Heterogeneity in selection on floral display in *Plectritis congesta*

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Introduction

In a heterogeneous environment, selection pressures on plant characteristics can vary by population. Previous studies have found floral display characteristics to be linked to pollinator visitation rates. However, this attraction of pollinators to a flower can be disrupted in small, isolated populations, or those with decreased floral display, or increased competition for pollination. This can affect not only the probability of persistence of a population, but can also strongly influence selection on floral display size.

Study Species – *Plectritis congesta*
Plectritis congesta, is a small annual herb with a terminal inflorescence of pink flowers, found in coastal areas of South-West British Columbia (BC) and the Pacific North West States. It is often a regular part of Garry Oak meadow ecosystems, and is therefore found on rocky headlands, clearings, and coastlines. *P. congesta* has a noticeable variation in floral display size, colour and number of inflorescences.

Pollinators
In *Plectritis congesta,* for outcrossed reproduction to occur, pollinators are needed. In areas of low pollinator visitation, a larger floral display may be selected for to attract more pollinators. It follows from this that the factors affecting pollinator visitation would have an indirect impact on the selection for floral display.

However, pollinator behavior could confound this selection by having a significant a role in self-fertilization rate. If pollinators are visiting multiple flowers per plant, selfing rates could be high due to geitonogamous selfing being increased. Greater floral number has been shown to cause an increase in the number of flowers visited per inflorescence. Pollinator behaviour is different in different taxa, and therefore the pollinator community could also be affecting the direction of selection on floral display.

It is known from previous studies that pollinator communities can vary drastically in sites that are isolated from each other.

Population size and Density
Pollinators are known to be attracted to large and dense populations of flowers. Decreased visitation in small and sparse populations could impose a selection for large floral displays to attract pollinators

Floral Display Metrics
Pollinators are known to be more attracted to large floral displays than to small floral displays.

Areas with decreased pollinator visitation to *P. congesta* should select for larger floral display to attract pollinators.

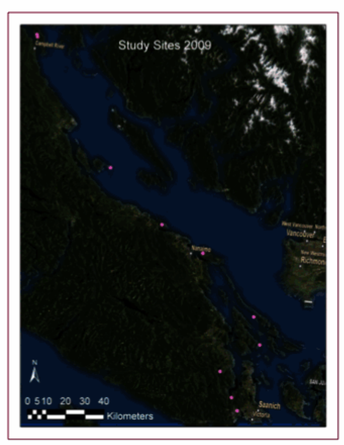
Increased pollinators allows for increased outcrossed reproduction in most cases. However, in multi-flowered plants increased numbers of flowers can lead to increased geitonogamy and therefore actually increase the selfing rate because as the floral number increases, the number of flowers per inflorescence visited also increases.

Co-flowering competition
Competition for pollination with co-flowering species could lead to *P. congesta* populations with high numbers and densities of co-flowering species to have an increased floral display, especially if the co-flowering species is preferred by pollinators.

Location
It is well known that increased distance from mainland or from larger islands decreases the presence and diversity of pollinators.

At these more "isolated" locations the lack of available pollinators could be causing increased selection for large floral displays, since large displays are more likely to attract any passing pollinator.

The different pollinator community at isolated sites could also impose a different selection pressure than at a non-isolated site.



Research Objectives

The main objective of this research is to determine the important factors which contribute to determining floral display size in *P. congesta*.

(1) Pollinator influence on Floral Display
I will examine the relationship between pollinator abundance and visitation, pollinator behaviour, and pollinator community makeup with floral display.

(2) Influences on pollinators within and amongst populations of *P. congesta*
I will examine whether the differences in pollinators in populations of P. congesta were related to differences in:
-Population Size and Density
-Co-flowering competition
-Location

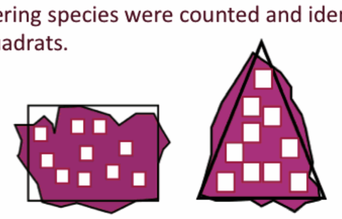
Methods

Pollinator Visitation
I also investigated [1] Pollinator visitation rate; [2] pollinator behavior; [3] pollinator ID.

To do this I have employed the following techniques:
[1] Hand-netting: Active pursuit of specimens has been made using standard entomological nets. Pollinators have been caught along a transect through the long axis of the population. Pollinators are caught when visiting *P. congesta.* Catching is done for 2 hours total each day around mid-day. 2 catching days were performed at each site. All visiting bees and flies were netted. Any Lepidopterans were photographed due to conservation concerns for endangered species in the area.
[2] Observation: Pollinators of *Plectritis congesta* were followed and monitored as they work within the population patch. At the first new *P. congesta* plant visited the number flowers visited, the number of flowers present on the inflorescence, and the next species of flower visited are recorded.
[3] All insects caught will be identified to genus, and morphospecies level to look for differences in community make-up and in species diversity at each site.

