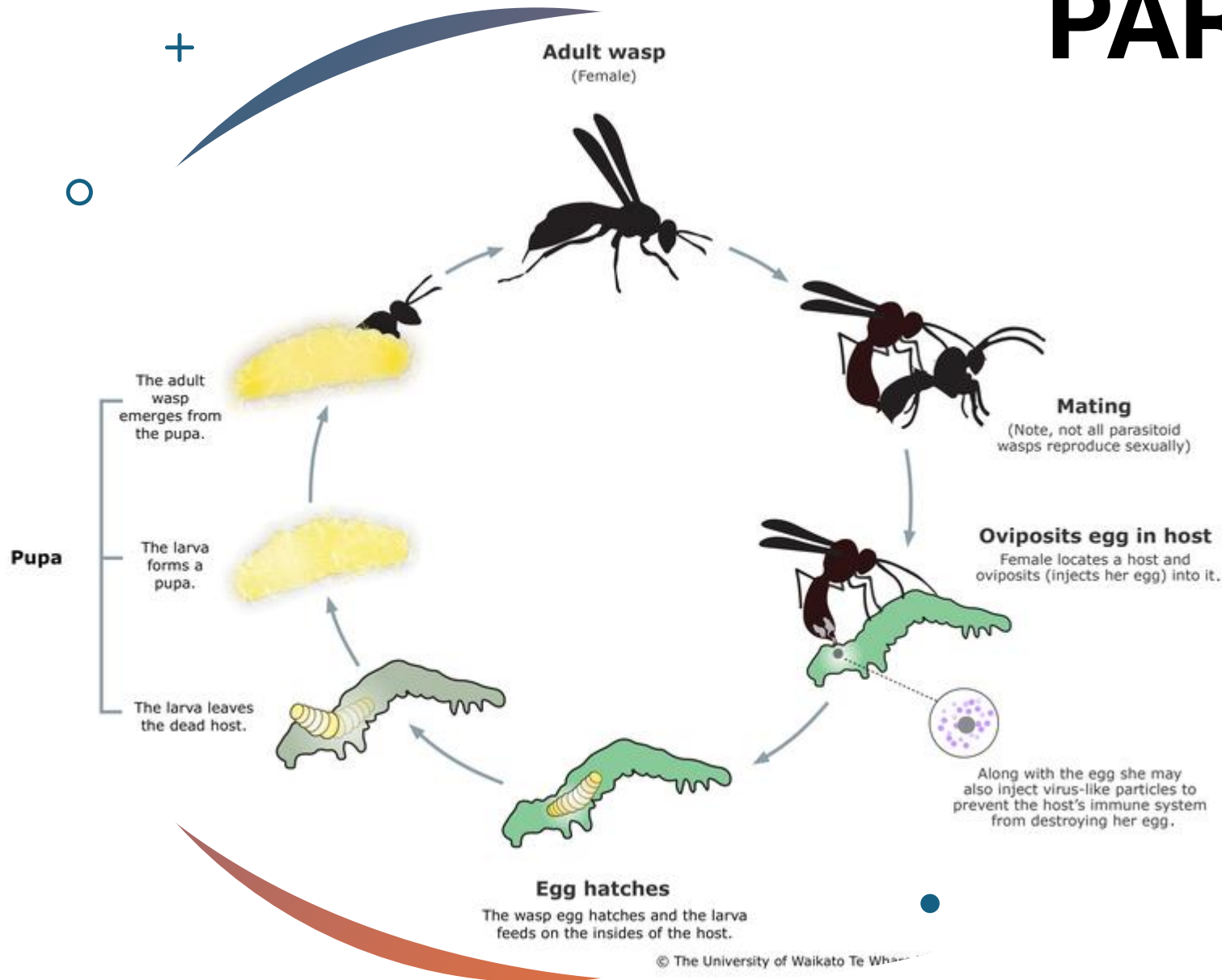


# The amazing life history strategies of parasitoids

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