Natural enemies of butterflies

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What are the natural causes of mortality in butterflies?

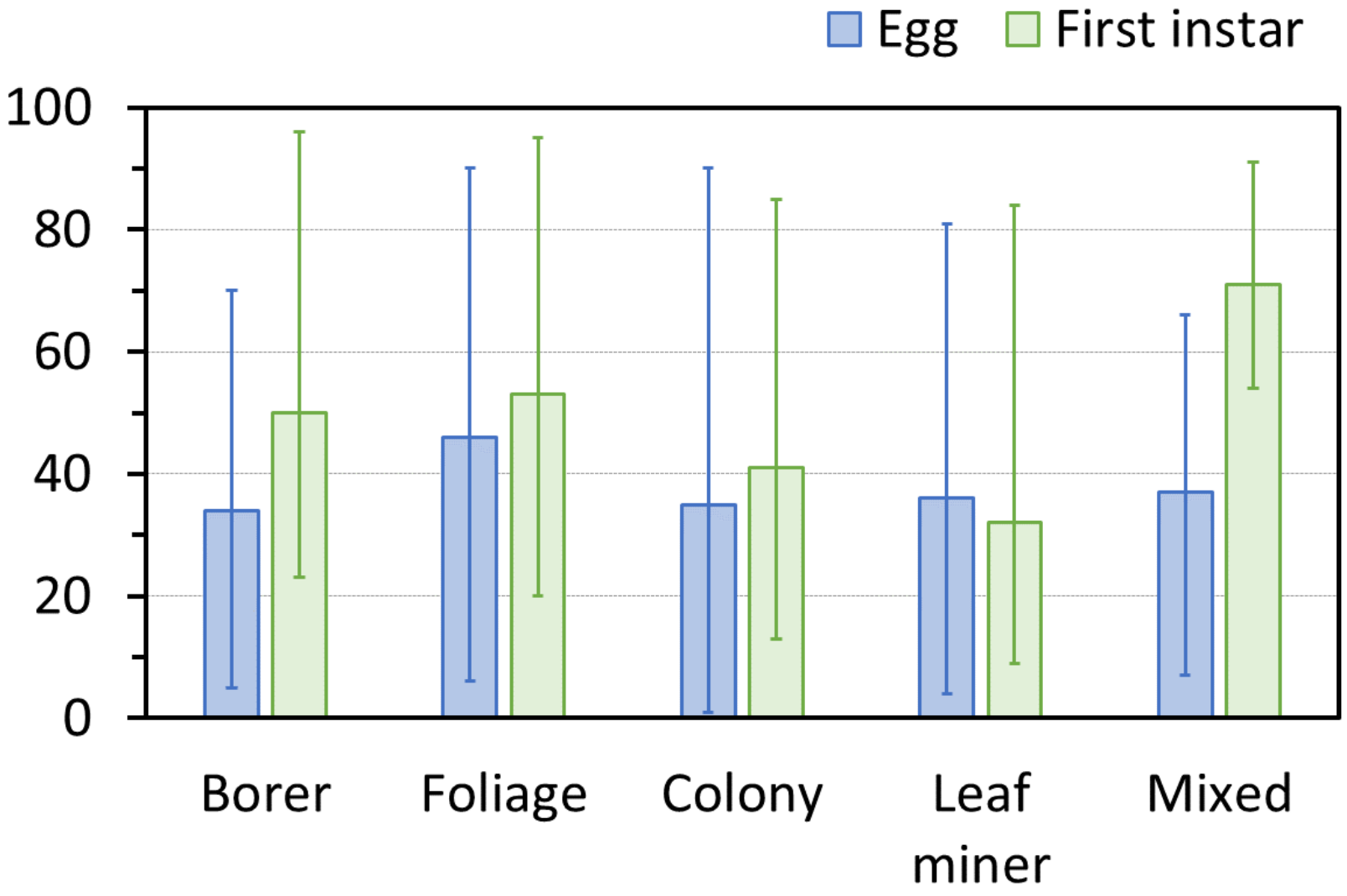
- Host plants
- Predators
- Parasitoids

Derek Ramsey, GNU FDL 1.2

Tony Bailey, I epidoptera.butterflyhouse.com.au/nymp/plexippus.html

Source: M. S. Thomson

Early mortality of Lepidoptera is high

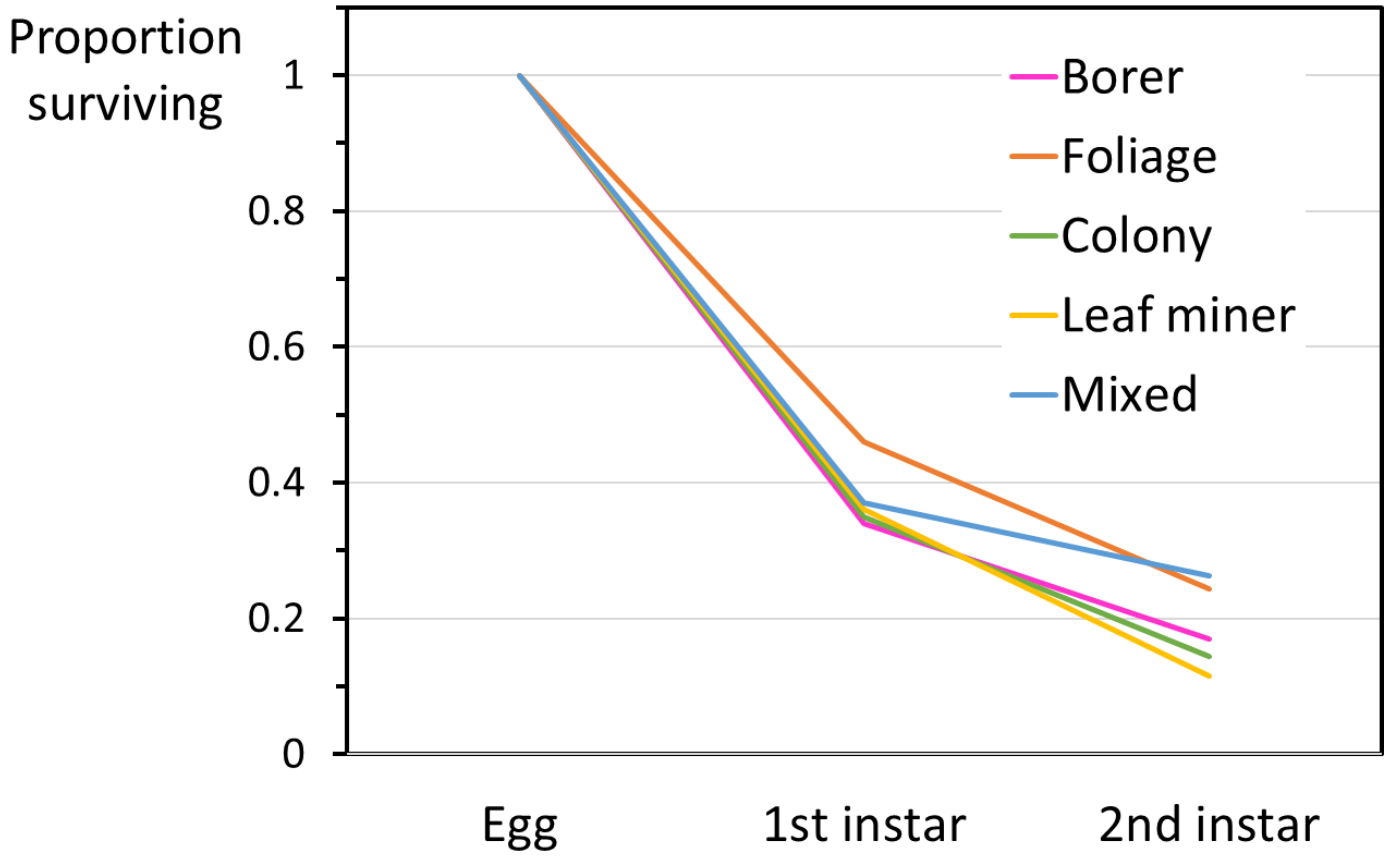


M. P. Zalucki, A. R. Clarke & S B. Malcolm. 2002. Ecology and behavior of first instar larval Lepidoptera. *Annu. Rev. Entomol.* 47:361–93

Causes of early mortality in Lepidoptera

- Predation and parasitism
- Physical factors (rain, wind)
- Host plant defenses
- Movement and failure to locate a host plant

Typical survival of early stages of Lepidoptera