Population size and Density and Co-flowering
To assess population metrics, the population area will be estimated as a polygonal shape. Within the discrete patch of *P. congesta 10 - 0.5 m. x 0.5 m.* quadrats were placed randomly to get density counts and these counts were extrapolated to estimate the population size.

Co-flowering species were counted and identified in these quadrats.

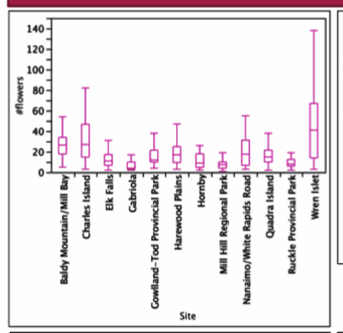


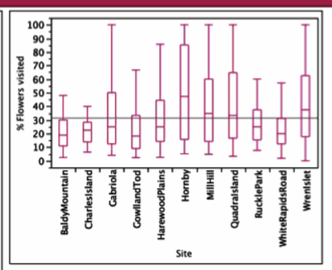
Floral Display Metrics
To assess floral display. Individuals chosen at random were measured for the following characteristics:

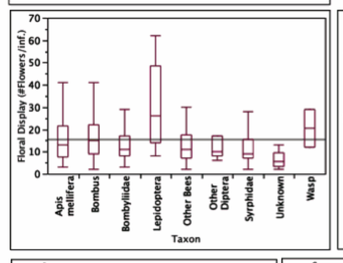
[1] Inflorescence height
[2] Number of inflorescences
[3] Number of flowers on each inflorescence

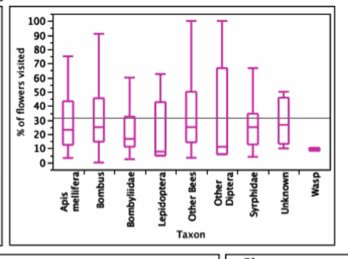
Location
For location variables I will be looking at:
[1] Distance from Vancouver Island & Mainland BC,
[2] Area of the island using GIS software (ARC GIS).

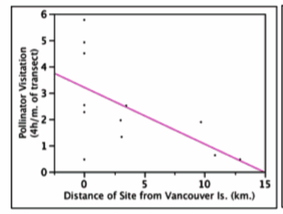
Results

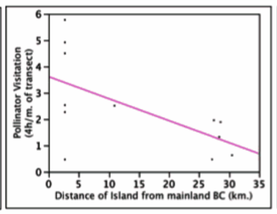


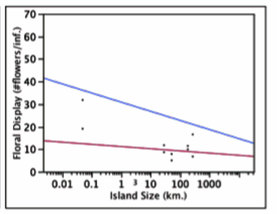












Figures – (Left to Right from top) [1] Number of flowers per inflorescence varies by site (p=<.0001); [2] Proportion of flowers per inflorescence varies by site (p=<.0001); [3] Number of flowers per inflorescence on first observed plant visit varies by taxon (p=<.0001); [4] Proportion of flowers visited per inflorescence varies by taxon (p=0.0046); [5] Pollinator visitation decreases with the distance of the site from Vancouver Island (p=0.0446); [6] Pollinator visitation decreases with distance of the island from mainland BC (p=0.0356); [7] Floral display decreases with island size: Red is 2009 (p=0.0562), Blue is 2010 (p=0.0180).

Future Directions

Plant Growth
Concern over the implication that floral display size is not heritable, but is a product of only environments has prompted a growth experiment. Seeds collected in 2009 and 2010 will be grown in growth chambers under uniform conditions, and floral display size measured. This will be compared with field data.

Insect Curation
Insect curation is in progress. The rest of the pollinators need to be identified to genus and morphospecies, databased, and the data compiled.

Discussion and Implications

This project will provide the much needed basic ecology of *Plectritis congesta* (which is currently represented by less than 5 peer-reviewed journal articles). As of yet, there are very sparse records of population sizes, densities, and no reliable data on floral display metrics in the published literature. There is no account of the pollinator visitors nor their visitation rates to *P. congesta.*

This project will act to give records as to the biotic and abiotic factors influencing floral display variation. This will provide important contributions to the state of knowledge about unique adaptations in British Columbian plants to isolated locations which are underserved by pollinators.

In addition this research may identify which areas are lacking in insect pollinators. This information could serve to aid agencies in developing strategies to bolster lacking pollinator communities, and preserve the many rare plants which occur in the coastal mediterranean ecosystems of the Gulf Islands of British Columbia (specifically Garry Oak ecosystems).

This project will provide important contributions to the state of knowledge concerning British Columbian bees and pollinating flies. This project will act to provide much needed specimens, and data on abundance, distribution, pollination behavior, and ecology of the group.

Acknowledgements

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