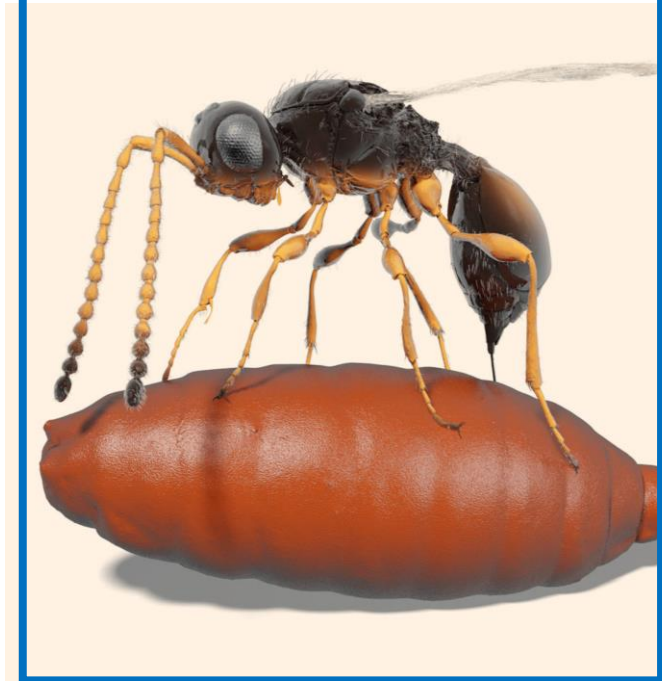
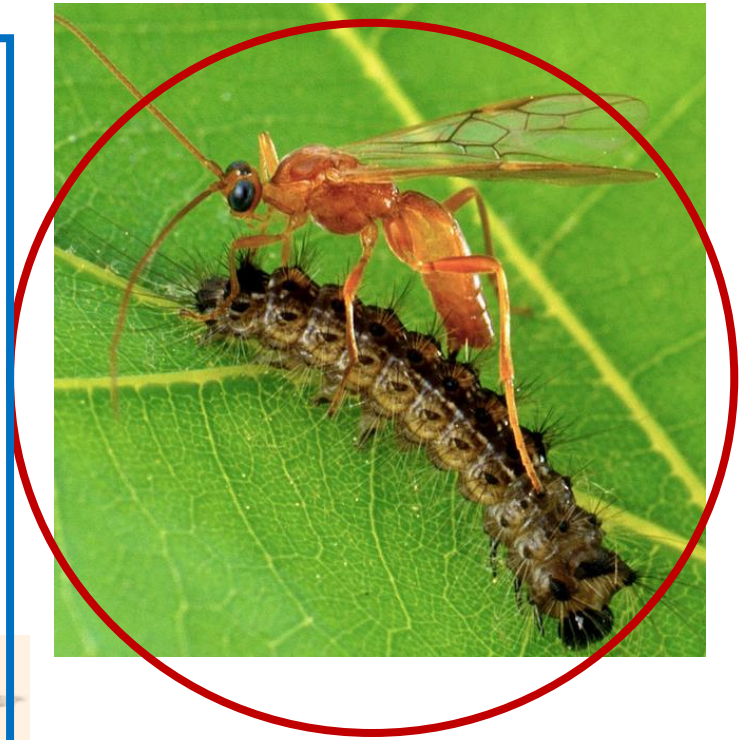
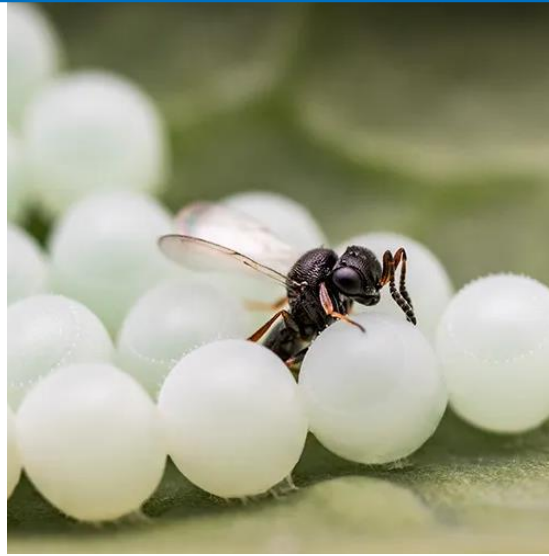
# PARASITOIDS



