Host plants of golden paintbrush influence its suitability as a food source for checkerspot butterfly larvae

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Indirect species interactions

Indirect species interactions can shape communities and ecosystems

Wolves

↕

Elk

↕

Plant community

Figure: Smith *et al.* 2003

Indirect species interactions can shape communities and ecosystems

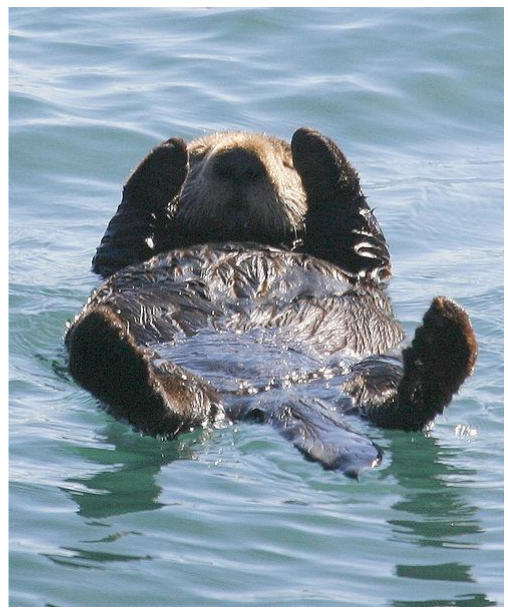
Sea otter

$\updownarrow$

Urchins

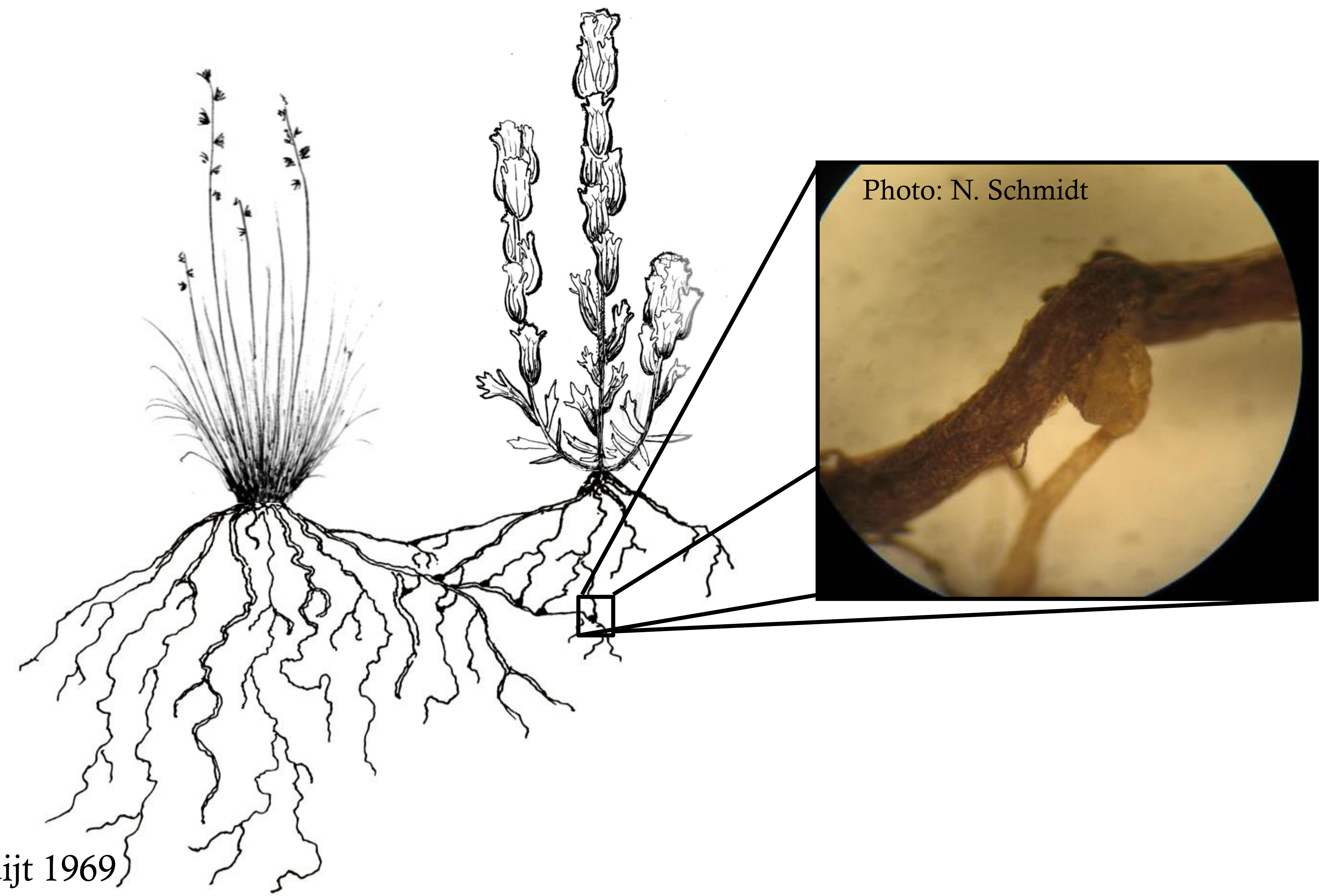
$\updownarrow$

Kelp forest



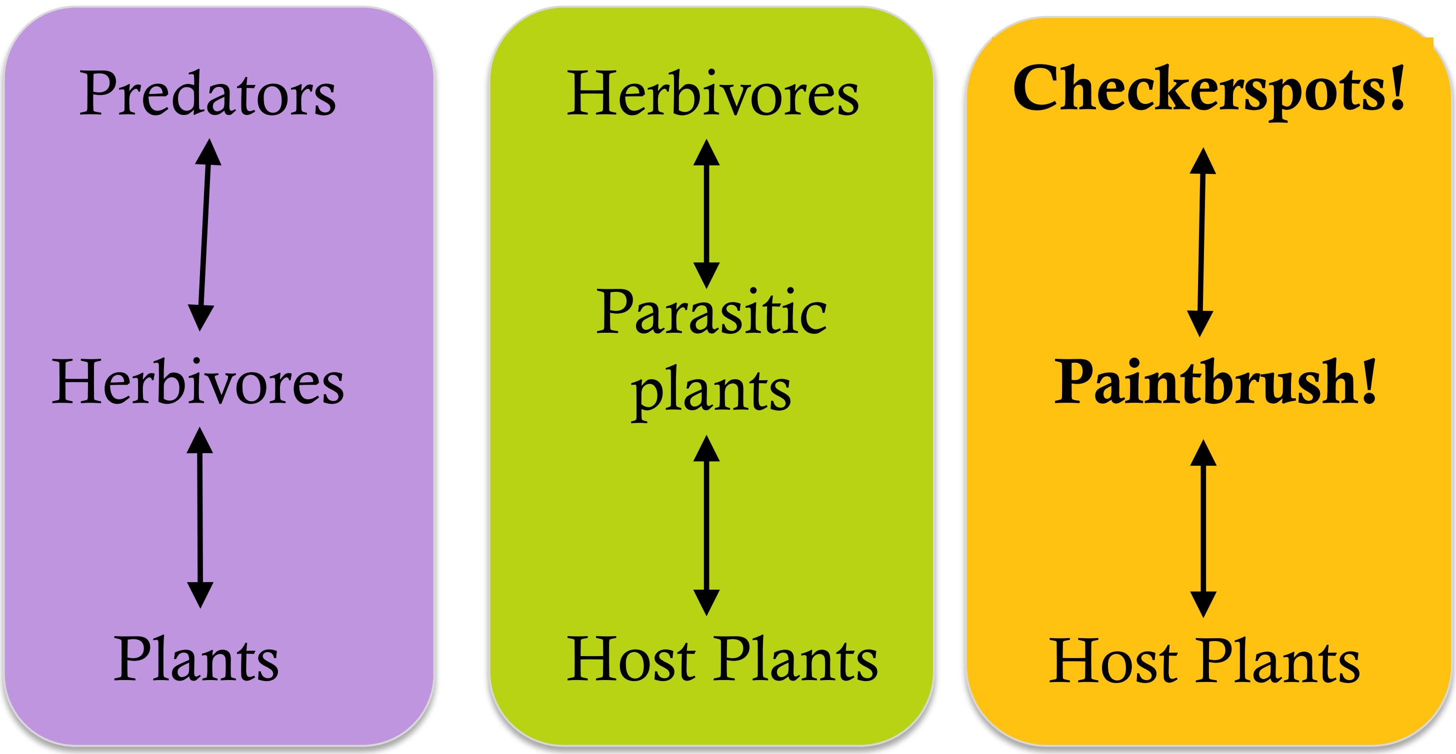
Otter: Michael L. Baird, creative commons. Kelp: Stef Maruch, creative commons

