LEPIDOPTERA LARVAE AS AN INDICATOR OF MULTI-TROPHIC LEVEL RESPONSES TO CHANGING SEASONALITY IN THE ARCTIC

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INTRODUCTION

Earlier snowmelt and warming temperatures in the Arctic will impact multiple trophic levels through the advancement in latitude of shrub vegetation and the timing and availability of food resources for animals.

Lepidoptera are a vital link within the Arctic ecosystem; their roles include pollinator, parasitized host for other pollinating insects, and essential food source for migrating birds and their fledglings.

HYPOTHESIS

Seasonal climate patterns affect total abundances of caterpillars in the Arctic. In response to changes in seasonality, including earlier snowmelt and warming, we expect caterpillar abundance to increase. Shrub-dominated landscapes generally melt later than open tundra, so we expect that caterpillar abundance will be higher in open tundra. We expect that caterpillars in moist acidic tundra are hosts to one or more pollinators. It is expected that larvae with thickest skin-type (hairy) will appear earliest.

OBJECTIVES OF STUDY:

-Quantify seasonal abundance of caterpillars in relation to the timing of snowmelt

-Evaluate the proportion of larvae that host parasites.

-Determine the timing of varying phenotypes of larvae (hairy, spiky, or smooth-skinned)

METHODS:

We determined the abundance of caterpillar larvae in relation to the timing of snowmelt through two approaches:

1) A climate change experiment in which we accelerated snowmelt by 15 days through the use of radiation-absorbing fabric and warmed air and soil temperatures using open-top chambers, individually and in combination with early snowmelt treatment for each of 5 replicate blocks.

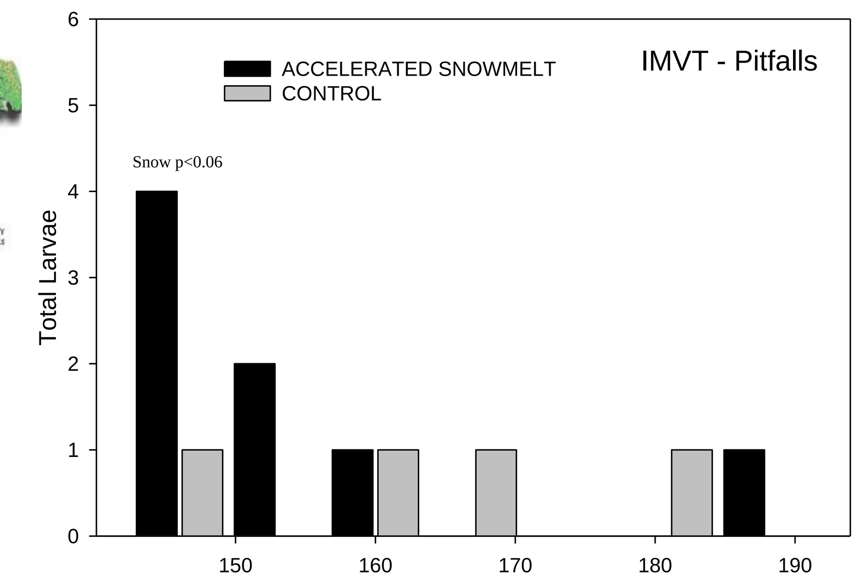
2) An observational 50 km transect study with 4 sites that naturally vary in the timing of snowmelt.

•Caterpillar abundance was determined by pitfall traps in all study plots, and we also did visual searches for caterpillars in the climate change experiment.

•In the climate change experiment, observations began one to three weeks after snowmelt. In the transect study, observations began prior to when study sites were completely snow free.