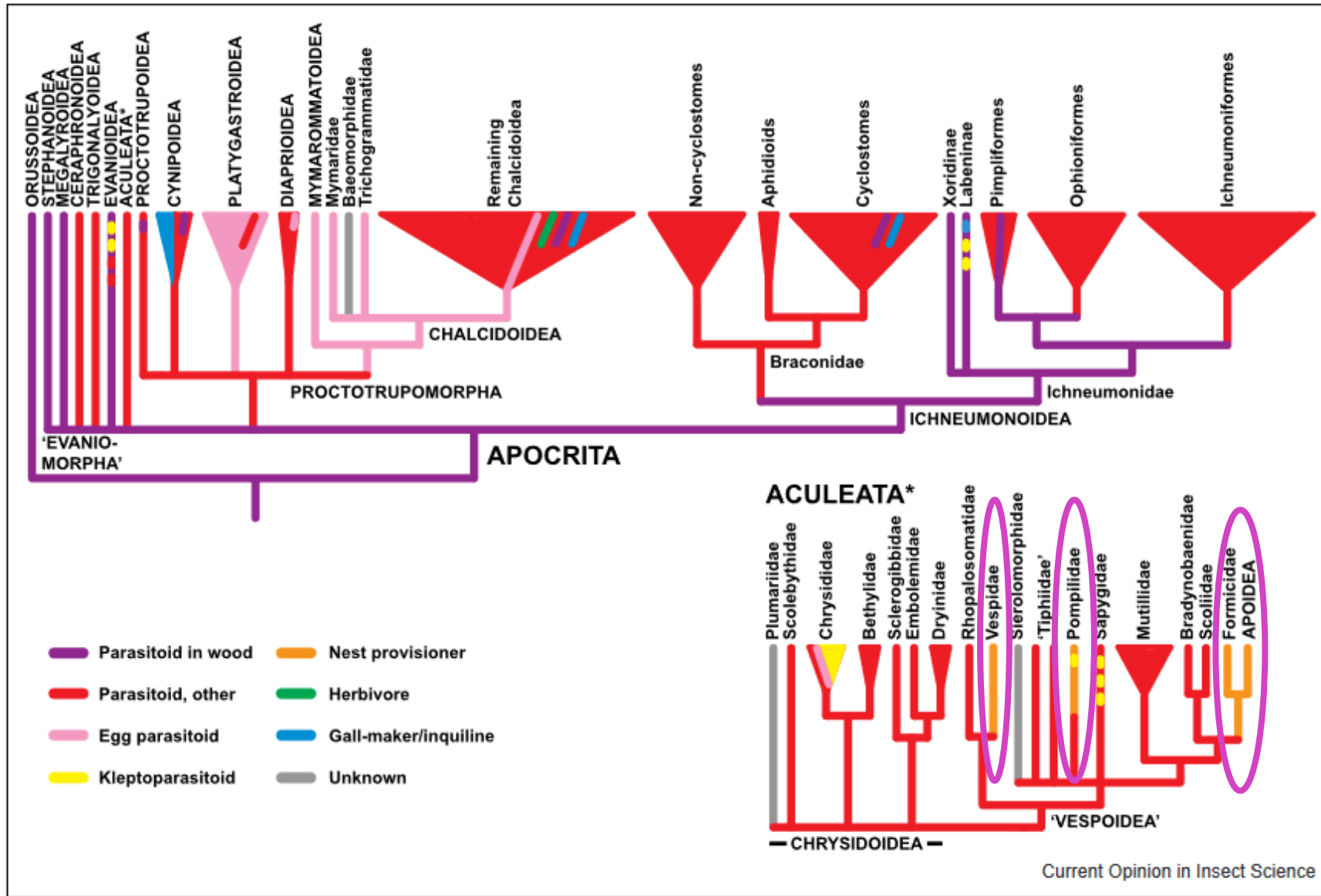
- Adult female lays her eggs *on, in* or occasionally *near* the body of the host.
- The eggs hatch and the developing parasitoid larvae consume the host, eventually killing it.
- Of the estimated 4-8 million species of insects, 1.5 - 2 million are parasitoids!
- Coined by Reuter at the beginning of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

# 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

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- **Ectoparasitoid**- feeds on the host from the outside.
- **Endoparasitoid**- lives within their host's body