Zalucki MP, Clarke AR, and Malcolm SB (2002) Ecology and behavior of first instar larval Lepidoptera. Annual Review of Entomology 47:361–93.

Eggs and first instars of wanderer butterfly suffer high rates of mortality

- Milkweeds produce toxic cardenolides that are concentrated in the milky sap.
- Even insects that specifically feed on milkweeds can be adversely affected by these toxins

entnemdept.ufl.edu/creatures/bfly/monarch.htm

Padrón, www.floridamuseum.ufl.edu

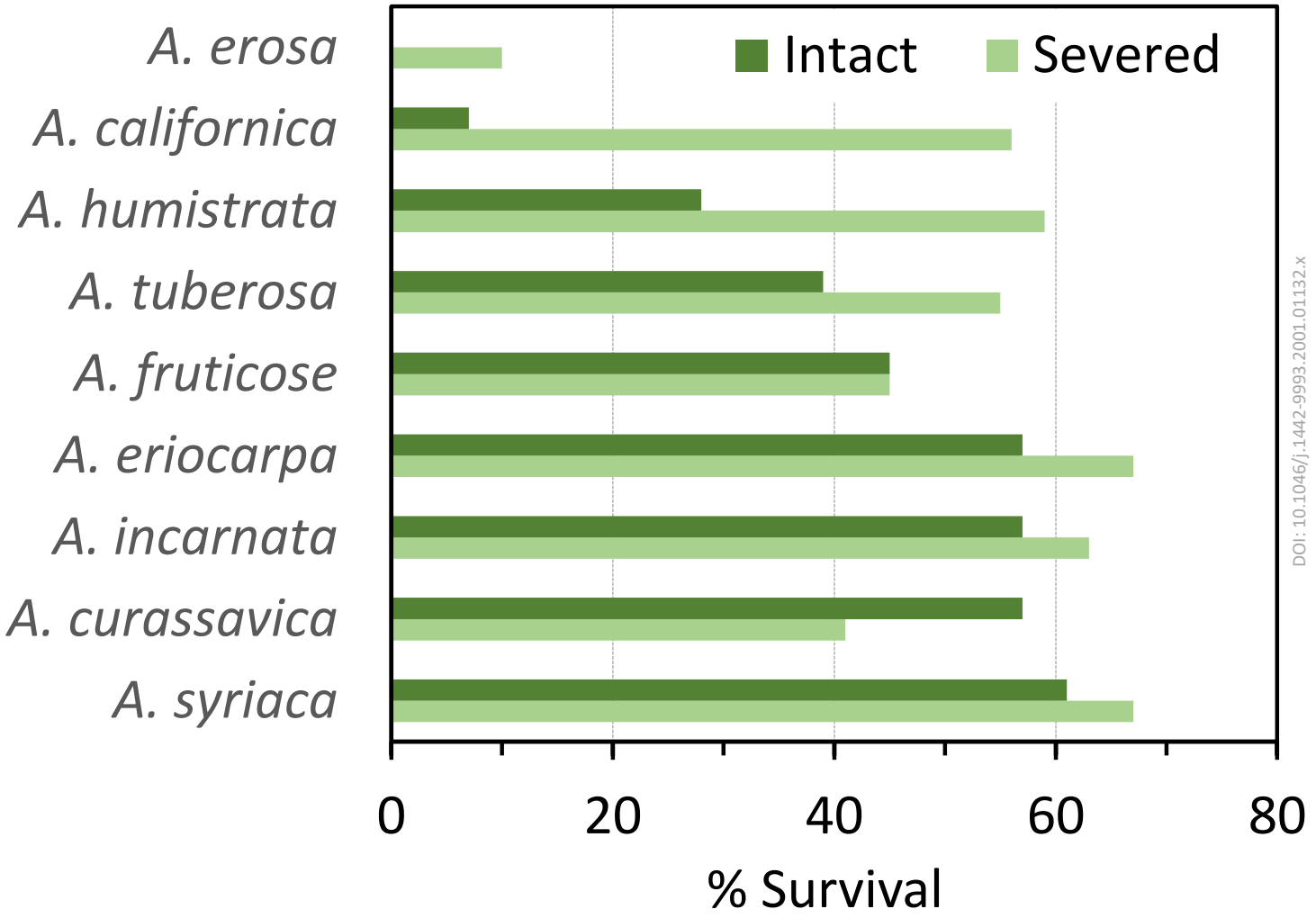
John A Davidson, Univ. Md, College Pk, Bugwood.org

Egg of wanderer butterfly

www.projectnoah.org/spottings/403986050

First instar of wanderer butterfly

Survival of first instar wanderer butterfly is affected by plant species and latex sap

