# ABUNDANCE OF PHORETIC MITES ON PASSALID BEETLES

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*Abstract:* Two species of passalid beetles coexist within decomposing oak logs in Costa Rican montane forests. Both beetle species are infested by two species of phoretic mites, whose relationship to their host organism (parasitism, commensalism or mutualism) is unknown. The larger mite species was found to be more abundant on the larger beetle species, while smaller mites were more abundant on the smaller passalid species. We also quantified approximate volume and mass of beetle individuals, regressed mass on volume, and calculated residuals in an attempt to remove volume effects on mass. We then correlated residual mass with mite abundances, to explore patterns that may result from mite-beetle interactions. However, we recognize that a rigorous analysis would include examination of allometric relations, which typically cause changing relationships among size metrics, and also between size and mass metrics, as animals increase in size.

*Key Words: montane tropical forest, mutualism, parasitism, passalid beetles, phoretic mites*

## INTRODUCTION

Two species of passalid beetles (Coleoptera: Passalidae) co-exist under decomposing oak logs in the high elevation montane forests of Costa Rica. The species are similar in all aspects of their appearance except size; one is larger (~4.6 cm in length, henceforth referred to as beetle species A), and the other smaller (~2.5 cm, beetle species B). There are at least two species of phoretic mites found on these beetles (mite species 1: smaller, more mobile, tan, with longer legs and antennae, and mite species 2: larger, rounder, reddish with short appendages). There are more mites on larger beetles (Baptista et al. 1998), but little is known about whether the relationship between the mites and the beetles is parasitic, mutualistic or commensal. In this exploratory study, we collected data on several metrics (size and weight) on both beetle species, and correlated these with counts of mites on individual beetles. Our motivation was to expose patterns and trends that could conceivably result from effects of the mites on the beetles (e.g. beetles that have low weight/volume ratios may be in poor health due to parasitism by mites).

## METHODS

On 28 January 2005, we collected beetles from under fallen trees on the eastern part of the Loop trail from the lookout to the "flat bench" area in the predominantly oak forest north of Cuerici Biological Station, Cerro, Costa Rica. We haphazardly sampled under 28 logs, and collected all beetles encountered (between one and four per log). We quantified the abundance of each mite species on each beetle, using a hand lens and a white surface to increase contrast. For each beetle, we measured the length from tip of mandibles to end of abdomen, width at widest point, and depth from dorsal to ventral surface.

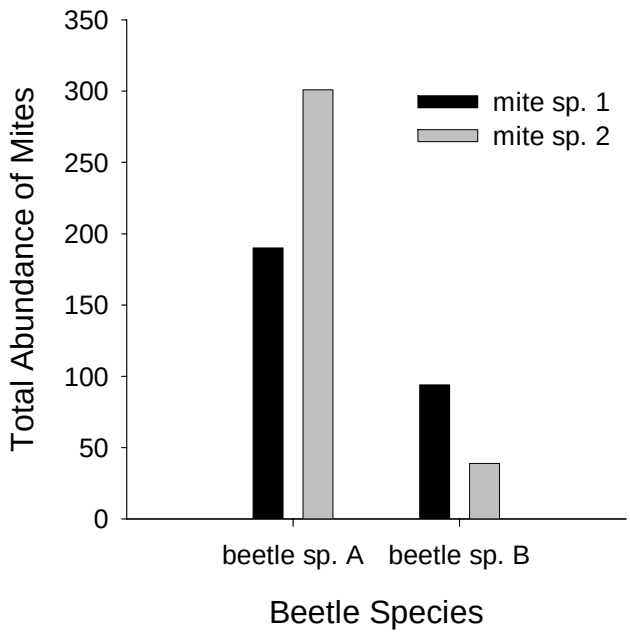


Figure 1. The abundance of mite species 1 and 2 on beetle species A (n = 13) and B (n = 33) (X2 = 41.9, df = 1, P = 0.05).

We then weighed the beetles using a 5 g spring scale for beetle B and a 60 g spring scale for beetle A. Each beetle was released near the log from which it was collected.

To analyze the data we used linear regressions in JMP 5.0.1, using the residuals of a mass to volume regression to remove the effects of volume on mass. (Note, however, that non-linear allometric relations, which are common in animals, can confound this "removal" of effects. We did not check for non-linear relations). We also performed a Chi Square test of homogeneity to identify the proportional differences in abundance of the two mite species on the two host beetles. Expected values were determined using the formula [(mite sp. on beetle sp.)/(total mites on beetle sp.) x total mites]. Our data met the assumptions for parametric tests.

## RESULTS

We found 47 beetles total, 13 of the larger beetle (sp. A) and 33 of the smaller beetle (sp. B). There was a significantly greater proportion of mite sp. 1 on beetle sp. B, and of mite sp. 2 on beetle sp. A (Fig. 1). Mite sp. 1 was more abundant than mite sp. 2 on beetle sp. B, while this relationship was reversed on beetle sp. A. The mean number of mites of both species was greater on beetle sp. A than beetle sp. B (Table 1).

We found no relationship between residual mass of beetles (including both species in the analysis) and total abundance of mites ($r^2 = 0.0001$, df = 1, P = 0.94). After separating the data by beetle species, there was still no significant relationship (beetle A: $r^2 = 0.06$, df = 1, P = 0.40, beetle B: $r^2 = 0.06$, df = 1, P = 0.29). These results indicate that there was no effect of total mite abundance on residual beetle mass.

