

From plants to birds: higher avian predation rates in trees responding to insect herbivory

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Introduction

- 'Crying-for-help' – tritrophic interaction between plants, herbivores and predators
- Feeding of larvae on a single branch can cause rapid systemic inducible responses in the tree
- Plant emissions can transmit herbivore-specific information that is detectable by parasitic wasps
 - volatile organic compounds, vision
- Predators (birds, parasitic and predatory insects) can reduce densities of leaf-chewing insects and thus improve plant fitness



Introduction

- How birds can find insect-rich trees?
- Visual cues:
 - larvae and their faeces
 - holes in leaves
 - changes in reflectance (photosynthesis)
- Olfactory cues:
 - volatile organic compounds (VOCs)
 - A large group of easily diffusible compounds.



Previous studies in aviary

- Mountain birch – sawfly larvae – willow warbler
 - birds more attracted to intact branches cut from herbivore trees than control trees
 - Ecology Letters 7(10): 915-918
- Silver birch – autumnal moth larvae – great tits & blue tits
 - birds more attracted to intact branches cut from herbivore trees than control trees
 - leaves of control trees reflected more light in the visible wavelengths (400-700 nm) than leaves of herbivore trees – visual cue for the birds?
 - Behavioral Ecology 19(2): 325-330

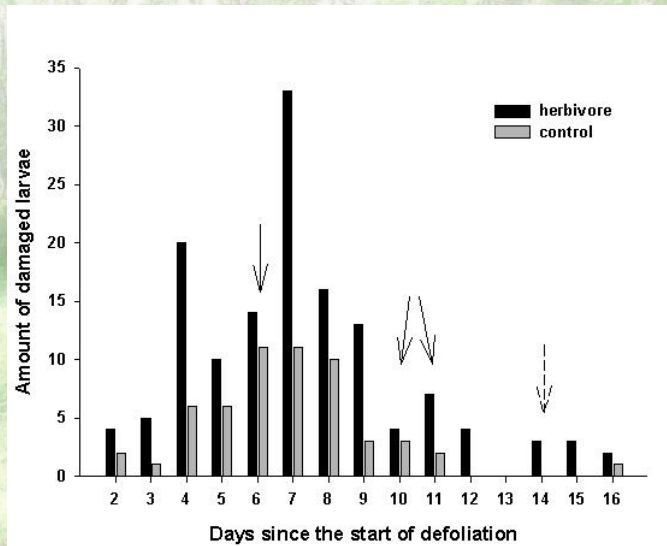
Experiment in nature

- Mountain birch (*Betula pubescens* ssp. *czerepanovii*) – autumnal moth larvae (*Epirrita autumnata*) – local insectivorous birds
 - at Kevo Subarctic Research Station in June 2007
 - 15 herbivore and 15 control trees
 - 3 × 20 larvae in each herbivore tree
- Plasticine larvae in both herbivore and control trees to study bird predation rate
 - 10 artificial larvae per tree
 - checked daily and replaced damaged for two weeks
- VOC emissions and net photosynthesis were measured from the same experimental trees

Mesh bags and plasticine larvae



Plasticine larvae



VOC emissions

- First week
 - From herbivore trees significantly more emissions of β -ocimene, linalool, (E)-DMNT, β -bourbonene, cis-3-hexenyl acetate and nonanal
- Second week
 - From herbivore trees significantly more emissions of limonene, β -ocimene, linalool, α -humulene, caryophyllene oxide, (E)- β -caryophyllene, β -bourbonene, cis-3-hexen-1-ol+(E)-2-hexenal and cis-3-hexenyl butyrate

Results

- The number of damaged plasticine larvae was significantly affected by treatment ($p = 0.0072$), time ($p = 0.0007$) and time² ($p = 0.0002$)
- Bird predation rate (no. of damaged plasticine larvae) correlated significantly with three VOCs [(E)-DMNT, β -ocimene and linalool]
- At the end of the experiment there was significantly more leaf photosynthesis in control trees than in herbivore trees ($p = 0.0024$)

Discussion

- Birds were more interested on birches that had hidden defoliation by autumnal moth larvae than on control trees with no herbivory
- The first evidence that passerine birds in nature can use cues other than visual recognition of herbivore larvae, damaged leaves or larval faeces to locate insect-rich trees

Discussion

- Support for both vision and olfaction as the candidate mechanism behind bird attraction
 - vision: different reflection in herbivore and control trees due to differences in photosynthesis
 - olfaction: significant differences in emissions of several VOCs between herbivore and control trees, and significant correlation with predation rate and three VOCs

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Thank you for your attention!