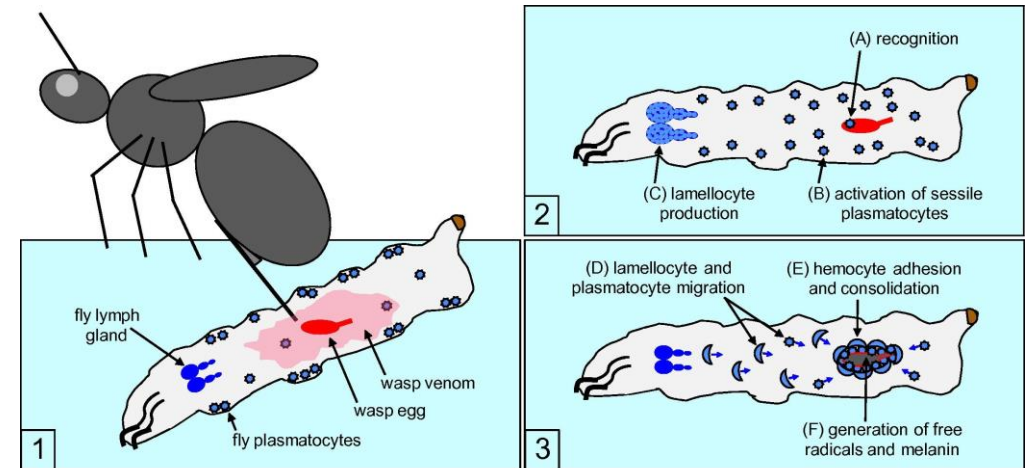
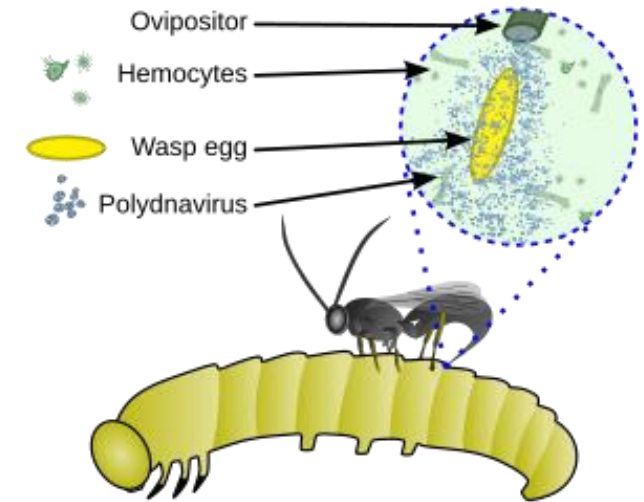
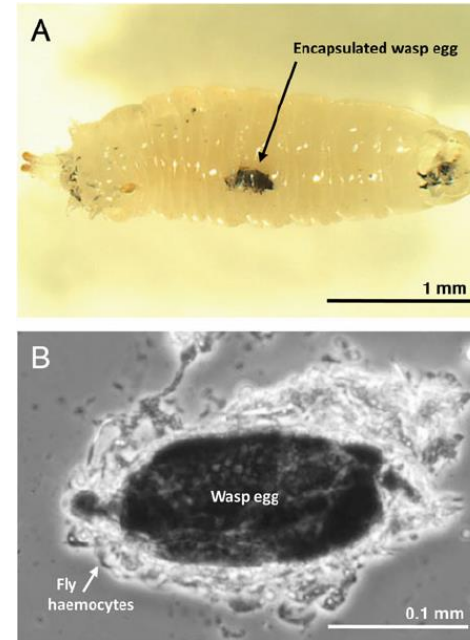
# First challenge: ***BREATHING***

- **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



#### Fly Encapsulation Steps That Wasp Venoms Are Known To Suppress

- (B) *Ganaspis* sp.1 venom SERCA suppresses plasmatocyte calcium burst, preventing activation
- (E) *L. bouleari* venom RhoGap alters lamellocyte cytoskeletal structure, preventing adhesion
- (E) *L. victoriar* unknown venom protein prevents lamellocyte surface protein N-glycosylation, preventing consolidation
- (F) *L. bouleari* venom serpin suppresses phenoloxidase cascade, preventing melanization
- (F) *L. bouleari* extracellular venom SOD suppresses phenoloxidase cascade, preventing melanization

# ***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.

## **Koinobiont**

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

*Trissolcus japonicus*



*Cotesia congregata*





# Social preference

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## **Solitary**

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



# Social preference

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## 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