Parasitic plants



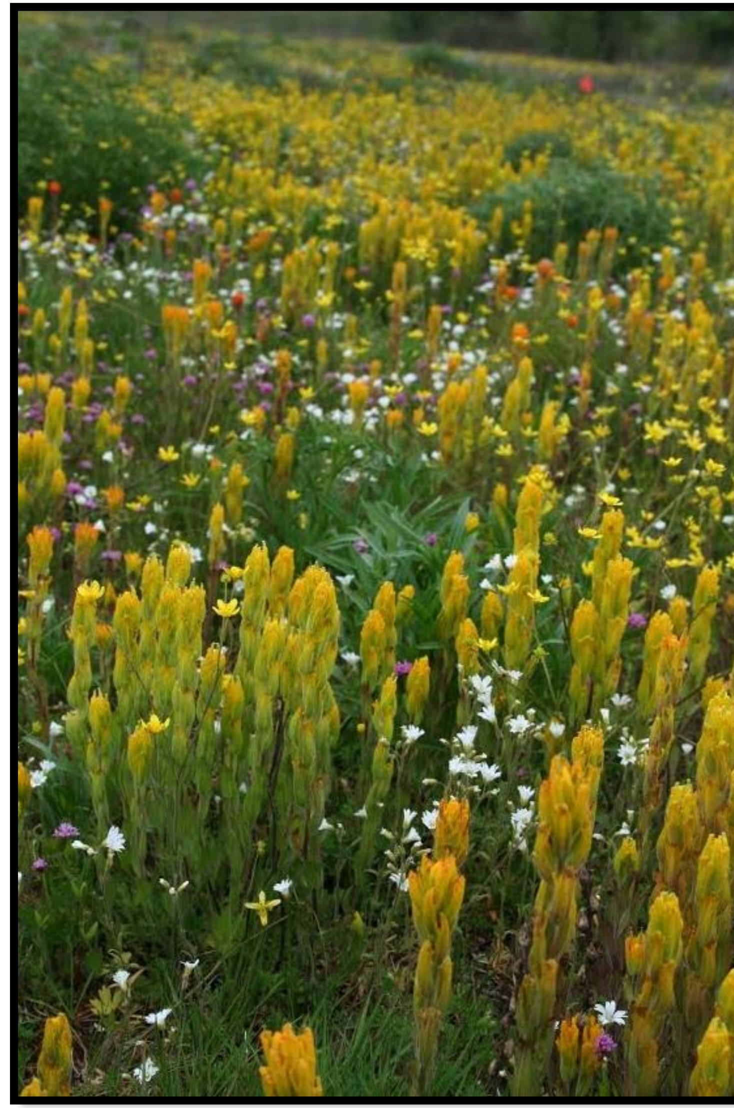
Kuijt 1969

Parasitic plants and indirect interactions



Golden paintbrush (*Castilleja levisecta*)

- Orobanchaceae (Scrophulariaceae)
- Facultative hemiparasite
- Host **generalist**



Taylor's checkerspot (*Euphydryas editha taylori*)

Eggs

Second instar

Fourth instar

Taylor's checkerspot
(*Euphydryas editha taylori*)

