Evolutionary response to artificial selection and heritability of ectoparasite resistance in a natural host-parasite association

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Introduction

- Ectoparasites are abundant in nature, can exert pronounced deleterious fitness consequences on their hosts, and are important vectors of transmissible diseases.
- This study establishes interesting parallels between insects and other animals in their ability to protect themselves and evolve behavioral defenses against ectoparasites.
- We test for the presence of additive genetic variation underlying resistance against ectoparasitic mites, and report replicate estimates of realized heritability for this trait.
- It was hypothesized that resistance against ectoparasites is heritable in the Drosophila-Gamasodes system.
- It was predicted that if resistance is heritable in the selected lines, then there should be a response to the selection.

Method

Selection Protocol

- The selection protocol consisted of exposing 200 flies of each generation to mites in experimental infestation chambers.
- The mouth of the jar was sealed with coarse paper towel. Flies were aspirated into a space excavated within the medium.
- All surviving flies were aspirated from chambers, and flies that had never been parasitized were used to seed subsequent generations (parasitized and scarred Individuals were discarded).

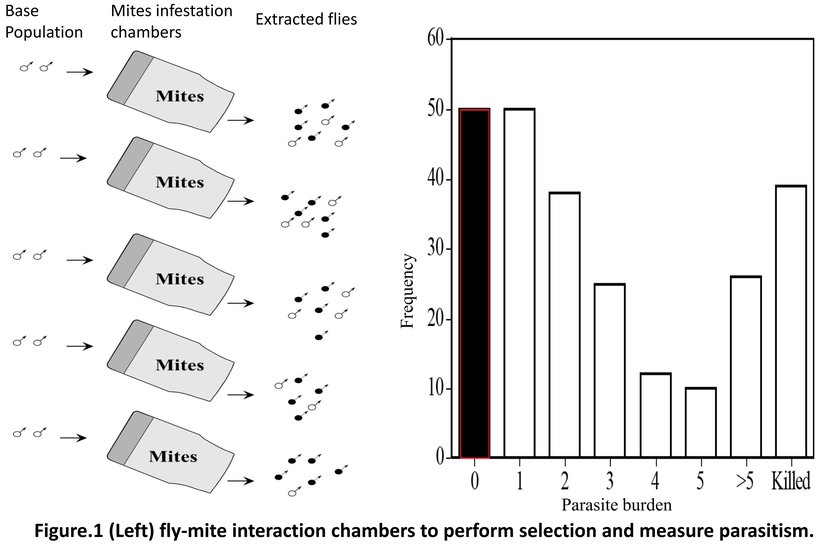
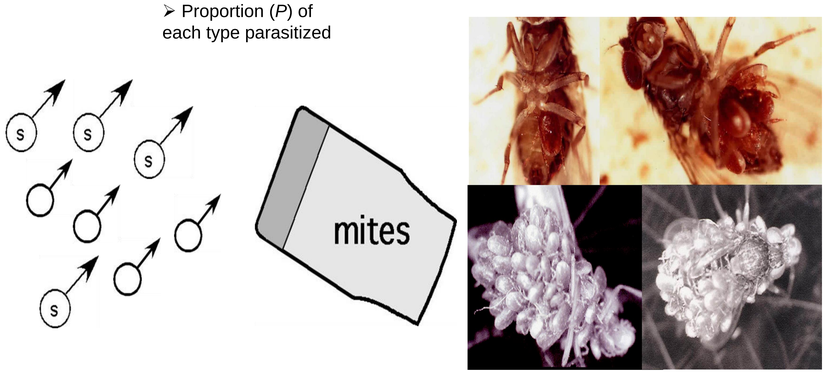


Figure.1 (Left) fly-mite interaction chambers to perform selection and measure parasitism. (Right) Diagram to show how the selection process works.

Response to Selection

- To track response to selection within each line, resistance was assayed at various generations of the experiment by contrasting resistance between the selected line and its paired control.
- The resistance assay consisted of aspirating groups of selected and unselected flies together in replicate chambers with mites.
- The sexes were exposed to the mites and no food resource was present within chambers, thereby minimizing competitive interactions for mates or concentrations of food resource.
- Groups consisted of flies of each type (control and selected), and the two groups in any one chamber were always equal in size. The identity of flies was determined by minute wing clips.