RESULTS

SEASONAL ABUNDANCE : SEASONALITY MANIPULATION & SHRUB vs OPEN



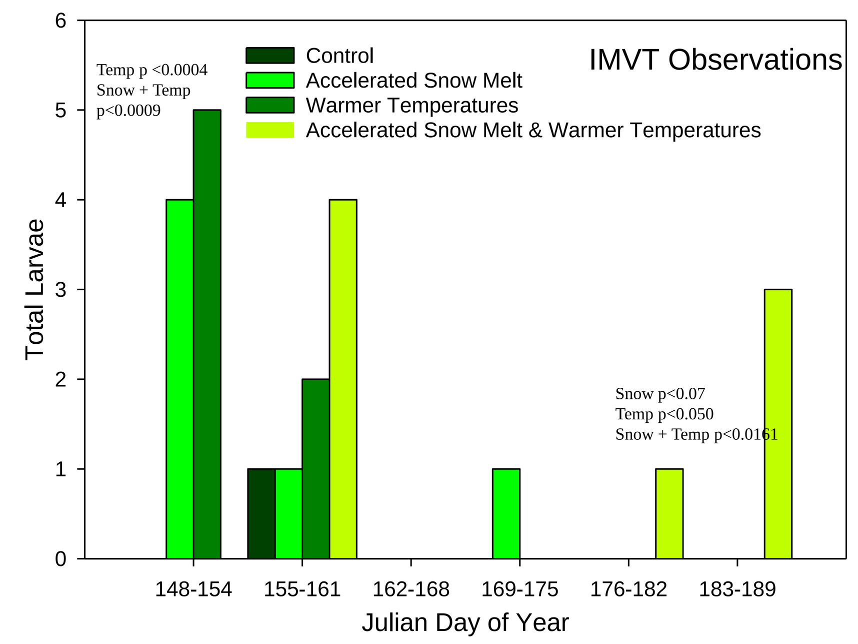


Figure 1 (above) : Total larvae observed in Summer 2011 within a moist acidic tussock tundra ecosystem at Imnavait Creek. Pitfall traps (top) were only located in the control and early snowmelt plots. The experiment included control, early snowmelt, increased temperature, and early snowmelt combined with increased temperature plots. Effects of early snowmelt, increased temperature, sampling period and all their interactions were tested using a 3-way ANOVA. Significant and nearly significant effects among treatment means are reported.

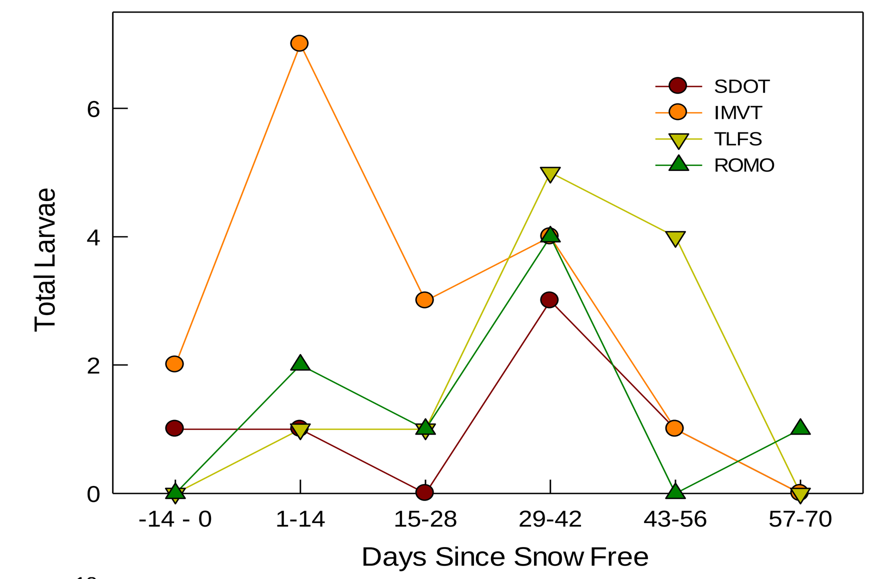


Figure 2 : Seasonal abundance of larvae from Day 0 – the date that each site was averaged to be 100% Snow free. The transect sites span a total distance of 50 km along the Dalton Highway in the North Slope of Alaska.