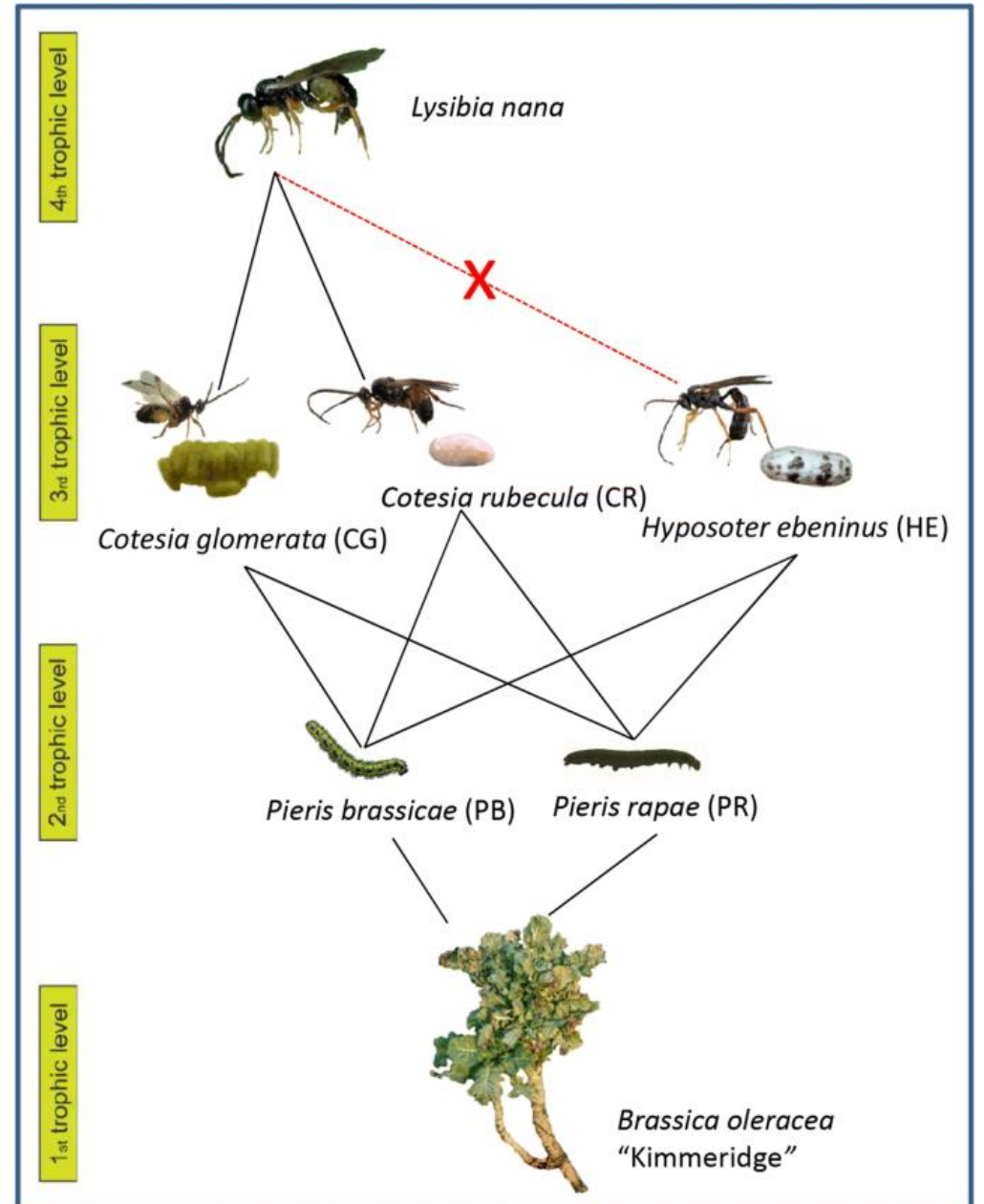
- **Host discrimination:** when parasitoid females avoid previously parasitized hosts; may be aided by chemical marks deposited by the first female.
- **Super-parasitism:** sometimes a second female will add her own eggs to the host already parasitized with an individual of the same species.
- **Multi-parasitism:** 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*

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- 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

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*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