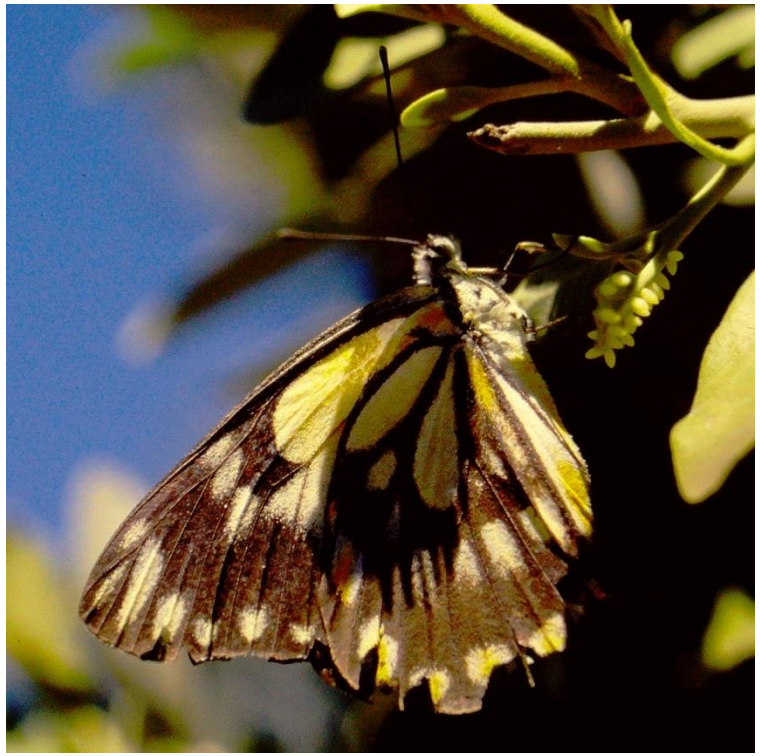


DOI: 10.1046/j.1442-9993.2001.01132.x

Common milkweed
A. syriaca

Pathogens

- Caper white, *Belenois java*, can be infected by a virus



Insectivorous birds

David Cook, (CC BY-NC 2.0) www.flickr.com/photos/kookr/7056077277

Willie wagtail

Benjamint444, (CC BY-SA 3.0), commons.wikimedia.org/wiki/File:Superb_fairy_wrens_mark_2.jpg

Superb fairy wren

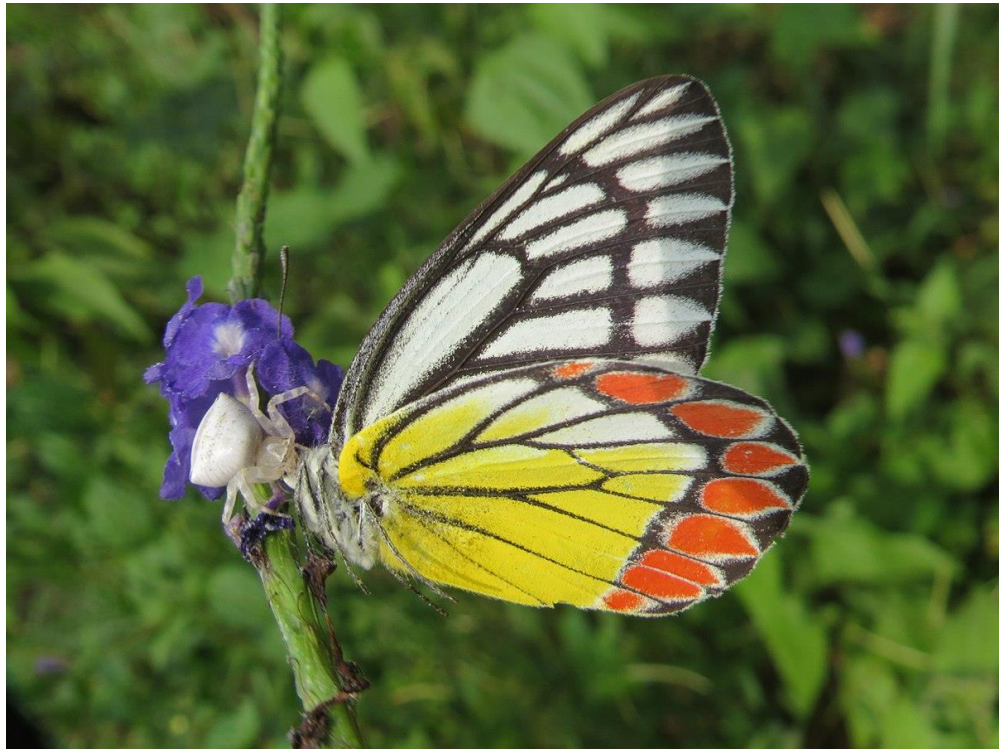
JJ Harrison, **(CC BY-SA 2.5)**, en.wikipedia.org/wiki/File:Phylidonyris_novaehollandiae_Bruny_Island.jpg

New Holland honeyeater

Spiders

Keren Levy, Bugwood.org

Crab spiders (Thomisidae) ambush flower visitors



Vinayaraj, commons.wikimedia.org

Spiders

David Cappaert, Bugwood.org

Jumping spiders,
Salticidae

Reza Hosseini

Wolf spider
Venator spenceri

www.bowerbird.org.au/observations/119799

Jumping spider,
Simaethula sp.

Catherine Herms, The Ohio State University, Bugwood.org

Jumping spider attacking butterfly

Predatory bugs

A pentatomid

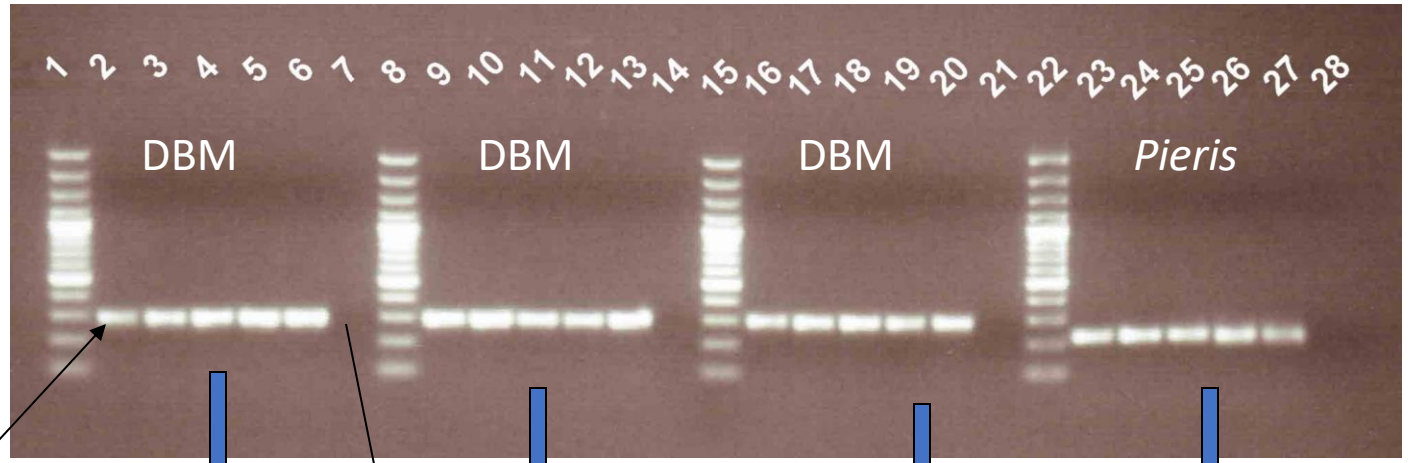
Tony Bailey, l
epidoptera.butterflyhouse.com.au/nymp/plexippus.html