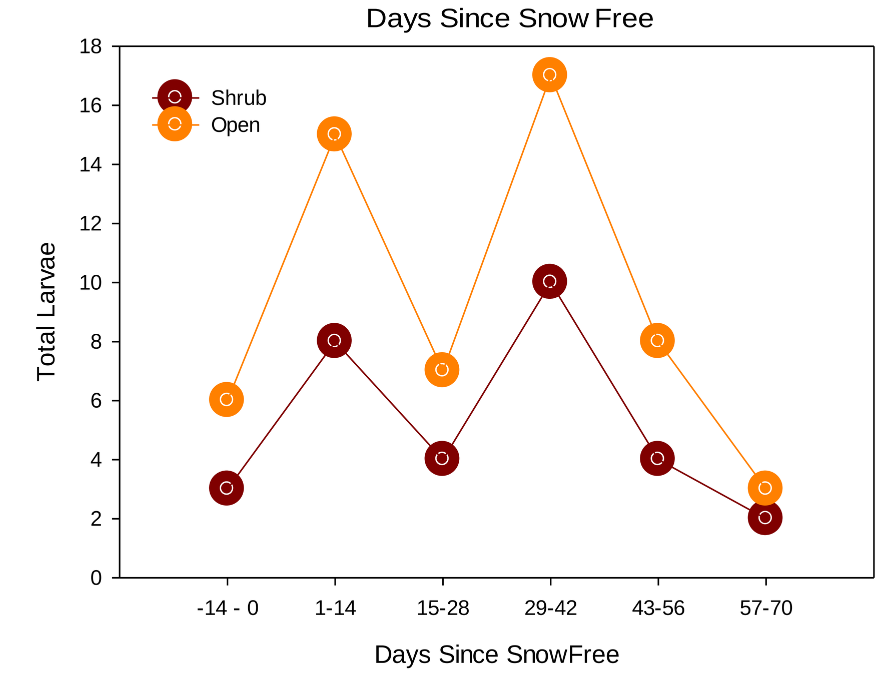


Figure 3 : Total seasonal abundance of caterpillars caught within pitfall traps in both open and shrub areas, summed across the four transect sites. As with Figure 2, day 0 represents when sites were determined to be 100% snow free.

PARASITISM

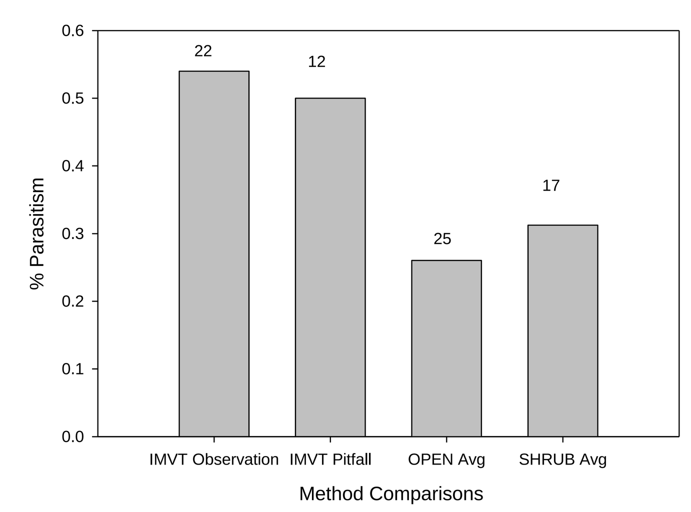


Figure 4: Percent of parasitized larvae observed within Imnavait Creek experiment: those caught in pitfalls within the experiment, and averaged between all open tundra and all shrub sites. The number above each bar represents total amount of larvae found in each method. Parasitism of Lepidoptera larvae was identified as being by braconid wasp and tachinid fly.