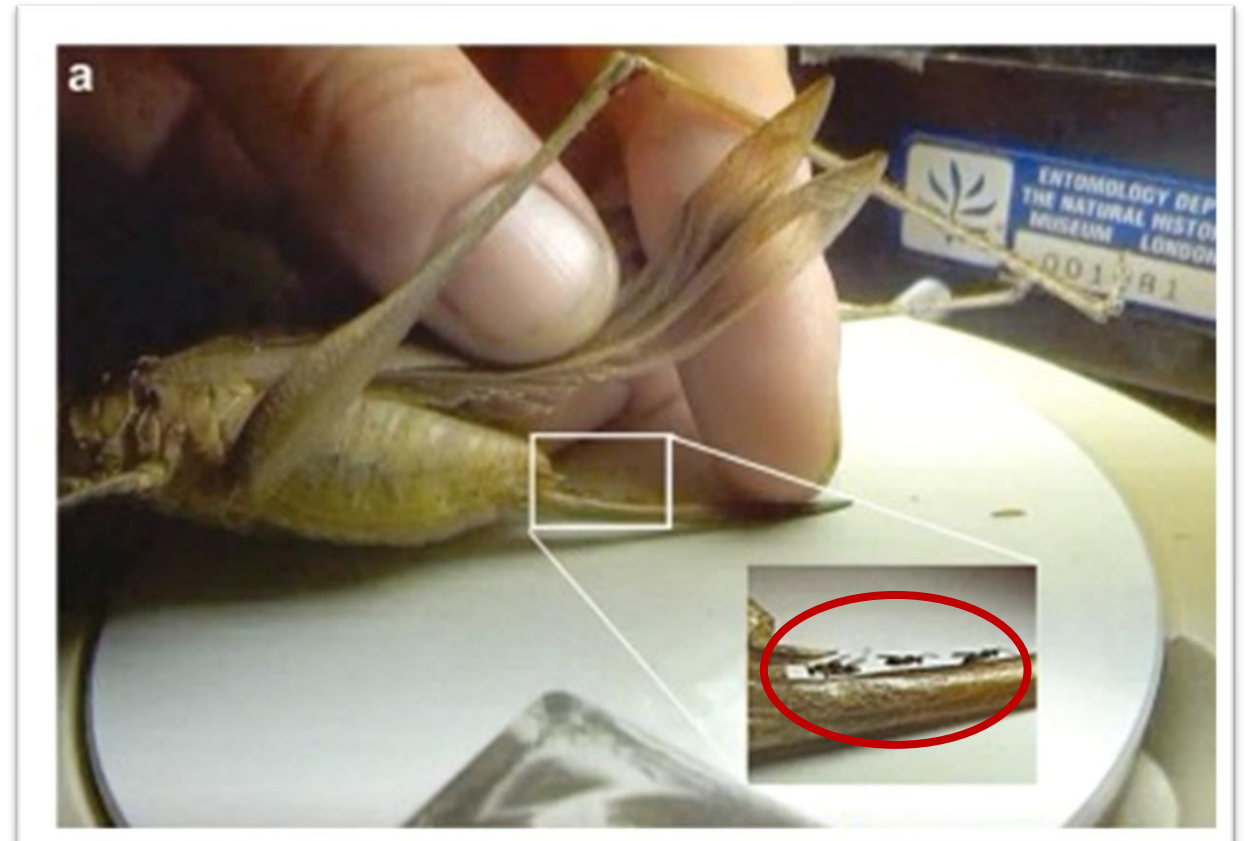
*Trichogramma brassicae*

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



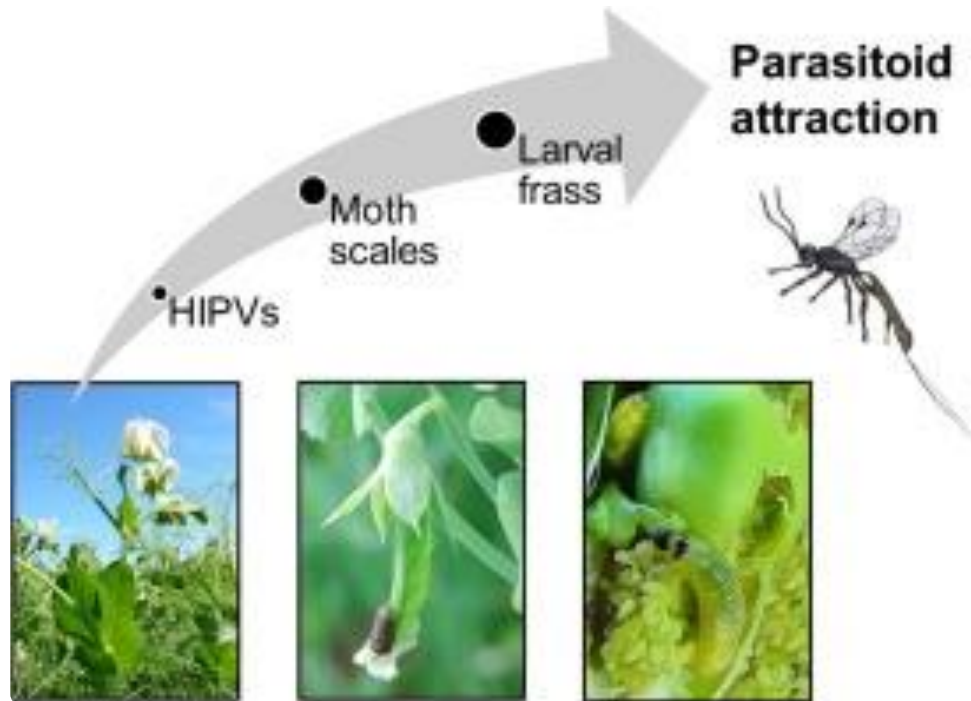
# Virus symbiosis

- 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.