Oechalia schellenbergii

Reza Hosseini

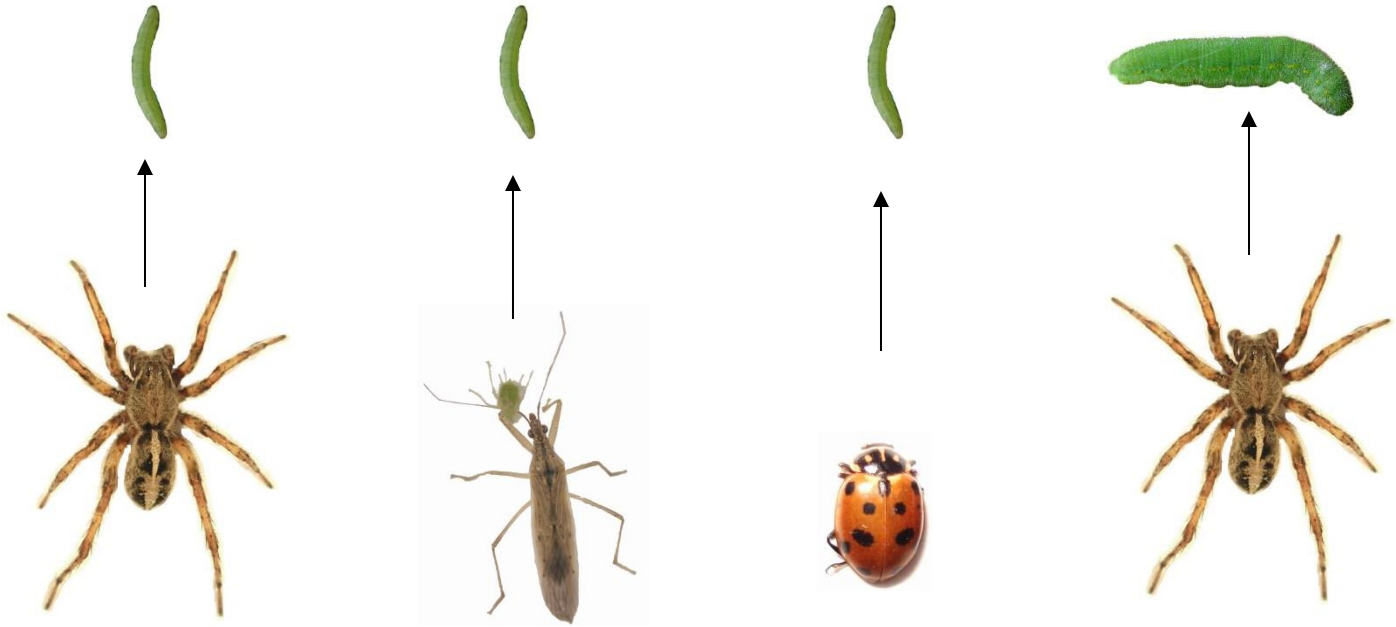
Nabis kinbergii

Detection of prey DNA in gut contents of predators

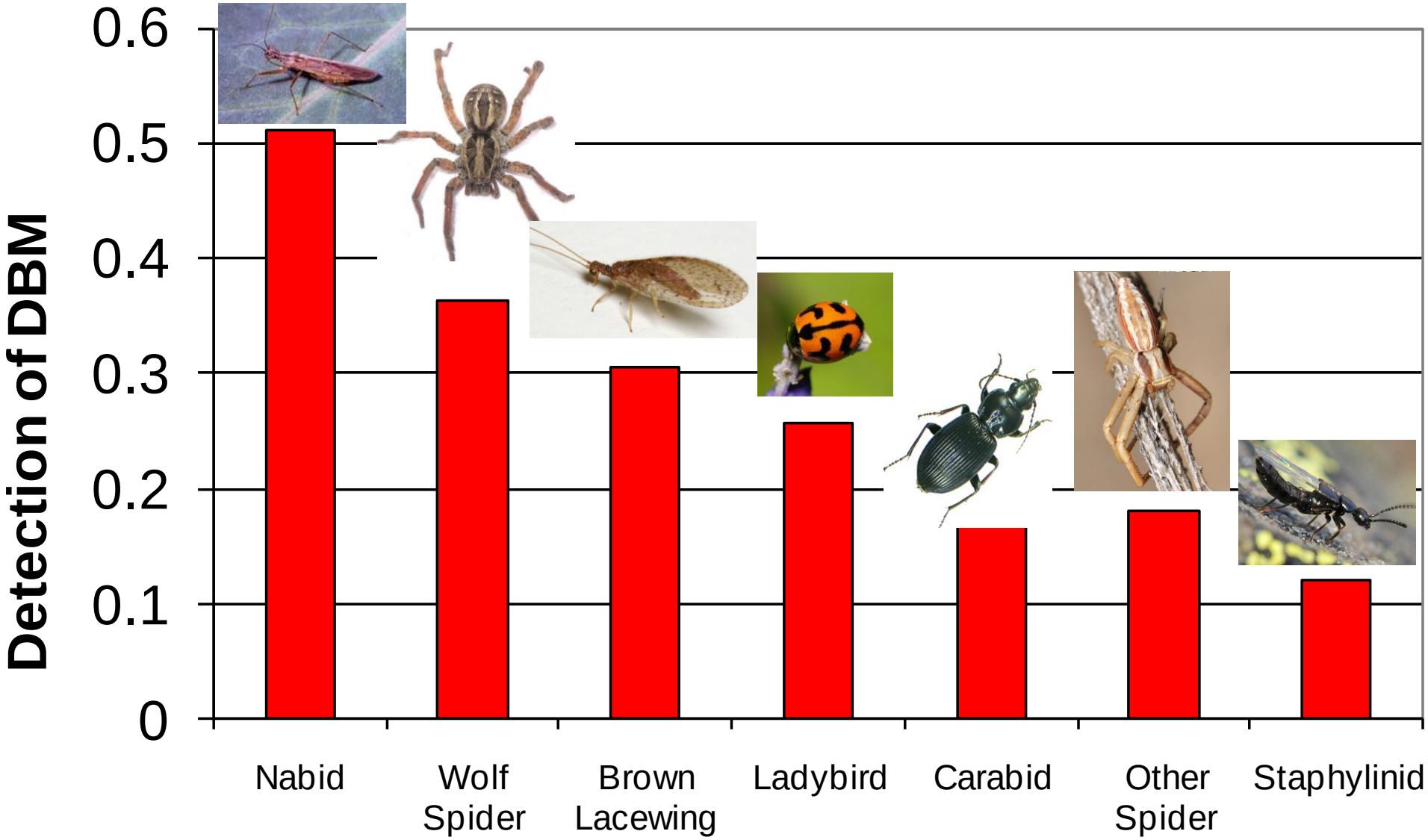


Positive control

Negative crl.



Consumption of diamondback moth by predators



What is a parasitoid?

- Larvae of a parasitoid feed on and develop in association with a single host insect and usually kill it.
- All insect parasitoids are holometabolous – their development includes egg, larval, pupal and adult stages

Cotesia glomerata stinging a larva of *Peiris rapae*

Cotesia rubecula (Hymeoptera: Braconidae)

Types of parasitism

- Ectoparasitism - larvae develop externally, usually with their mouthparts buried in the body of their host

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Ectoparasitoid: Larvae of the wasp *Euplectrus agaristae* parasitising a larva of the grapevine moth

- Endoparasitism - larvae feed and develop within the body of their host

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Endoparasitoid: Larva of the wasp *Cotesia rubecula* parasitising a larva of *Pieris rapae*

