Beetle, Spider, and Bumblebee Communities Differ Across an Elevational Gradient in Denali National Park & Preserve, Alaska

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Introduction

- Alaska is warming and drying faster than any other state and experiencing profound ecological change.[1] Alpine tundra ecosystems are of particular concern due to the upslope expansion of forest and shrubs.[2,3]
- We expect corresponding disruptions and losses to alpine arthropod communities as alpine tundra shrinks and/or fragments.[4] Habitat specialists are most vulnerable.
- We compared beetle, spider, and bumblebee (Apidae: *Bombus*) communities across a montane elevational gradient to better understand this rapidly changing ecosystem.

Objective: Determine how alpine tundra arthropod communities differ from those of forest and shrubs.

Denali National Park & Preserve

- Denali National Park & Preserve encompasses 24,500 km^2 (larger than the state of New Hampshire) and contains an expansive elevational gradient (Fig. 1 & 2).
- The park's arthropod fauna is nearly unknown. Past sampling documented only 80 of an expected 1,000+ species (based on comparable regions of Alaska).

Figure 1. Map of Alaska showing Denali National Park & Preserve highlighted in yellow.

Figure 2. Vane trap in front of Denali (formerly Mt. McKinley), North America's tallest peak.

Methods

Specimen Collection

- Collection occurred in July & August of 2016 (first of 3 years of sampling).
- Sampled along four elevational transects, each composed of a forest (low-elevation), shrub (mid-elevation), and alpine tundra (high-elevation) plot (Fig. 3).
- We used a combination of pitfall traps, vane traps (Fig. 2), litter sampling, and timed (10 minute) ground searches.
- Identifications of spiders were done by J. Slowik, aleocharine staphylinids by J. Klimaszewski, and the remainder done by the authors.
- All specimens accessioned into the University of Alaska Museum Insect Collection, and specimen data made publicly available via Arctos.

Statistics

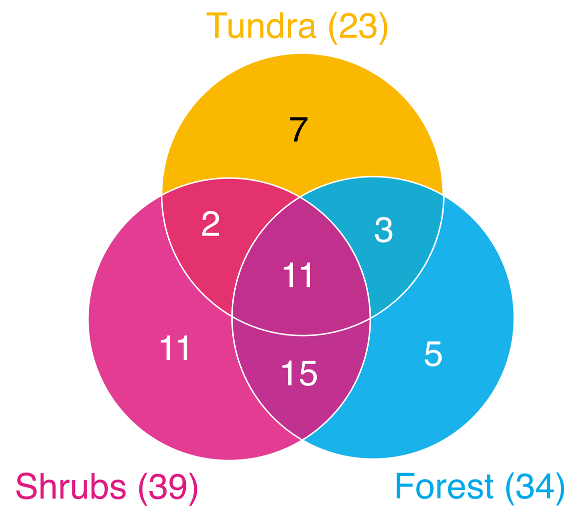
- Singleton taxa removed pre-analyses.
- Non-metric multidimensional scaling (NMDS) ordination was performed using the Bray-Curtis dissimilarity measure. Only taxa comprising >1% of total specimens were retained for ordination.
- Multi-response permutation procedure (MRPP) was used to test for differences in community composition among habitats.[5]
- All analyses performed with the vegan[6] package in R 3.3.1.[7]