*Coleomegilla maculata*

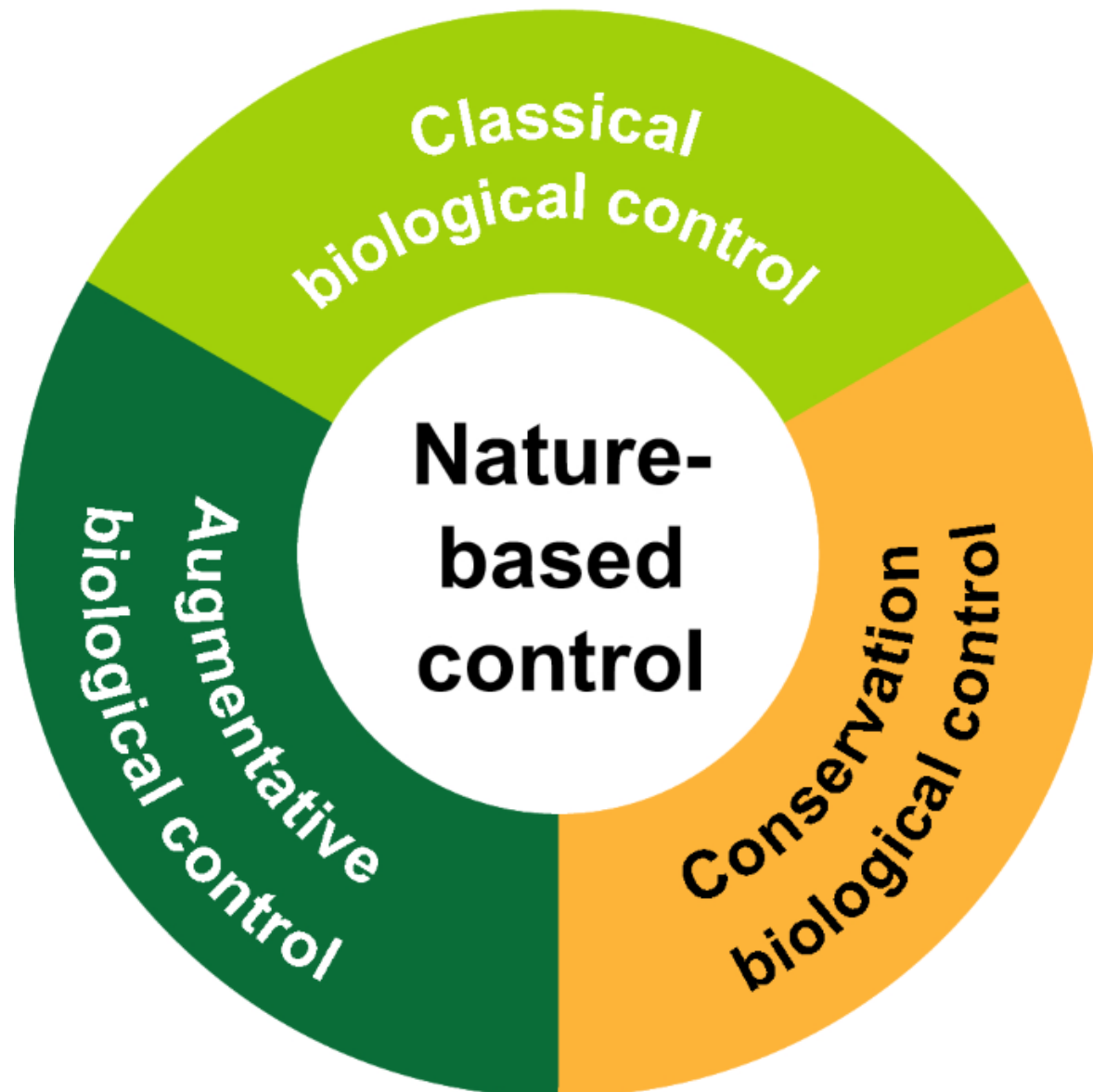
# ***HOST LOCATION***



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



# Conservation biocontrol



## Native Trees Food and Shelter

Alone or in windbreaks, trees such as conifers, willows, or maples provide resources, travel routes, and safe haven for predators, parasites, and insect-feeding birds year-round.



## Perennial Shrubs Food and Shelter

Native shrubs such as oceanspray, elderberry, or rose provide pollen, nectar, and homes for non-pest prey—as well as undisturbed habitat—for predators and parasites.



## Cover Crops Food and Shelter

Including cover crops such as buckwheat and clover in planting rotations helps to build soil and add nutrients while providing patches of flowers to support predator and parasite populations.



## Sunflowers Food and Shelter

Sunflowers support alternative prey and provide nectar and pollen for predators and parasites. They also offer escape cover for insect-feeding birds.



## Insectary Blocks Food and Shelter

Blocks planted with a variety of annuals and perennials such as rose, elderberry, or yarrow can provide resources throughout the year.



## Bat and Bird Nest Boxes Shelter

Bats forage in the air above crops, where they feed upon the flying stages of insects, including pest species. Birds may eat insects and rodents. Providing nest boxes for these animals gives them a home on your farm.

## Harmful Practices

Cultivation, field burning, and broad-spectrum pesticides disturb or kill natural enemies and their non-pest prey. Reducing disturbance and using selective pesticides and non-chemical controls will help minimize impacts.