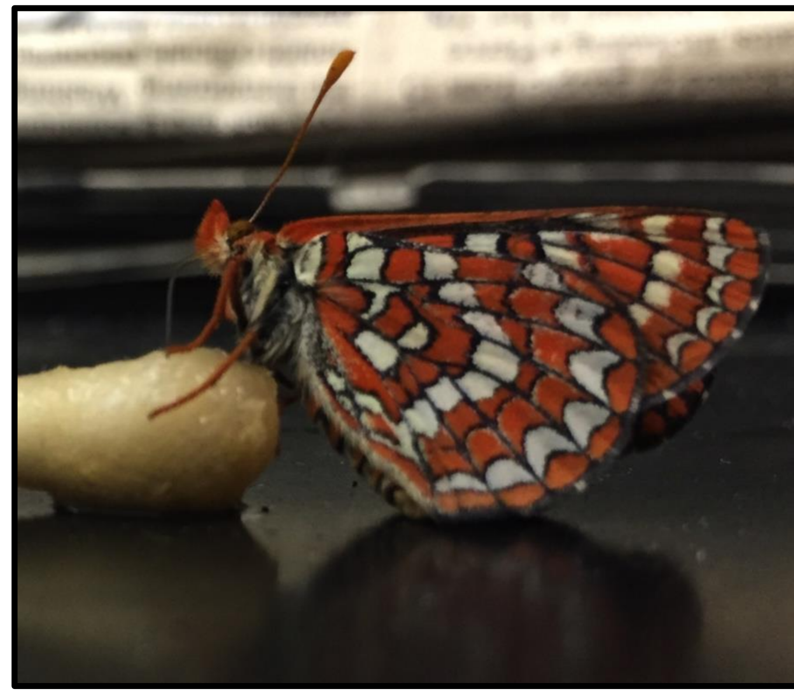
Fifth instar

Pupa

Adult

Surrogate species: E.e. colonia

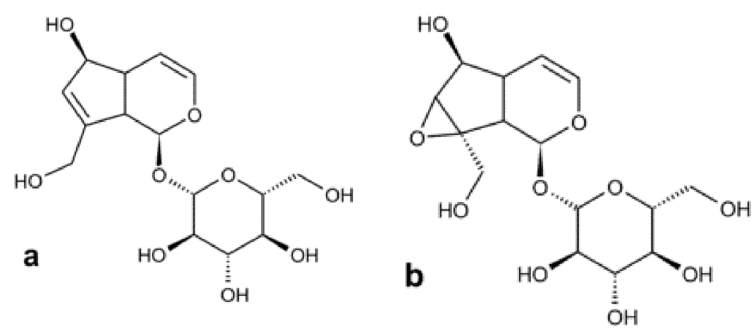
E.e. taylori



E.e. colonia

The checkerspot diet

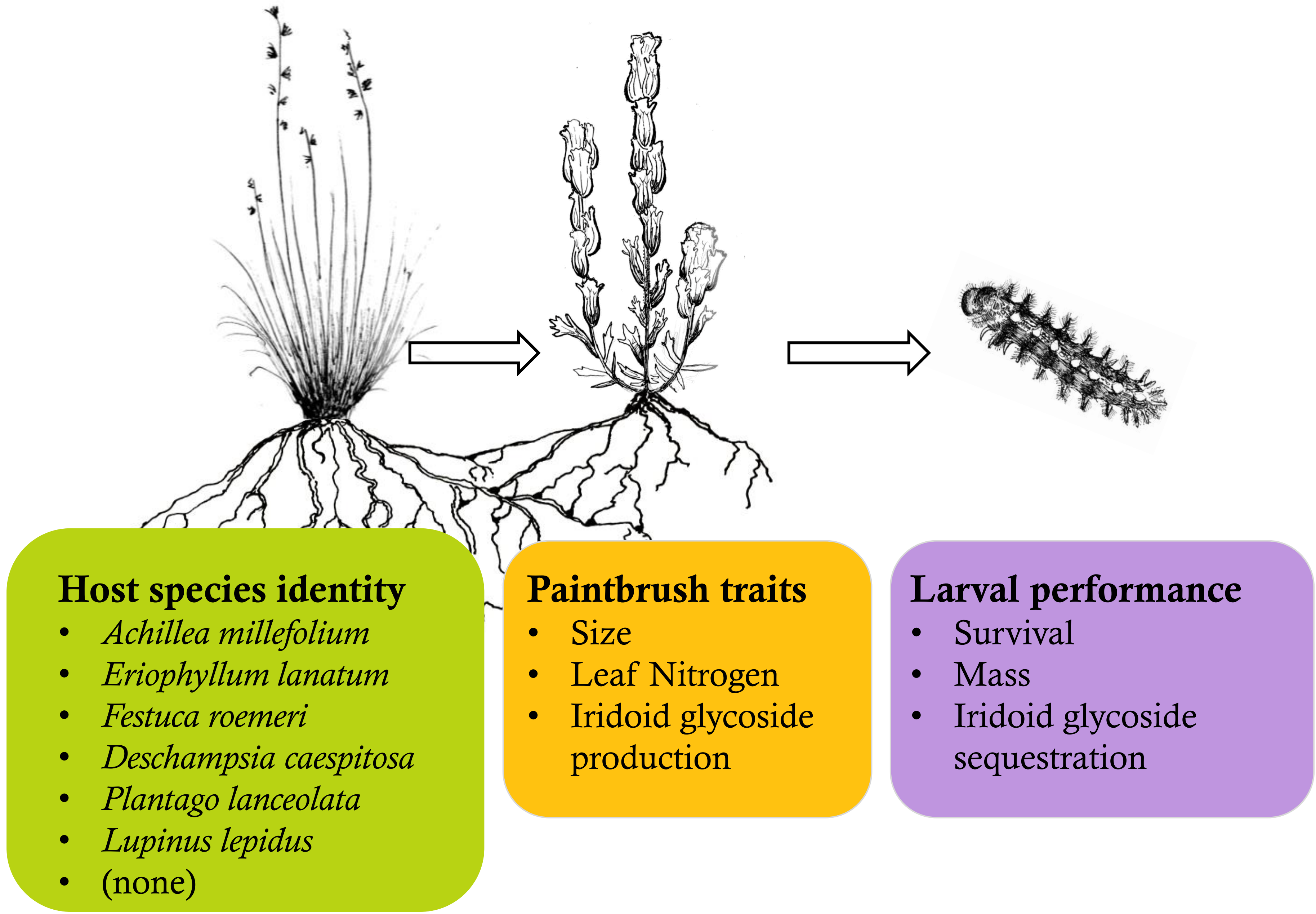
- Orobanchaceae, Plantaginaceae, a few other families
- In South Sound:
  - *Castilleja hispida*
  - *Castilleja levisecta*
  - *Plantago lanceolata*
- **Iridoid glycosides**



aucubin catalpol

Bowers 1980, 1983; Gardner & Stermitz 1988, Bowers & Williams 1995, Bowers 1991, Dobler *et al*. 2011.

Molecular structure illustrations: Dobler *et al.* 2011


Host species identity
Achillea millefolium
Eriophyllum lanatum
Festuca roemeri
Deschampsia caespitosa
Plantago lanceolata
Lupinus lepidus
(none)
Paintbrush traits
Size
Leaf Nitrogen
Iridoid glycoside production
Larval performance
Survival
Mass
Iridoid glycoside sequestration

Experimental setup

- In the greenhouse: *Castilleja levisecta* grown with one of six host species or a no-host control
- Five caterpillars released on each *C. levisecta* in a cage and monitored until diapause

Host species:

- ***Achillea millefolium***
- ***Eriophyllum lanatum***
- ***Festuca roemeri***
- ***Deschampsia caespitosa***
- ***Plantago lanceolata* (mesh exclusion)**
- ***Lupinus lepidus***
- **(none)**