SEASONAL VARIATION IN PHENOTYPES

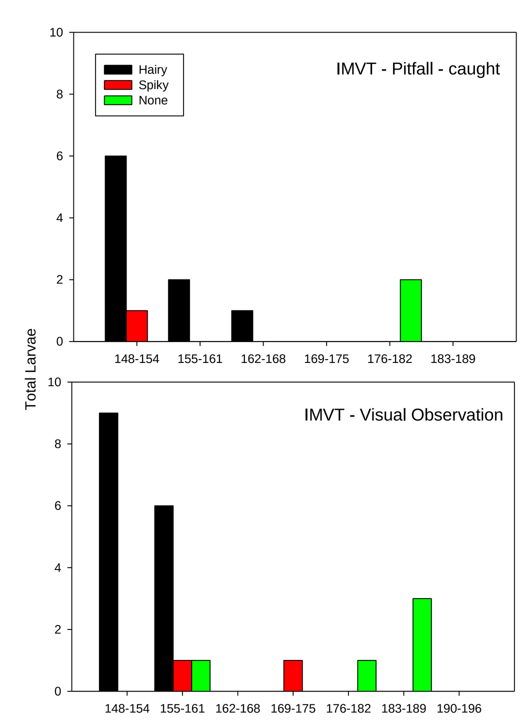


Figure 5 : (left) Seasonal variations in phenotypic appearance at Imnavait Creek within pitfall traps (top) and visual observations (bottom)

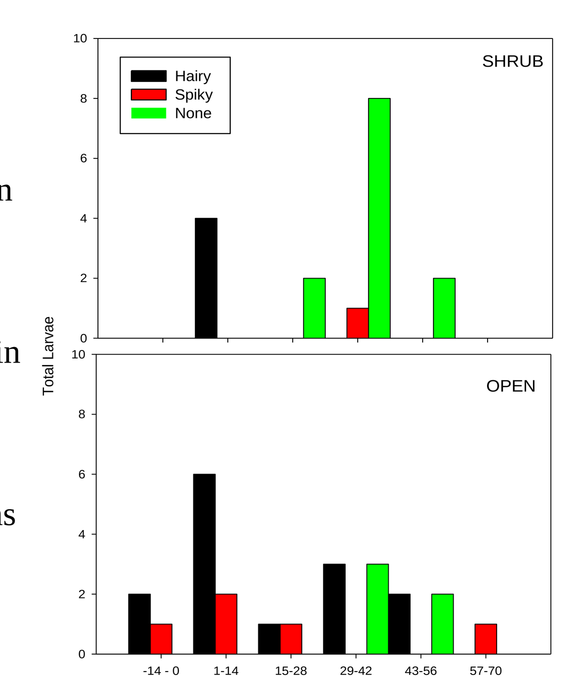


Figure 6 : Seasonal variations in phenotypic appearance of larvae within Shrub (top) and Open (bottom) habitats across the Dalton transect.

Larvae were classified as being hairy, spiky, or smooth skinned. This method of classification was chosen because species identification (through raising larvae to adulthood) was not possible due to the constraints of each method: observations occurred within the established climate manipulation experiment where larvae could not be removed, and the pitfall method is lethal.

SUMMARY / DISCUSSION:

Lepidoptera larvae appear to exhibit drastic variation in seasonal abundance:

- Where snowmelt was experimentally accelerated and temperatures were warmed, caterpillar abundance was greatest and more were seen earlier in June.
- Within the transect study, we observed two seasonal peaks in caterpillar abundance. One occurs within two weeks of snowmelt and one occurs four to six weeks following snowmelt at all four sites.

Shrub vegetation is increasing in the Arctic as temperatures warm. Vegetation differences may influence Lepidoptera larvae abundance:

- Throughout the season, more caterpillars were continuously found in open tundra plots compared to shrub plots.

Lepidoptera serve an essential role as parasitized host to other pollinating insects:

•Proportion of parasitism was up to 54% of the observed animals and was greatest for caterpillars observed visually in the climate change experiment compared to those observed in pitfall traps in the experiment and across the transect.

Seasonal emergence of larvae phenotypes may be linked to temperature:

•In both studies, we found that caterpillars found soon after snowmelt were hairy or spiky, while caterpillars with smooth , not spiked/hairy skin were most abundant later in the season.

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