## Insectary Field Borders and Strips Food and Shelter

A variety of strip plantings—blocks of calendula, alyssum, yarrow, or phacelia, for example—interspersed in and around crops are easily managed to provide resources for beneficial insects at the times and places where they are most valuable.



## Beetle Banks Food and Shelter

Creating permanent raised banks near fields, and densely planting them with bunch grasses, will provide overwintering habitat for predatory beetles and spiders.



## Bolting Crops Food and Shelter

Retaining bolting or flowering crops for a while after harvest may provide beneficial insects with an important nectar source when and where pests are active.



## Wildflower Patches Food and Shelter

Patches of volunteer annuals or innocuous weeds allowed to flower along field edges help provide an unbroken sequence of nectar and pollen during the growing season.



## Conservation Cover Food and Shelter

Sowing crop alleys or field roads with clover or other flowering plants can add soil nutrients and provide resources for predators and parasites through the year.



*Chrytochetum iceryae*



# Classical biocontrol

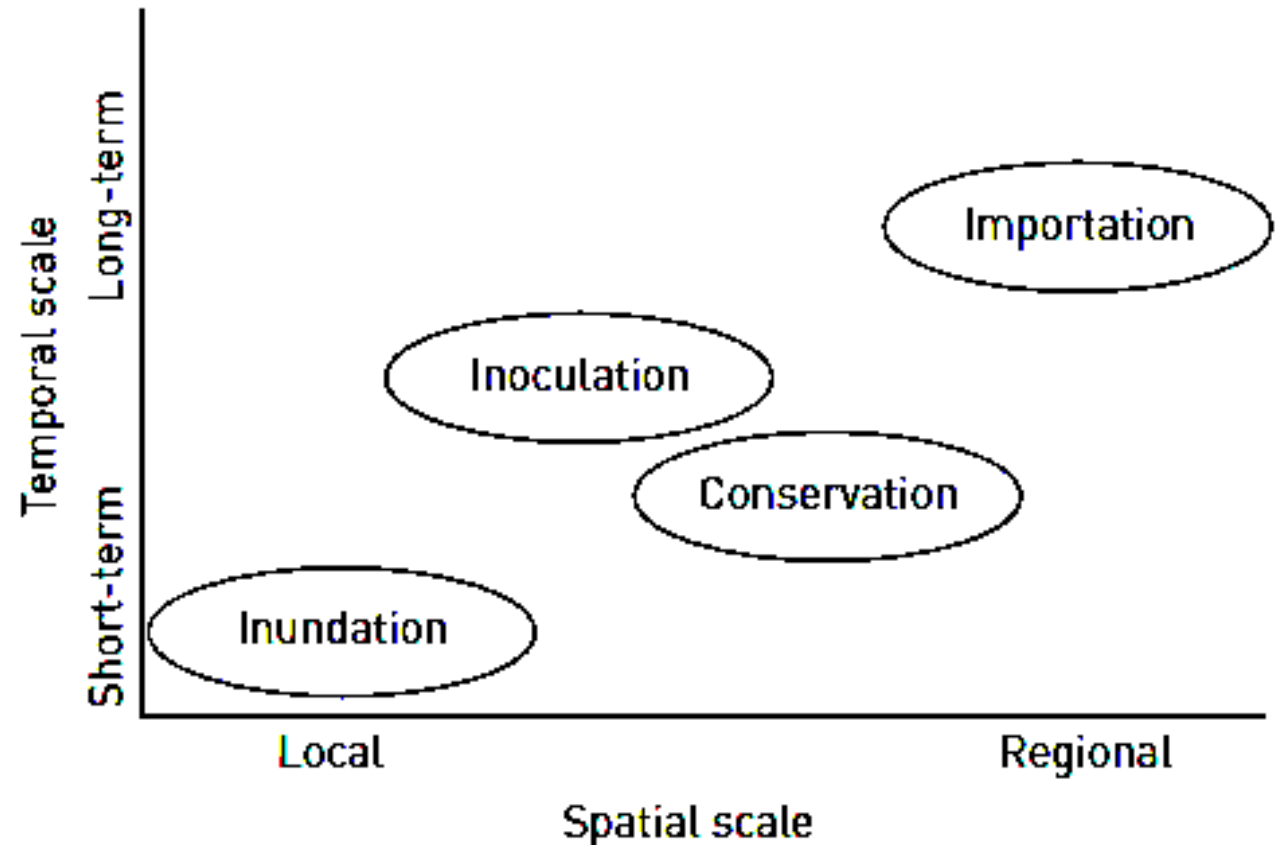
- It involves the discovery, importation, and establishment of exotic natural enemies with the hope that they will suppress a particular organism's population

# 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)

<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>)