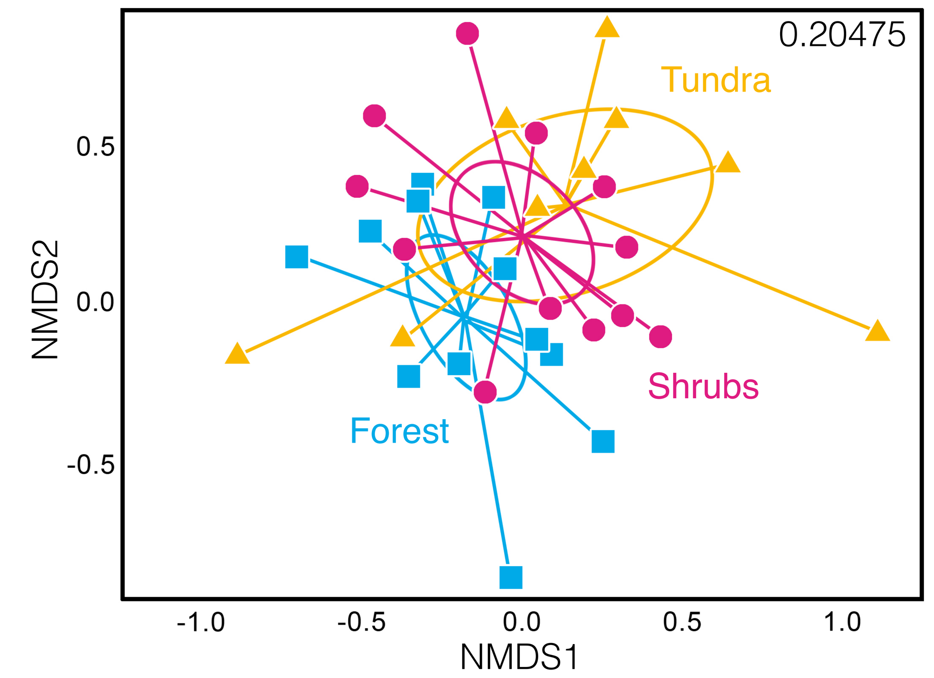
Figure 3. Examples of forest (A), shrub (B), and alpine tundra (C) habitats.

Results

Beetles

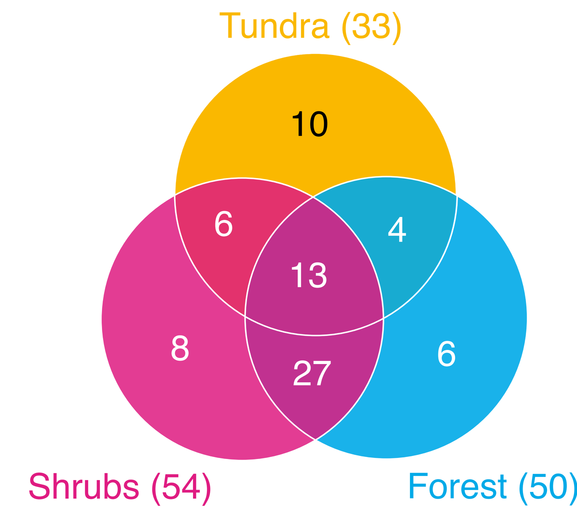
54 species
1,918 specimens
MRPP: f = 2.020, p = 0.009