Response to selection = $P_c - P_s$

Figure.2 (right) Mites attached to Drosophila, (left) model for response to selection by performing resistance assay

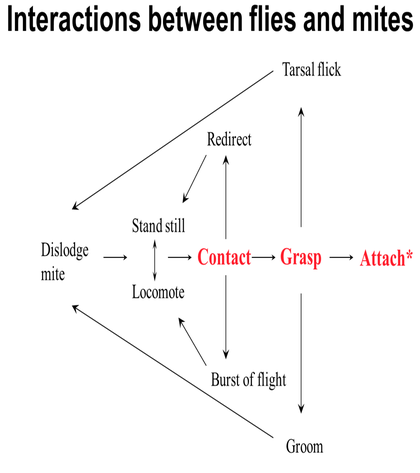
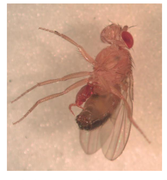


Figure.3 Schematic of mite-fly interactions

Approach host

Fly-mite interactions

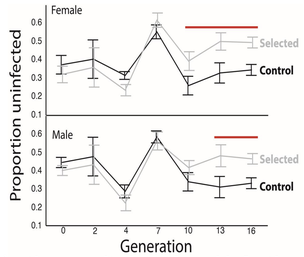


Attach (parasitism)

Ectoparasitic mite interacting with Drosophila.

Results

- Drosophila Melanogaster evolved heritable genetic variation for resistance against ectoparasites mites species.. (Figure 1)
- Realized heritability estimates ranged around 8% across replicate lines of the experiments.
- Mean $h^2 = 0.0792$ (0.00385)* $P = 0.015$ (Figure 2)
- Resistance evolution was not coupled with body size difference between control and selected lines. (Figure 3)
- Drosophila melanogaster selected against Gamasodes also showed resistance against Macrocheles, thus evolved cross-resistance. (Figure 4)

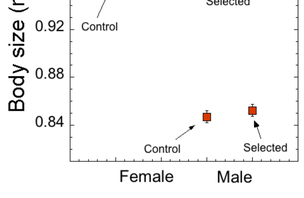


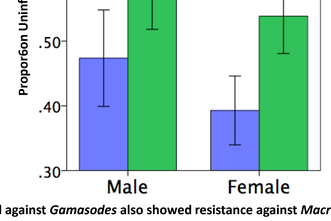
selection results in reduced infection

Table 1. Slopes of the regression of response to selection on generation number in each of three replicate selection lines. Artificial selection was carried out for 16 generations.

Line	Slope	SE ‡	P ‡‡	h^2 ‡‡‡(SE)
1	0.0477	0.0105	0.006	0.0954 (0.021)
2	0.0454	0.0151	0.030	0.0908 (0.0302)
3	0.0257	0.0086	0.031	0.0514 (0.0172)
				Mean $h^2 = 0.0792$ (0.00385)*

‡ SE, standard error; ‡‡ *P*-value testing H_o: Slope=0; ‡‡‡ h^2, realized heritability; * $P = 0.015$





Flies selected against *Gamasodes* also showed resistance against *Macrocheles*.

Conclusion

- The data indicate that D. melanogaster contains significant additive genetic variation in resistance against *Gamasodes* mites.
- Current knowledge of the genetic, demographic and mechanistic basis of ectoparasitism in the present fly mite system establishes parallels between insect and vertebrate hosts in their relationships with ectoparasites.
- The available evidence indicates that traits mediating host–ectoparasite associations possess significant evolutionary potential, one critical component of co-evolutionary processes expected to be occurring between host organisms and their natural enemies.

Future Directions

Our studies provide potential mechanisms associated with insect-ectoparasite interactions in natural populations. The future steps for this study is to perform cost related assays to see the fitness trade-offs associated with host resistance in a insect host-parasite interaction. The cost assay being performed are egg size measurement

Acknowledgement

Support from the NSF grant DEB-165447 to M.Polak, J. Benoit and the University of Cincinnati's Department of Biological Sciences. Many thanks to my lab members Joy Bose and Parker Young for their help with experiments.