For beetle sp. B, however, there was a positive relationship between abundance

Table 1. Mean mass of each passalid beetle species, and mean mite abundances of each beetle species.

| | Mass (g)(±SE(n)) | Mite sp. 1/ beetle | Mite sp. 2 / beetle |
|---|---|---|---|
| Beetle sp. A | 4.45 ± 0.09 (14) | 14.6 ± 1.4 | 23.2 ± 2.0 |
| | | | |
| Beetle sp. B | 0.8 ± 0.05 (33) | 3.1 ± 0.9 | 1.3 ± 1.3 |
| | | | |

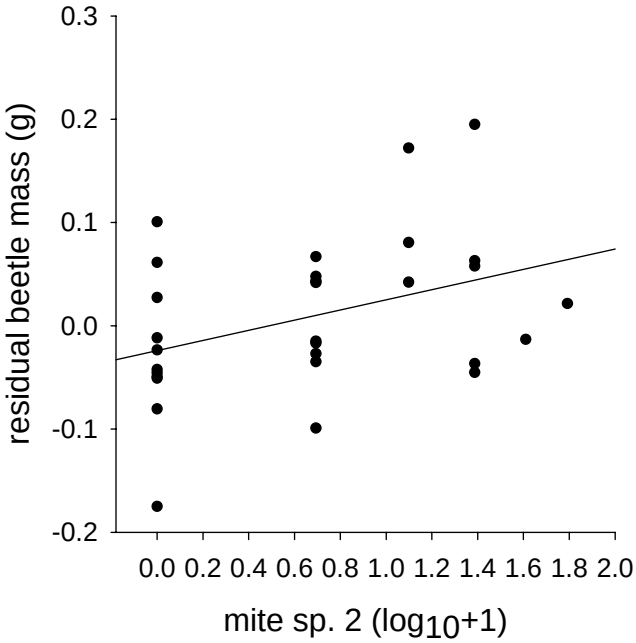


Figure 2. The relationship between residual mass of beetle sp. B and number of mite sp. 2 (r2 = 0.15, df = 1, P = 0.04).

of mite sp. 2 and residual mass (Fig. 2) and a negative relationship between abundance of mite sp. 1 and residual mass (Fig. 3). No relationship was found between mite abundance and residual mass of beetle sp. A. All analyses on residual mass assume, as noted above, that relations between volume and mass were linear.

## DISCUSSION

While there was no general effect of mite abundance on residual mass, abundance of mite sp. 1 and mite sp. 2 individually seemed to have opposing effects on the residual mass of the smaller passalid beetle species.

The higher proportional abundance of mite sp. 1 on beetle sp. B and of mite sp. 2 on beetle sp. A (Fig. 1) could result from size differences between the mite species. The larger, more rotund mites of sp. 2 may require large gaps in the exoskeleton of their host in which to attach, which would be scarce on small beetles but more plentiful on larger passalids. Small mites of sp. 1, which could occupy tight spaces in the carapace of a small beetle, might be excluded from many of the corresponding areas on the large beetle species by larger mites. Our study was limited by sample size, imprecise weighing techniques and a lack of attention to allometric relations which can strongly affect the relations among metrics as animals increase in size. Even if mite-beetle interactions do influence the relations between beetle volume and residual mass, one must consider carefully when the effects of mites on a beetle may have occurred, relative to the timing of molting events. For all these reasons, we do not attempt to interpret the patterns (or, in some cases, lack of patterns) in the rela-

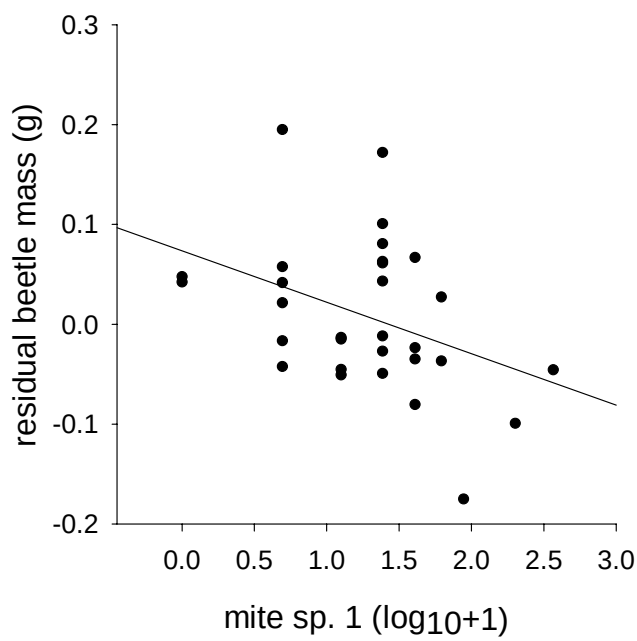


Figure 3. The relationship between residual mass of beetle sp. B and number of mite sp. 1 (r2 = 0.15, df = 1, P = 0.03).

tions between beetle volume and mass. We include those results for the benefit of other researchers who may be interested in a more complete analysis of those relations.

## LITERATURE CITED

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