Do not distur

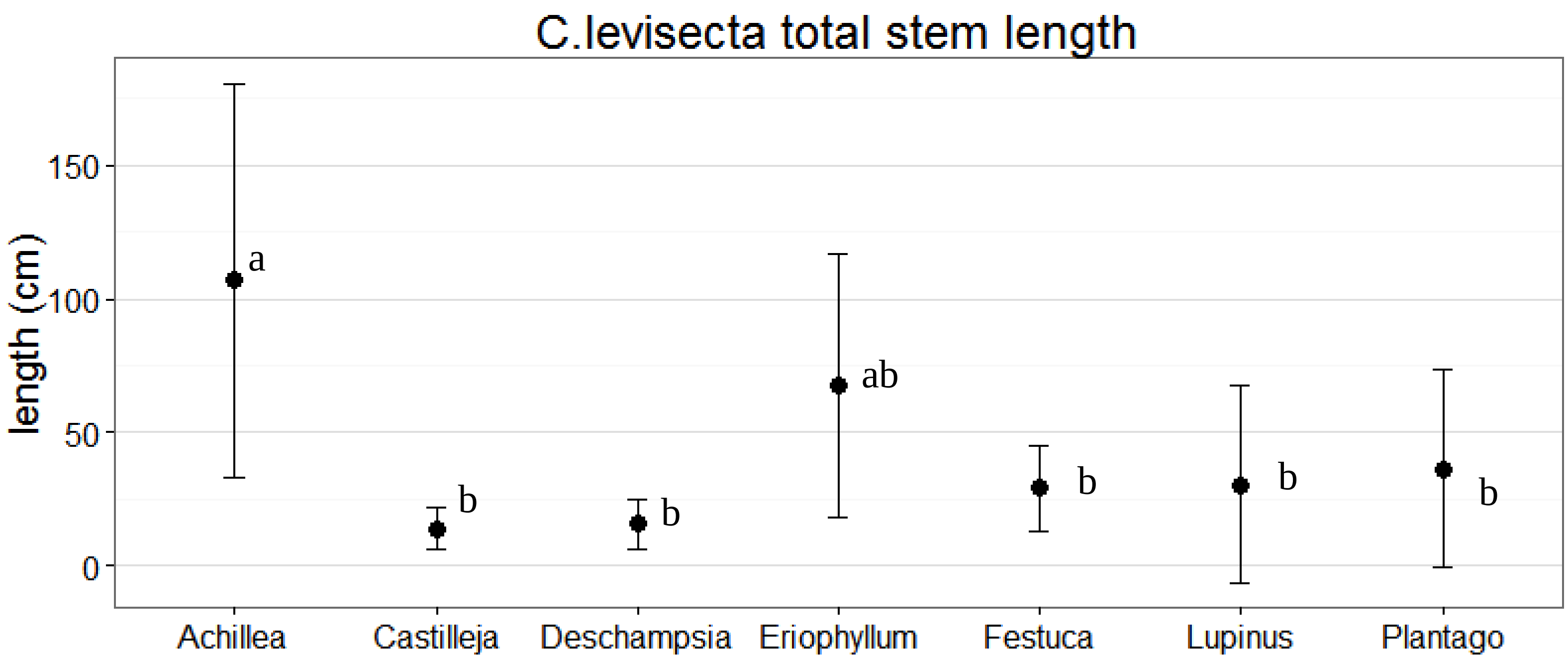
Measurements

- **Paintbrush**
  - Length of each stem
  - Aboveground mass
  - Leaf nitrogen
    - CHN analyzer
  - Leaf iridoid glycosides
    - Gas chromatography in Bowers lab, U. Colorado

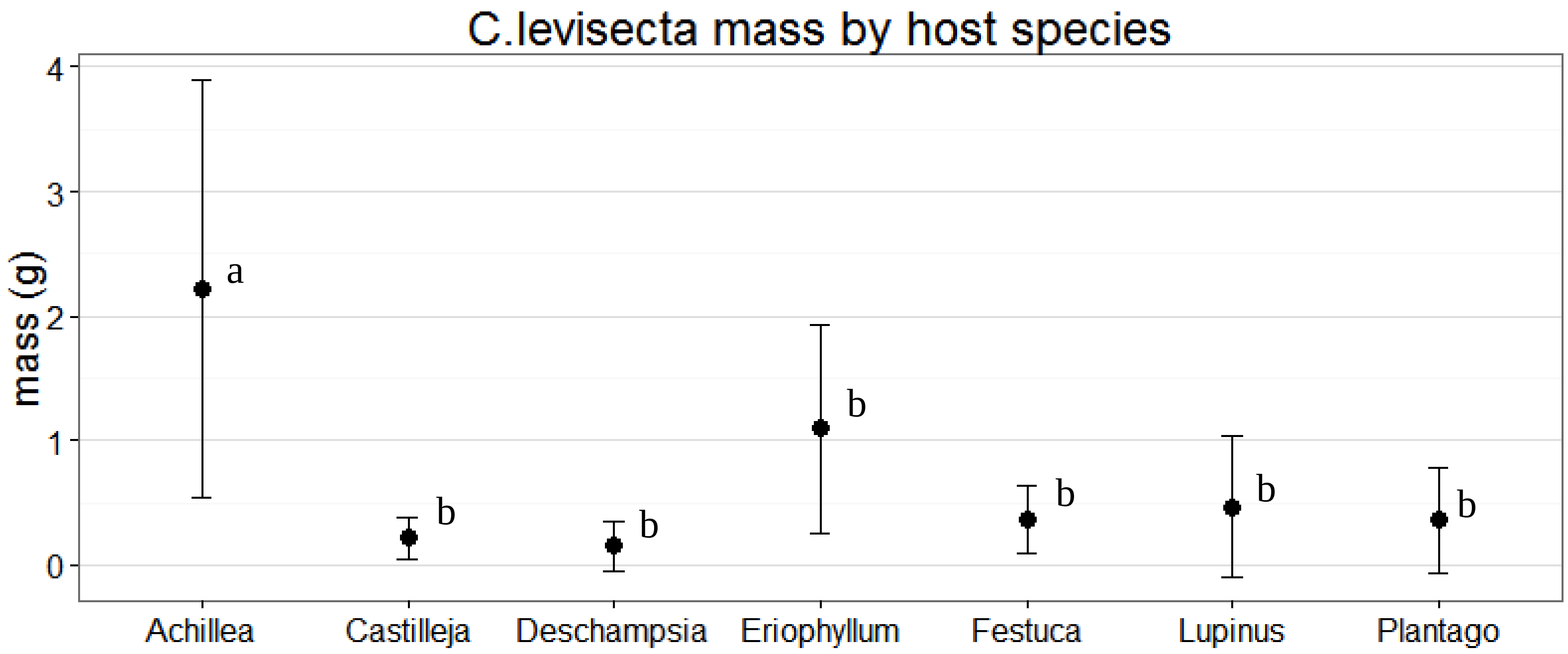
- **Checkerspot larvae**
  - Survival
  - Mass
  - Iridoid glycosides

Direct effects of hosts on golden paintbrush

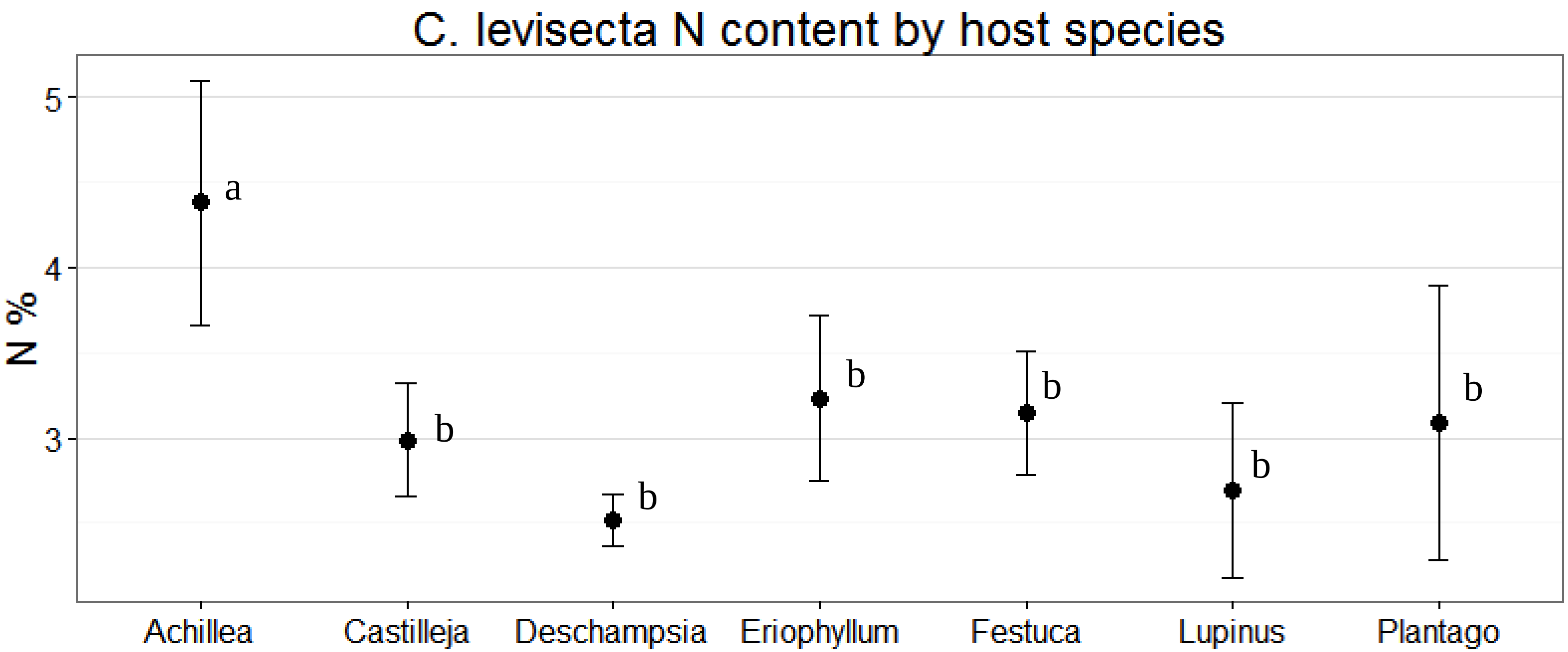
Direct effects of hosts on *C. levisecta*