Types of parasitism

- Idiobiont - host development is arrested by oviposition
- The food resources available to the parasitoid are fixed

Source: M. S. Thomson

Trichogramma exiguum parasitises the eggs of Lepidoptera. It is an idiobiont.

- Koinobiont - hosts to continue to develop after oviposition
- Host development can extend the amount of food available to the developing parasitoid

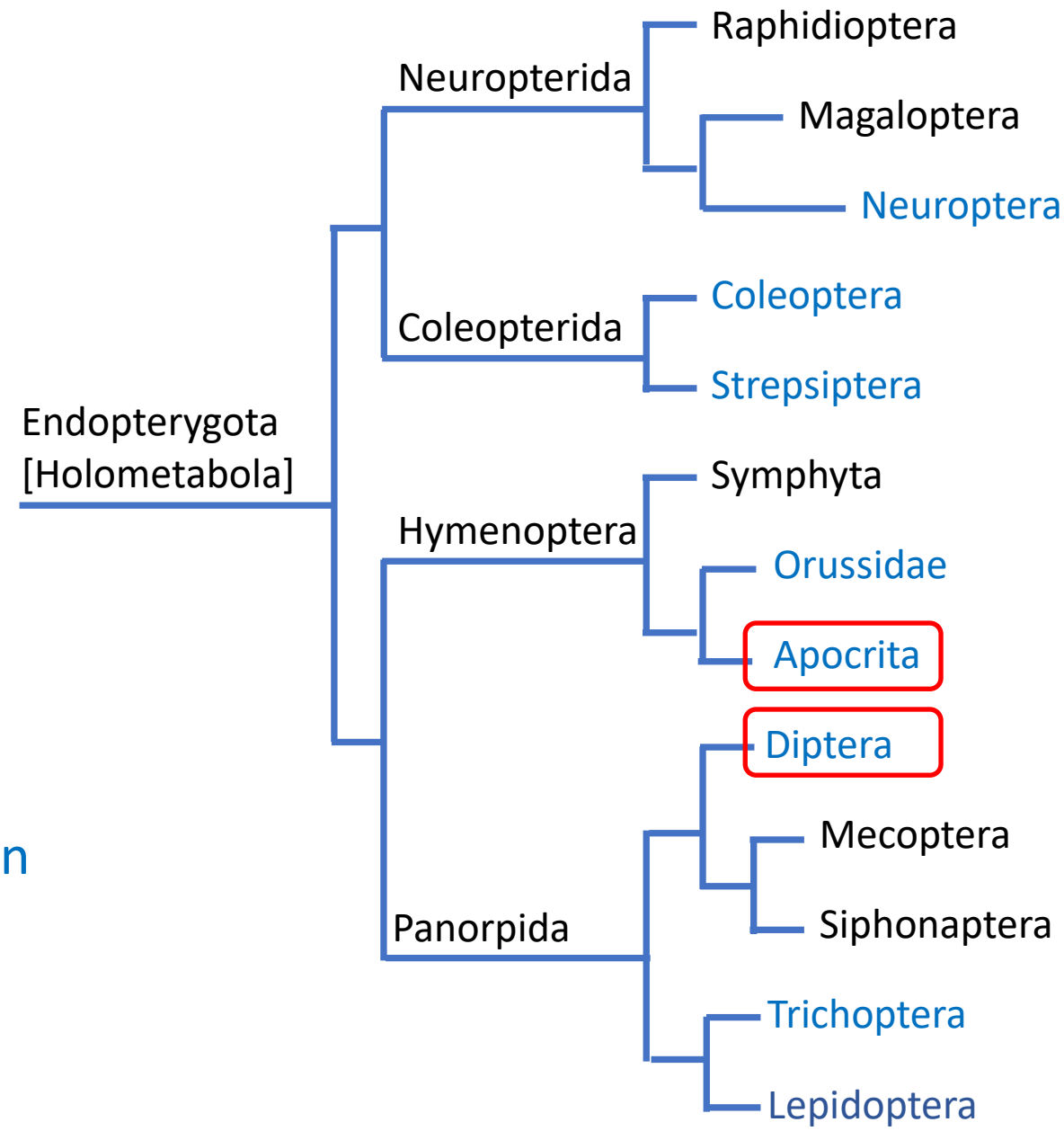
Modes of parasitism

Solitary vs. gregarious parasitoids

- Solitary parasitoids – only one individual normally develops in one host
- Gregarious parasitoids – more than one parasitoid normally parasitises one host

- Superparasitism – more parasitoids attack a host than can normally develop on it
- Multiparasitism – a host is parasitised by more than one species
- Hyperparasitism – a parasitoid is parasitised by another parasitoid

Taxonomic range of parasitoid insects



Groups that contain parasitoids are shown in blue

Hymenoptera: Apocrita

- This is the most diverse group of insects!