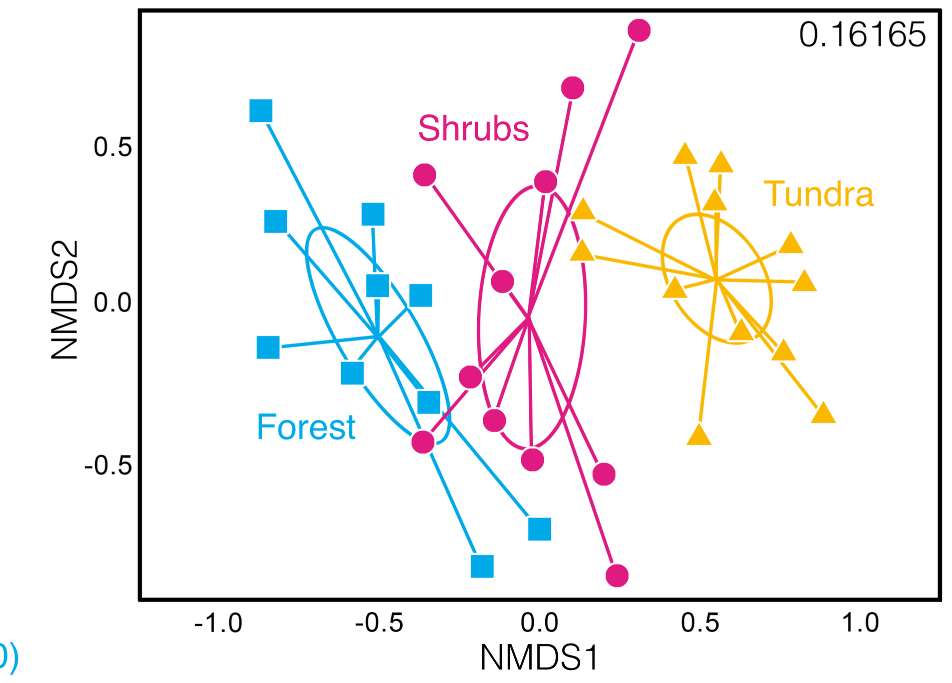




Spiders

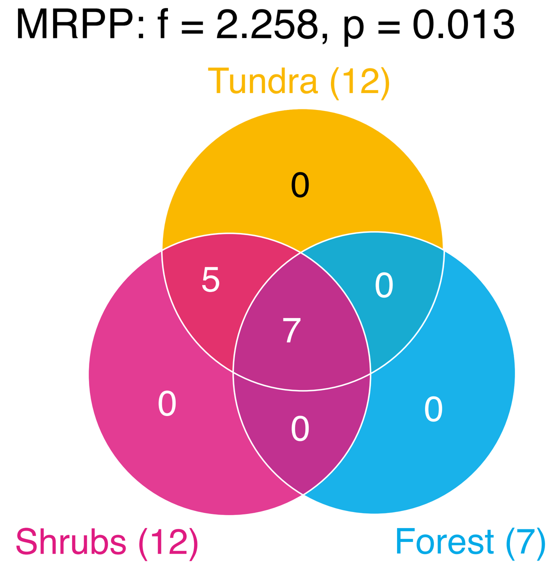
74 species
990 specimens
MRPP: f = 2.829, p = 0.003