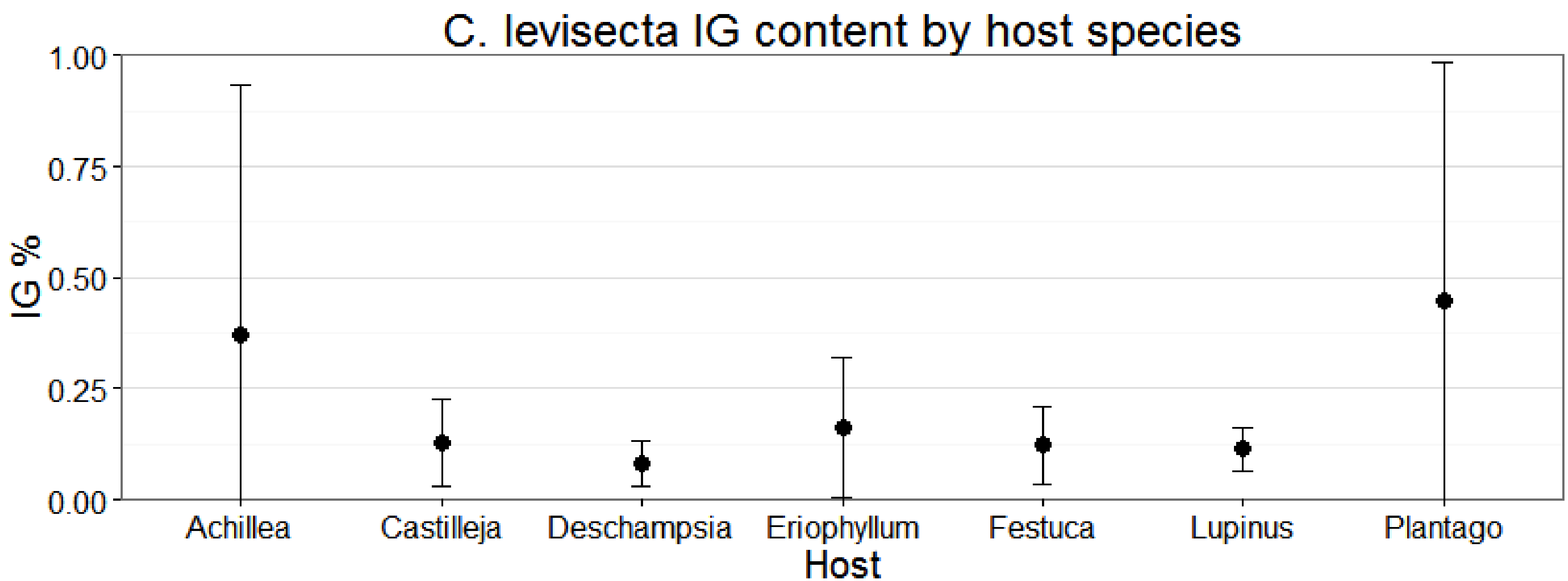
Direct effects of hosts on *C. levisecta*