Source: USDA

Trichogramma pretiosum
Parasitising lepidopteran egg

Source: news.science360.gov

Aphidius ervi parasitising an aphid

Source: agresearchmag.ars.usda.gov

Pteromalus puparum
on fly puparium

Source: Jian Duan

Spathius galinae parasitises the larvae of emerald ash borer inside ash trees

Orgilus lepidus parasitises larval potato tuber moth

Euplectrus agaristae is an external parasitoid of grapevine moth

Photo: M. S. Thomson

Trichogramma exiguum parasitises the eggs of Lepidoptera. It is about 0.5 mm long!

Parasitic Diptera

- ~16,000 described species of Diptera are parasitoids
- Parasitoid lifecycle has evolved >100 times in Diptera!

Source: Univ. of California

Eggs of a tachinid on
a lepidopteran larva

Source: hedy2411

Source: Clarice

Voria ruralis (Tachinidae)
parasitises lepidopteran larvae

Parasitoids of *Epiphyas postvittana*

Brachymeria phya

Pupa

Adult

Egg

Trichogramma carverae

Dolichogenidea tasmanica

L_1

L_2

L_3

L_4

L_5

L_6

Therophilus unimaculatus

Voriella uniseta

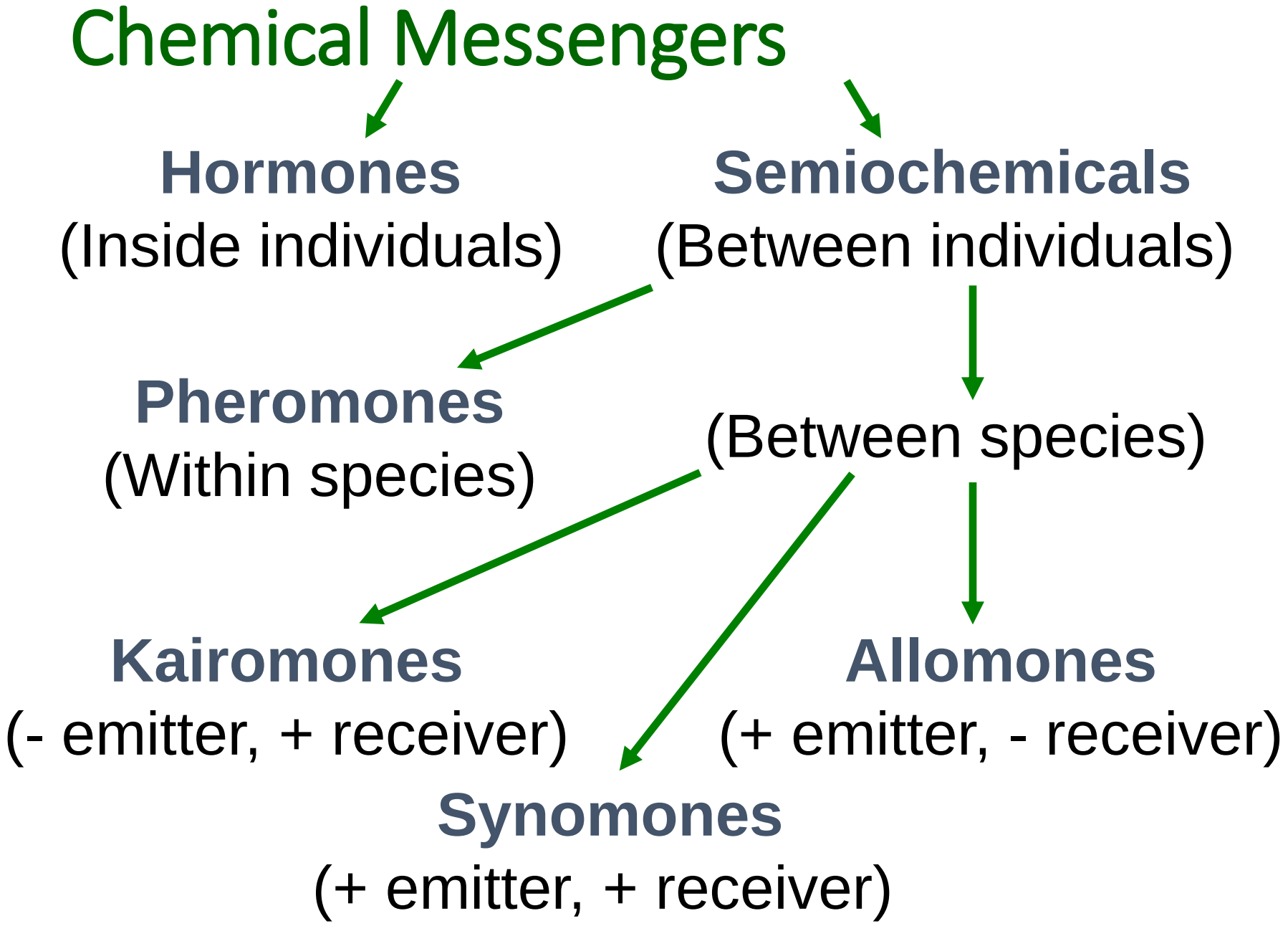
Hymenopteran reproduction

- Many species exhibit haplodiploid reproduction
  - Females are diploid
  - Males are haploid
- Females control the sex of offspring by choosing to fertilise eggs when laying them
- Often sex ratios are biased toward females.