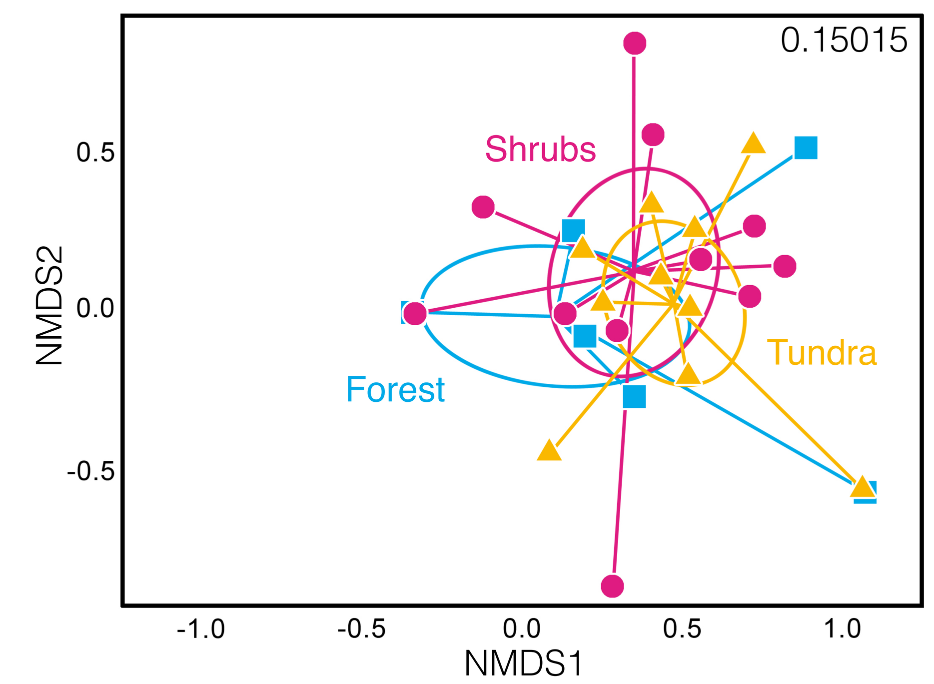




Bumblebees

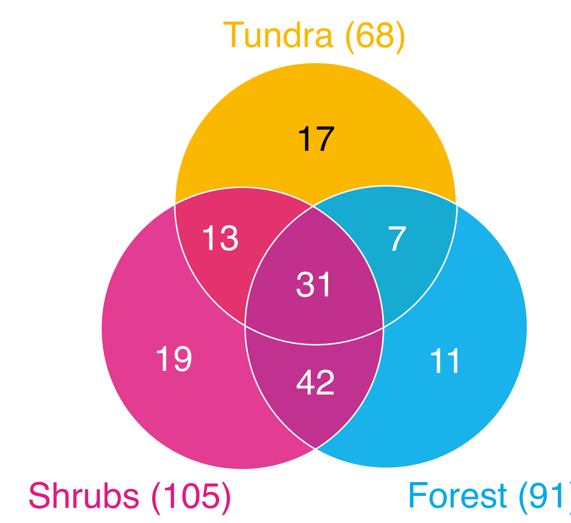
12 species
1,078 specimens
MRPP: f = 2.258, p = 0.013





Combined

140 species
3,986 specimens
MRPP: f = 3.107, p = 0.001



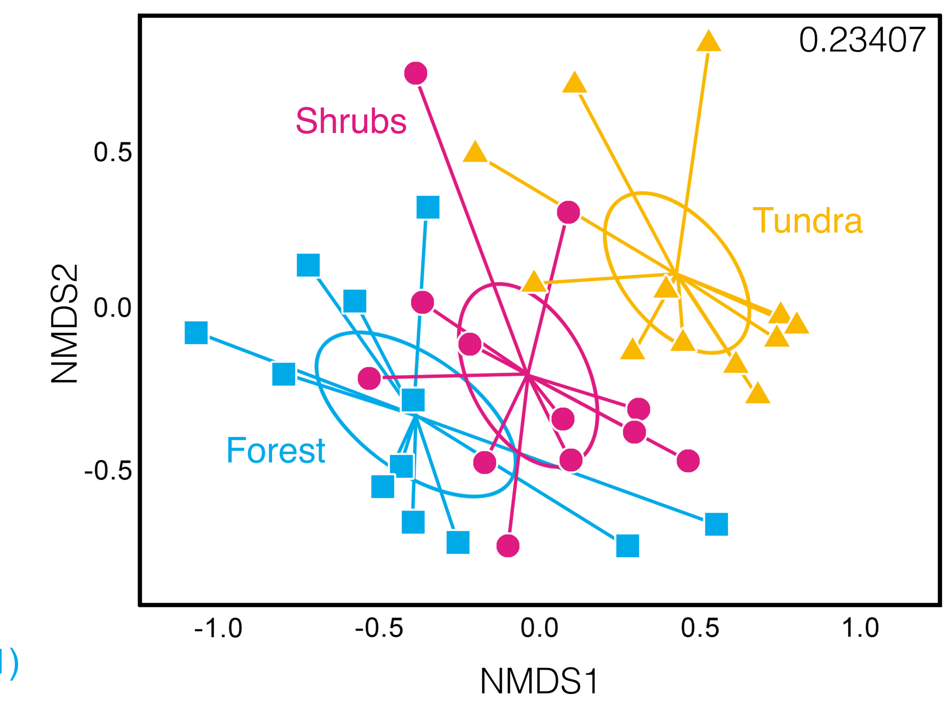


Figure 4. Comparisons of arthropod community composition in forest, shrub, and alpine tundra habitats. **Left:** Venn diagrams showing the number of unique and shared species (observed richness) among habitats. **Right:** NMDS ordinations and stress of arthropod communities in each habitat. Ellipses represent 95% confidence intervals of the centroids.

Conclusions

1. Alpine tundra arthropod communities differ from those of forest and shrubs. MRPP analysis found that community composition significantly differed by habitat for all taxa. However, only spider and combined communities were clearly stratified in NMDS ordination.

2. Alpine tundra contains proportionally more habitat specialists. Alpine tundra had the lowest observed species richness (68), but 25% of those species (17) were habitat specialists. No bumblebee species were specialists.

Significance

Arctic tundra arthropod populations are declining dramatically in response to climate change.[8] We have identified the potential for similar losses in Alaska's alpine tundra communities, particularly among spiders.

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