Direct effects of hosts on *C. levisecta*

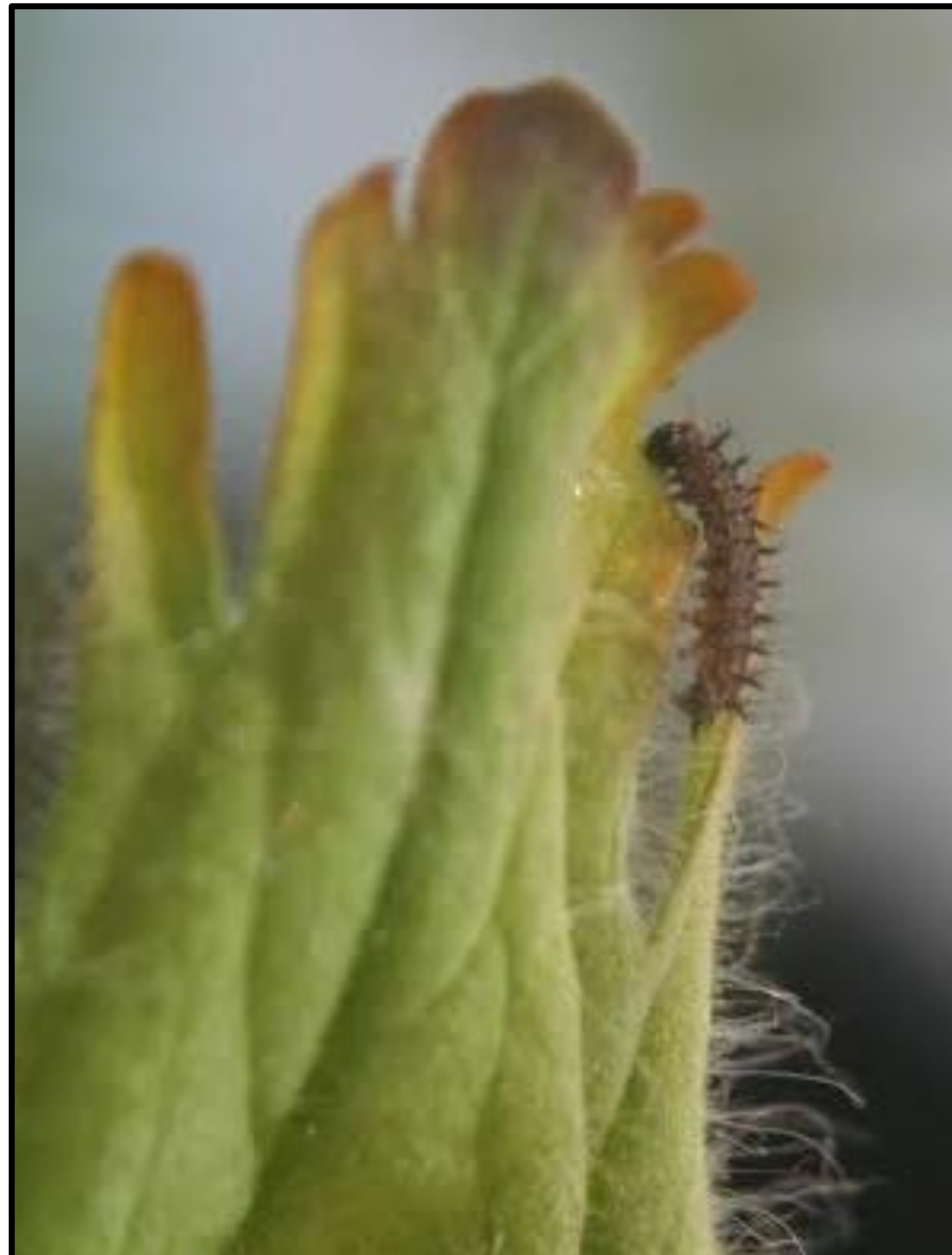


Direct effects of hosts on *C. levisecta*

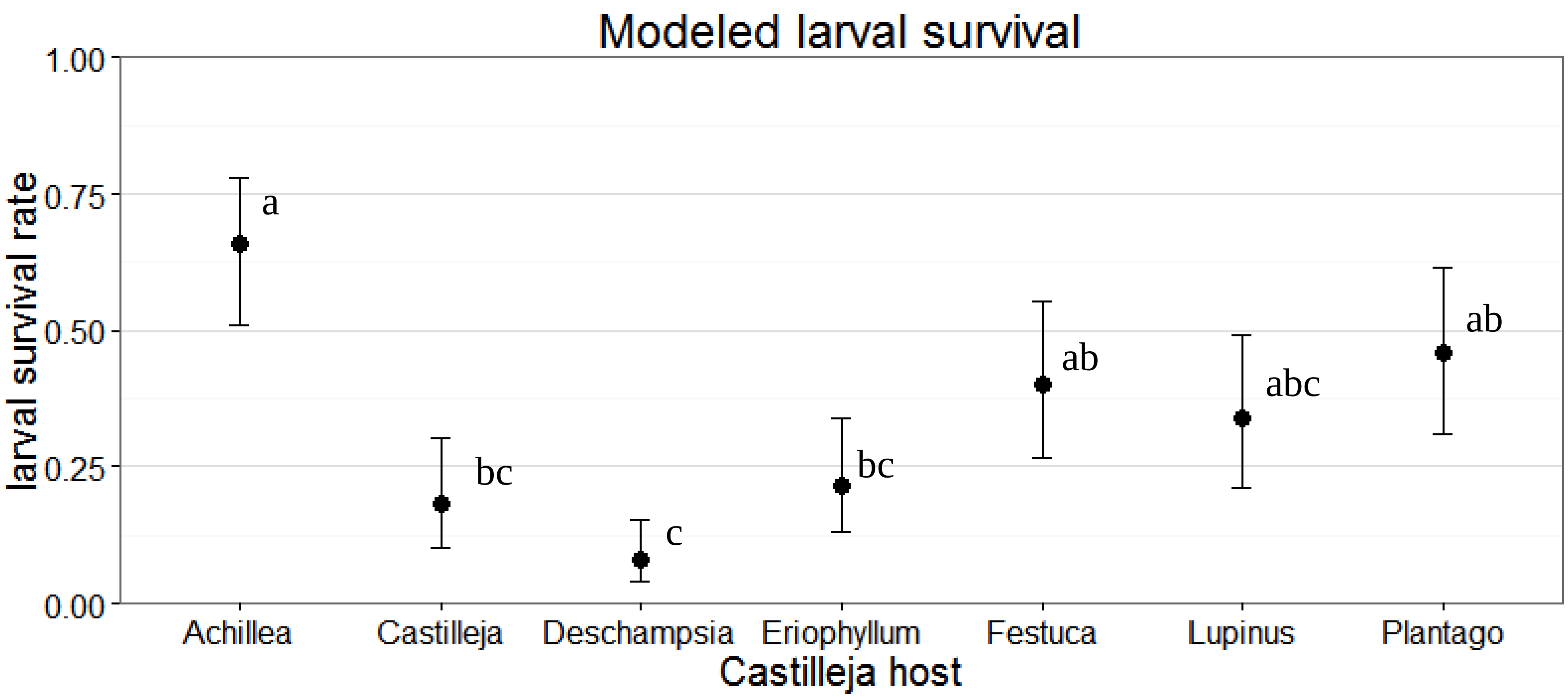


No significant difference among hosts.

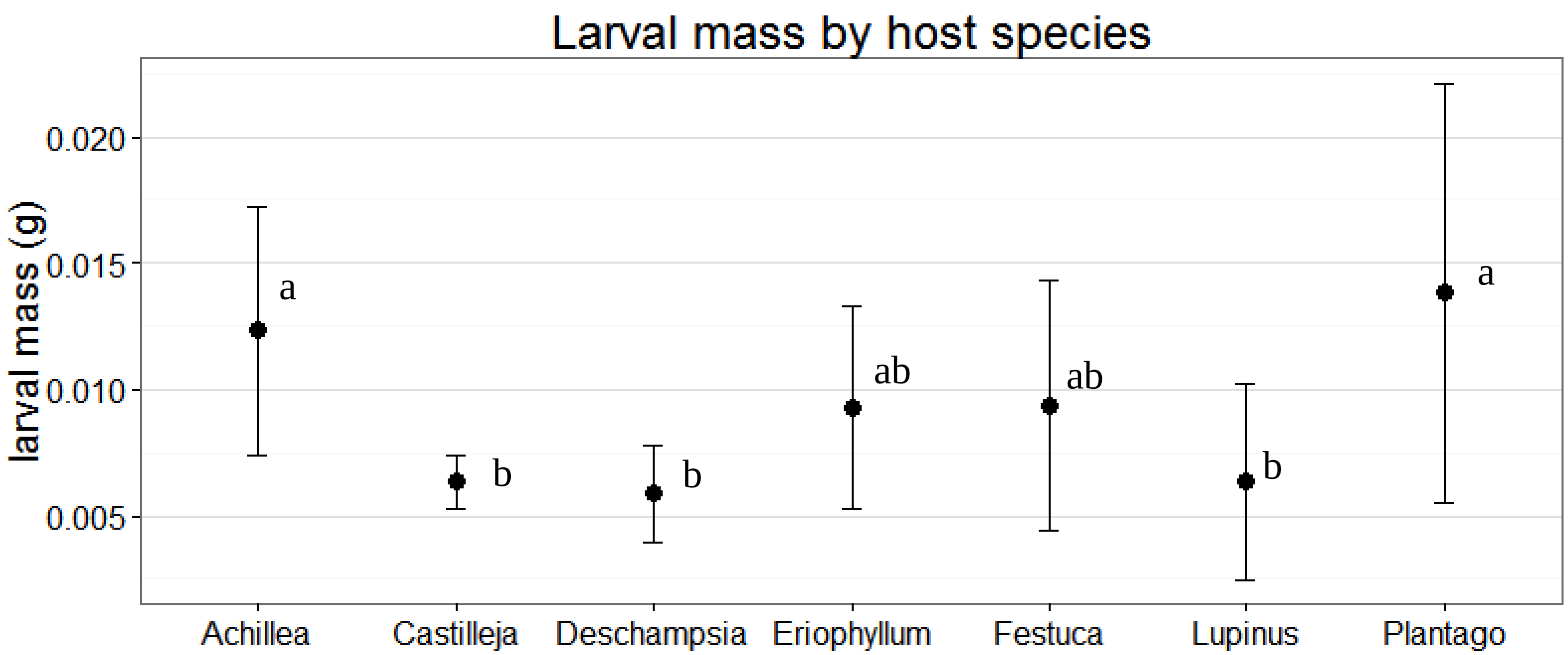
Indirect effects of host identity on checkerspot larvae