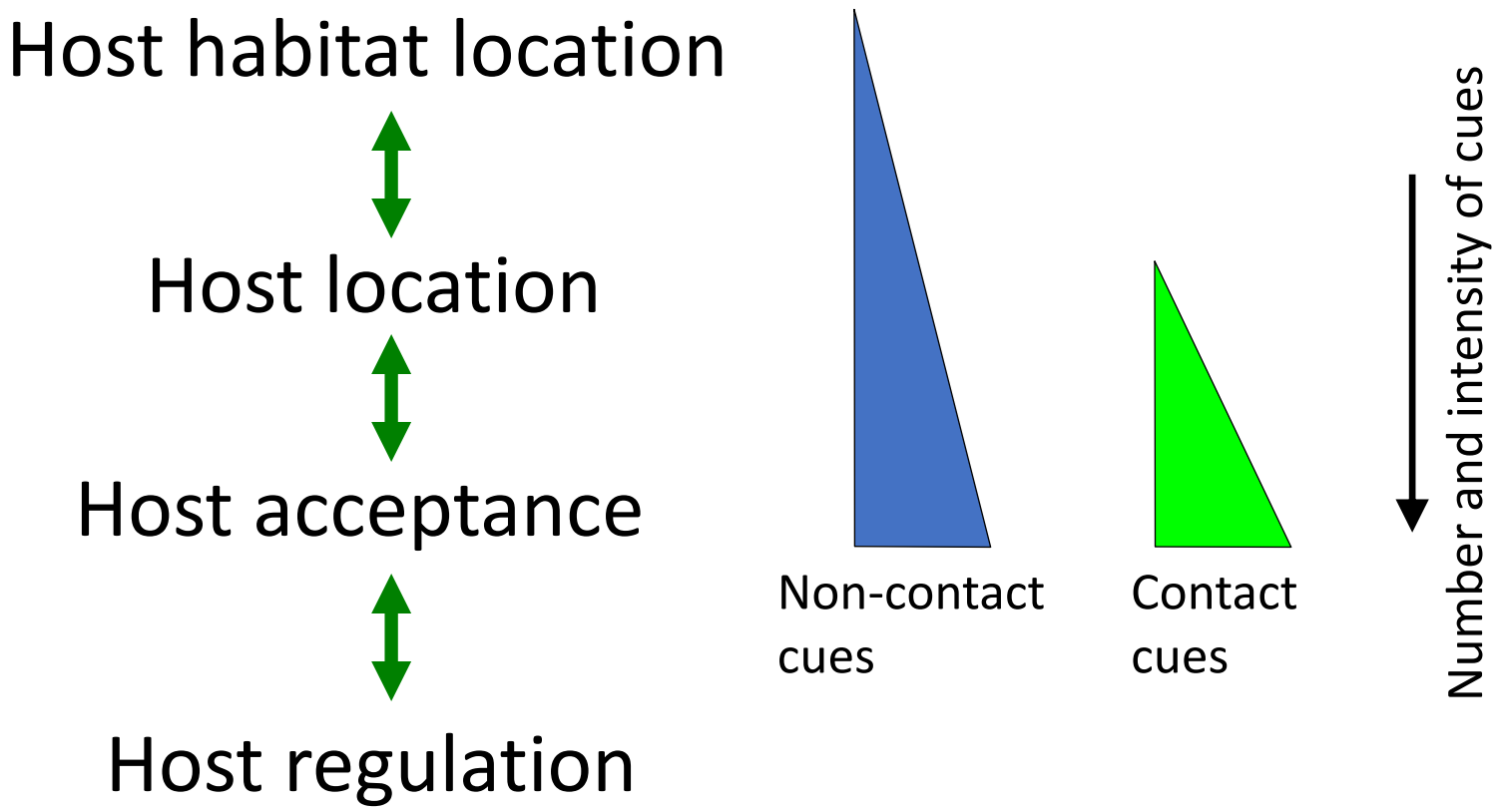
Complementary sex determination

- Species have several to many sex-determining alleles
- If any sex allele is heterozygous, then the offspring is female
- If all sex alleles are homozygous or hemizygous, then the offspring are male
- Diploid males typically don’t develop to maturity; those that do develop are sterile

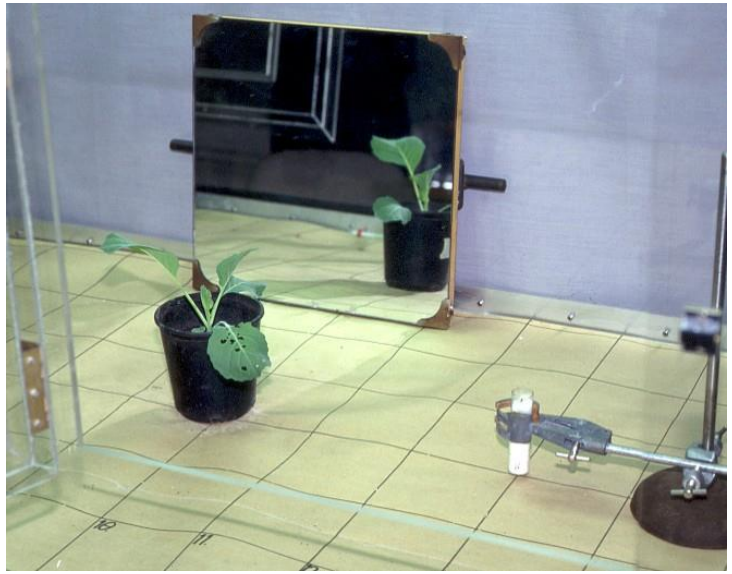
What factors influence the searching behaviour of parasitic wasps?


Chemical Messengers
Hormones
(Inside individuals)
Semiochemicals
(Between individuals)
Pheromones
(Within species)
(Between species)
Kairomones
(- emitter, + receiver)
Allomones
(+ emitter, - receiver)
Synomones
(+ emitter, + receiver)