Indirect effects of host identity on checkerspot larvae

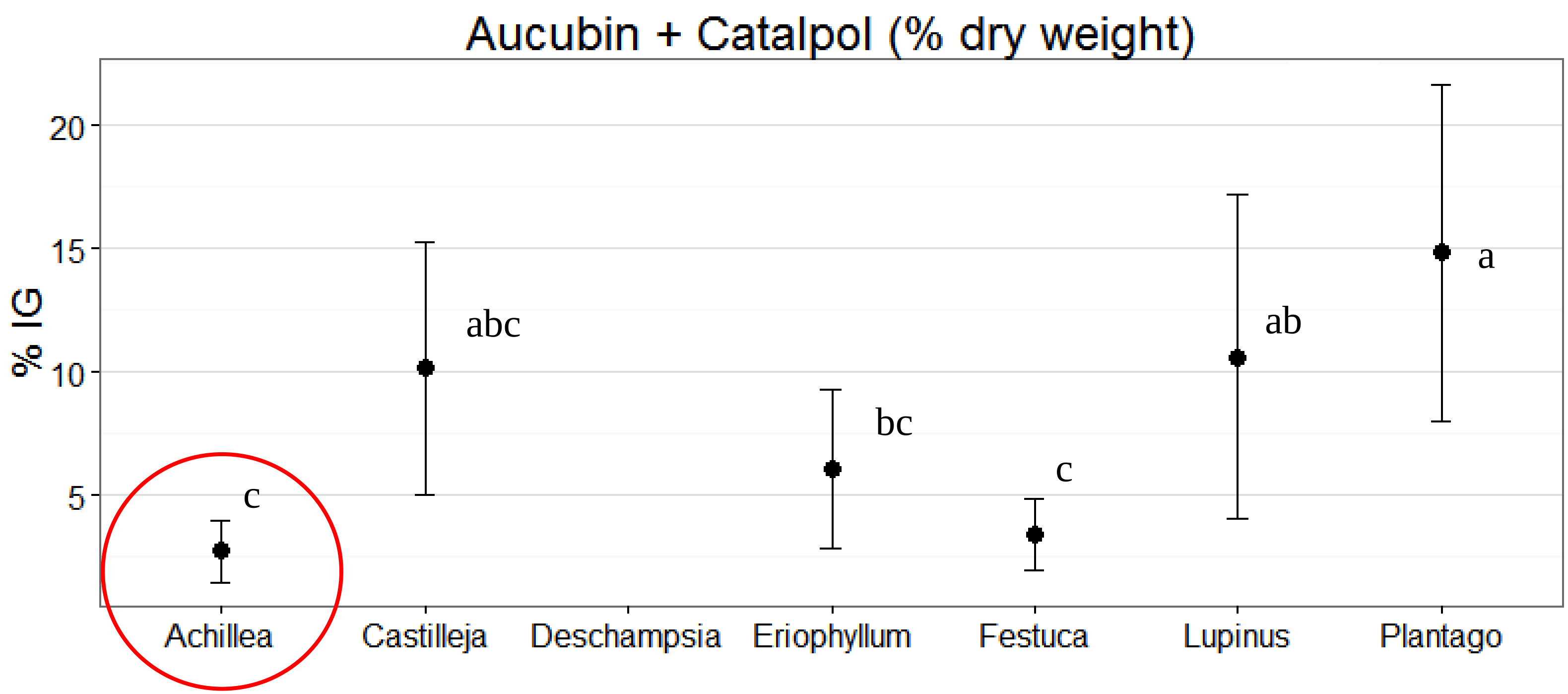


Indirect effects of host identity on larvae



Indirect effects of host identity on larvae

(preliminary)



Different hosts have different (indirect) effects on checkerspot larvae

Host Species 	***Castilleja* size** 	***Castilleja* iridoids** 	**Larval survival** 	**Larval mass** 	**Larval iridoids** 
Achillea	Large	Variable	High	High	Low
Plantago	Small	Variable	Medium-high	High	High
Deschampsia	Small	Low	Low	Low	na
Eriophyllum	Medium	Low	Medium-low	Medium-high	Medium-low

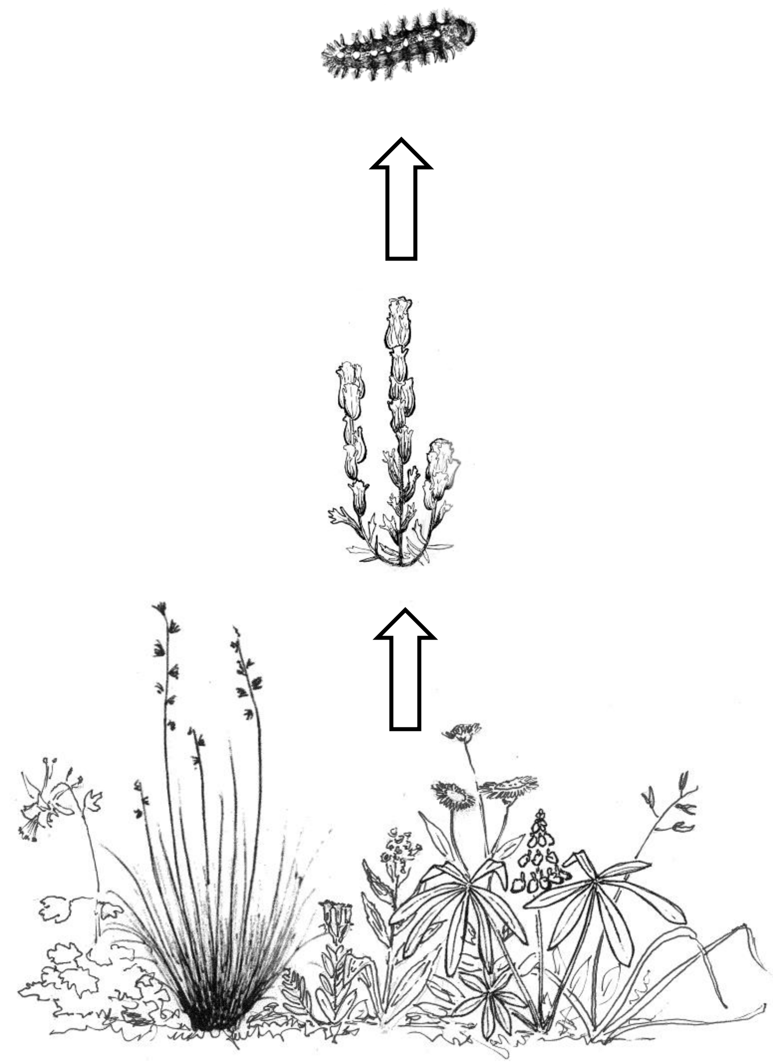
Some basic conclusions

- Practical stuff
  - **Castilleja hosts influence its suitability as a food plant!**
    - **Different size**
    - **Different nutrition**
    - **Different chemical profile**
  - Effects are mixed – no silver bullet host