Host selection by parasitoids

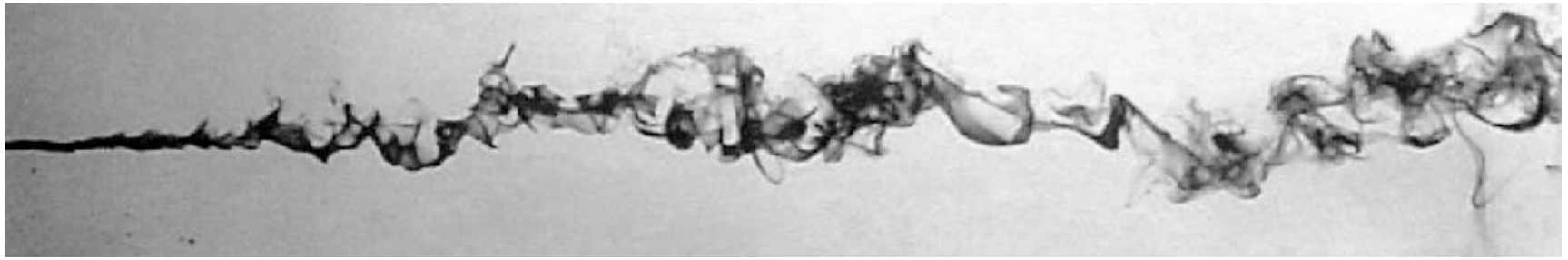


Experiments on the behavior of parasitoids



Navigation in flying insects

Odour plume
In a wind tunel



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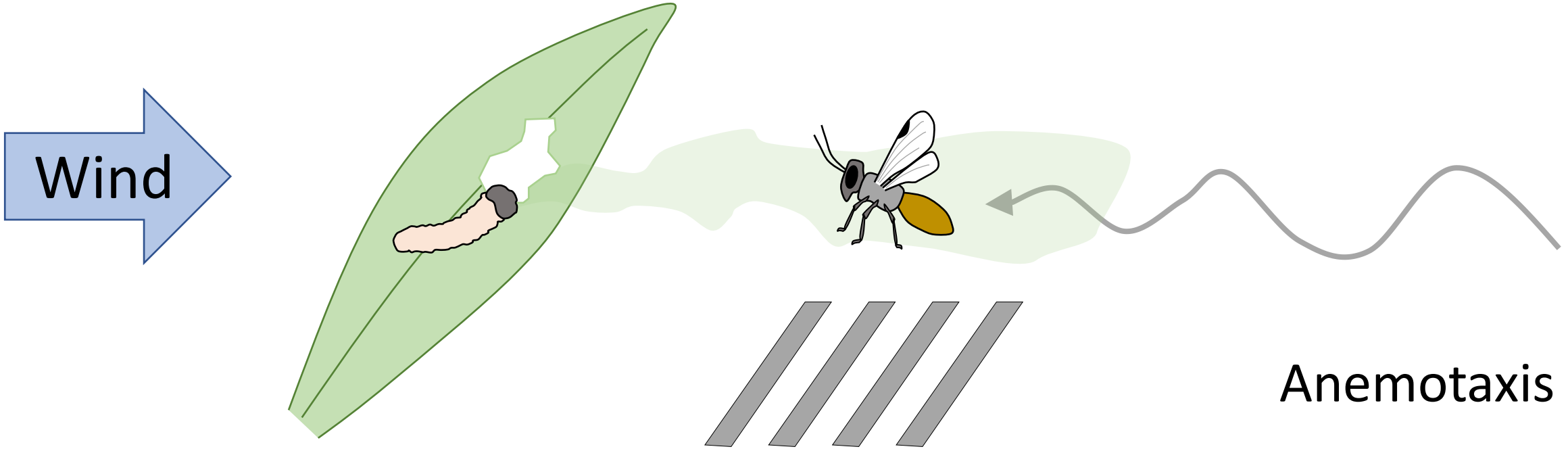

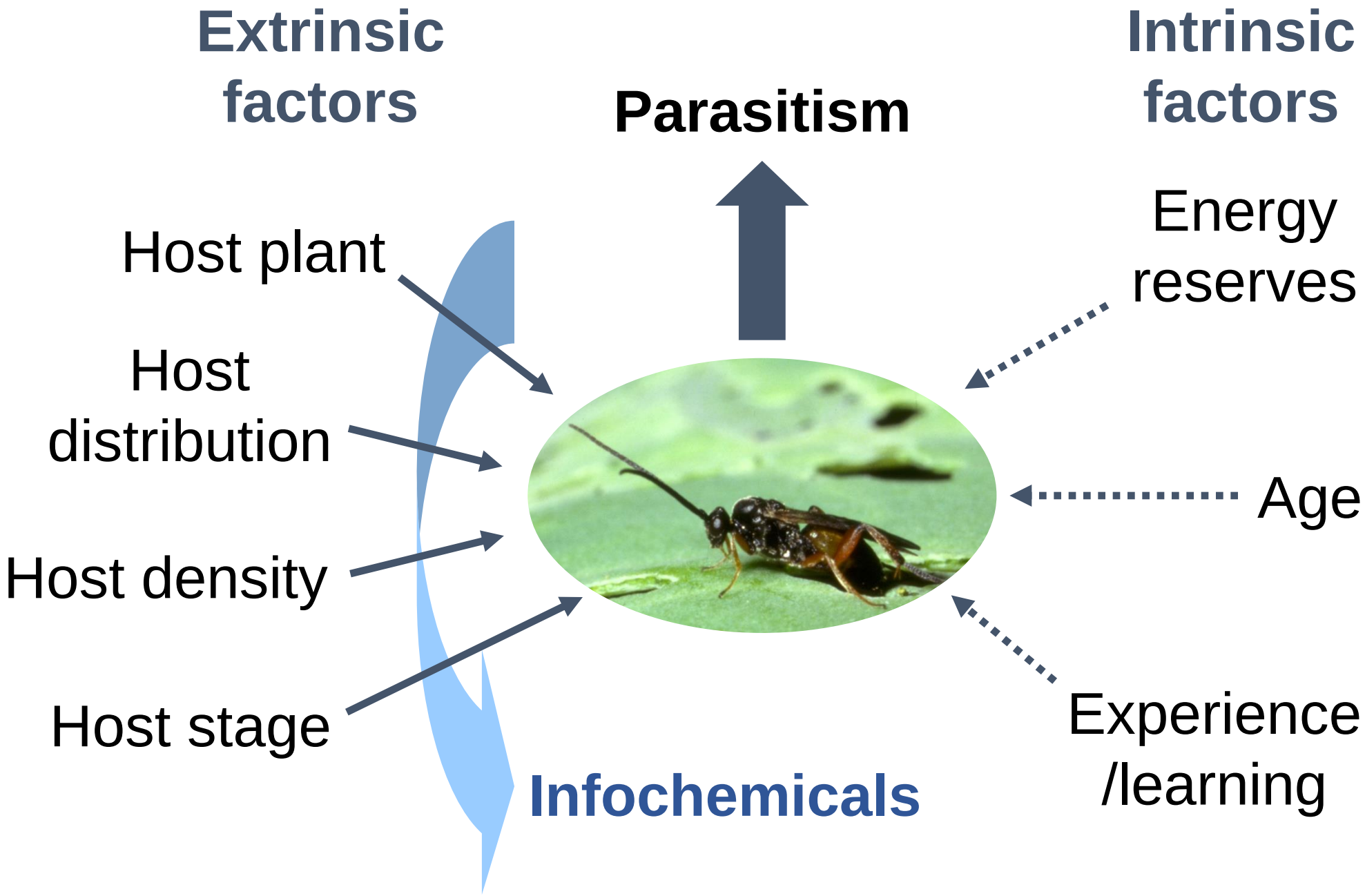
Extrinsic factors
Parasitism
Intrinsic factors
Host plant
Host distribution
Host density
Host stage
Energy reserves
Age
Experience /learning
Infochemicals

Host plants, predators and parasitoids threaten the survival of butterflies

Derek Ramsey, GNU FDL 1.2

Tony Bailey, l epidoptera.butterflyhouse.com.au/nymp/plexippus.html

Source: M. S. Thomson