- Theoretical ecology stuff
  - Strong bottom-up indirect effects mediated by a hemiparasite
  - Parasitic plants do interesting things to food webs

Relevance and next steps

- Greenhouse ≠ prairie
- We don't know which hosts are being parasitized in a field setting
  - But maybe we can guess based on what's growing nearby
- Paintbrush probably parasitize **multiple species simultaneously** in natural settings
  - Indirect effects of host community on larvae?
  - Interesting but complicated




I’m picking up notes of yarrow
with a fescue finish

Thanks

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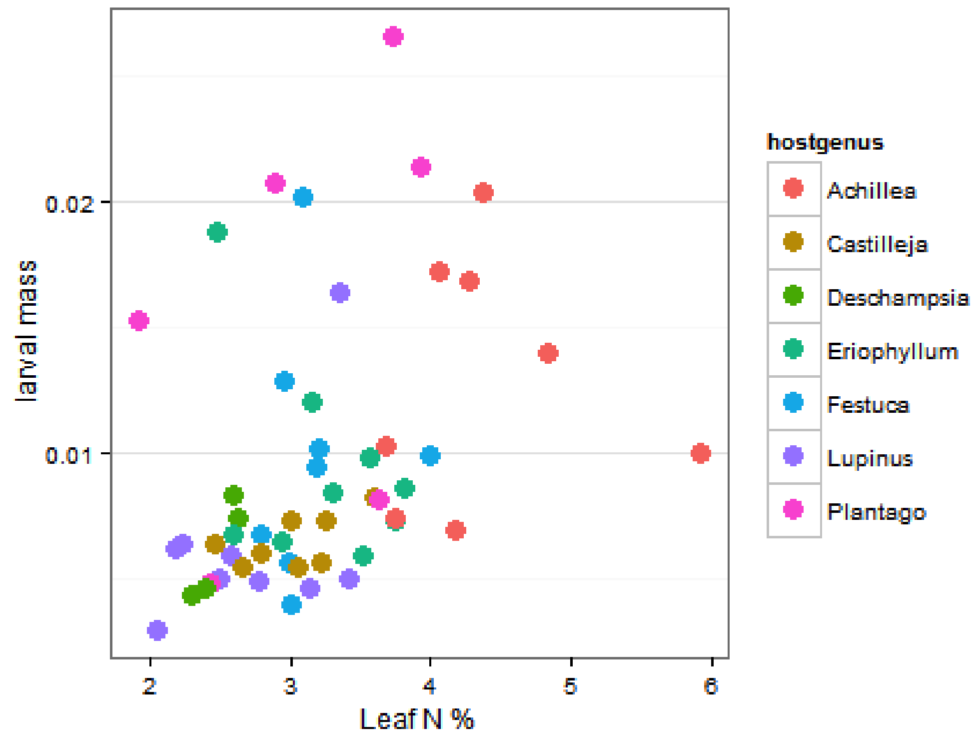
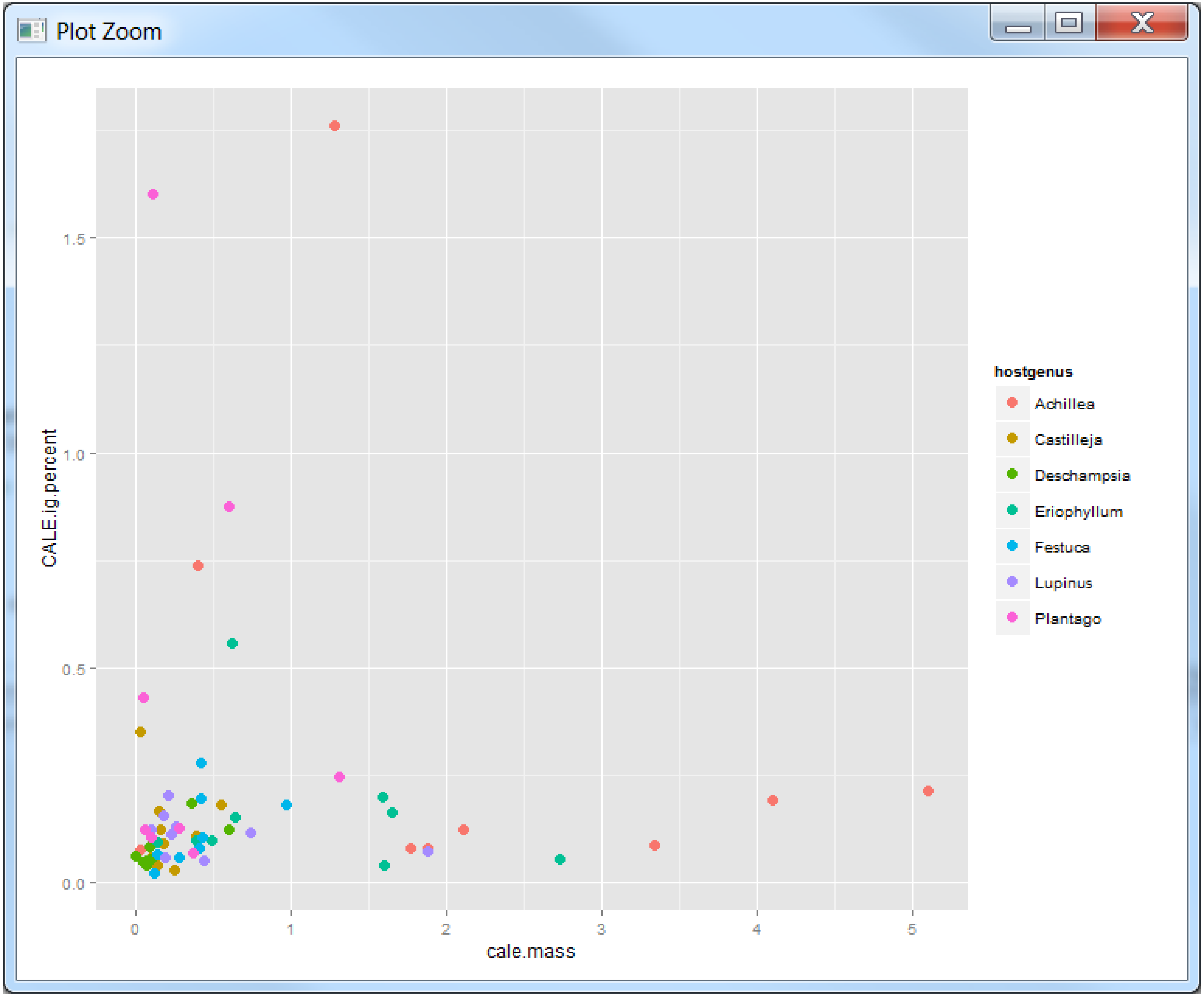
Next steps: relationships between hemiparasite traits and larvae

- Linking herbivore variables to hemiparasite traits is more complicated





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Festuca
Lupinus
Plantago