

Introduction

The animal order Hymenoptera (wasps, bees, sawflies, and ants) is incredibly diverse, encompassing a range of environmentally important behaviors from pollinators and parasitoids to herbivores and predators. They are considered the most diverse order beside Coleoptera (beetles) (Forbes, A. et al., 2018). Studies on Hymenoptera in Michigan and the Great Lakes region, specifically those involving anything outside of bee and ant populations, are incredibly sparse (Wheeler, G. et al., 1994; Gibbs, J. et al., 2017). Little is known about many basic, yet essential, questions relating to Hymenopteran biology and ecology. Yet, they provide incredibly necessary and beneficial assets to all life on earth, such as pollinating flowers of staple foods and regulating populations of pest insects. This study strives to answer some of these fundamental biological questions and fill the knowledge gap concerning Hymenoptera in Michigan.

The objectives of this study were to:

1. Document what Hymenoptera are present in southern Michigan
2. Discover what habitats support the greatest diversity and abundance of Hymenoptera

Methods

- Data was collected at two field sites at two different locations:
 - E.S. George Reserve (ESGR) (Field 1 & Field 2) (1,300 acres 25 mi from town)
 - Saginaw Forest (Lakeside & Grassland) (80 acres 5 mi from town)
- Data was collected at each location every other week during May and June 2019
- Specimens were collected using active and passive methods
 - Hand netting (active; 6 hour collection period) (Fig. 1)
 - Pan traps (passive; 6 hour collection period)
 - Malaise traps (passive; 14 day collection period) (Fig. 2)
- Specimens were processed on non-field days for optimal specimen preservation:
 - Wash & blow dry (bees)
 - Hexamethyldisilazane (HMDS) solution soak (parasitoid wasps)
- All specimens were pinned/pointed, labeled, & given a unique identifier number
- Data was analysed using R Core Team (2013)
- Voucher specimens will be deposited in the UM Museum of Zoology Insect collection and all data will be available via the online via the Global Biodiversity Information Facility (GBIF)



Figure 1. Example of hand netting using an entomological air net at Saginaw Forest grassland site to collect Hymenopteran specimens. Hand netting captures the majority of bees and provides floral association records.



Figure 2. Example of malaise trap at Saginaw Forest. Traps are left out for two week intervals before specimens are collected. Malaise traps capture the majority of parasitoid wasps.

Results

- 2,034 Hymenoptera specimens were collected and identified from May and June 2019 (1,106 spp. from the E.S.G.R. and 929 spp. from Saginaw Forest) (Fig. 3). There was no significant difference in abundance ($p = 0.7234$) between locations.
- 25 different Hymenoptera families were identified (22 from the E.S.G.R. and 19 from Saginaw Forest) from five different biological guilds (herbivores, predators, parasitoids, pollinators, kleptoparasites) (Fig. 3). There was no significant difference in family richness ($p = 0.2048$) between locations.
- Most families were found at both locations, however there were 6 families only found at the ESGR and there were 3 families only found at Saginaw Forest (Fig. 4).

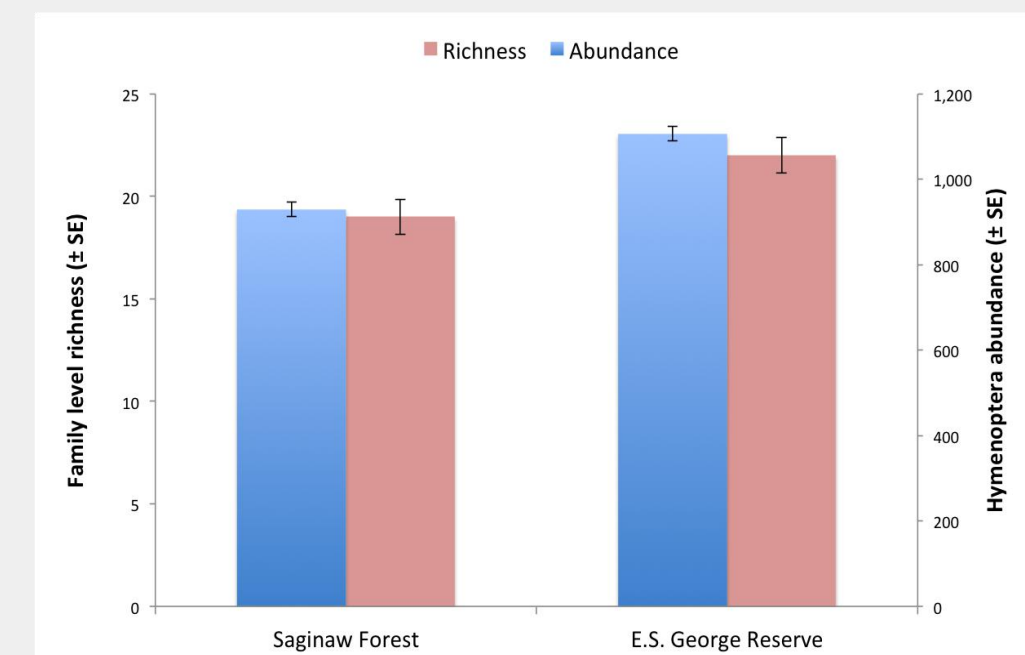


Figure 3. Comparison of Hymenoptera abundance and family level richness at the ESGR and Saginaw Forest. Neither abundance ($t = 0.3575$, $df = 27.887$, $p = 0.7234$) nor family richness ($t = 1.3468$, $df = 11.143$, $p = 0.2048$) was significantly different between sites.

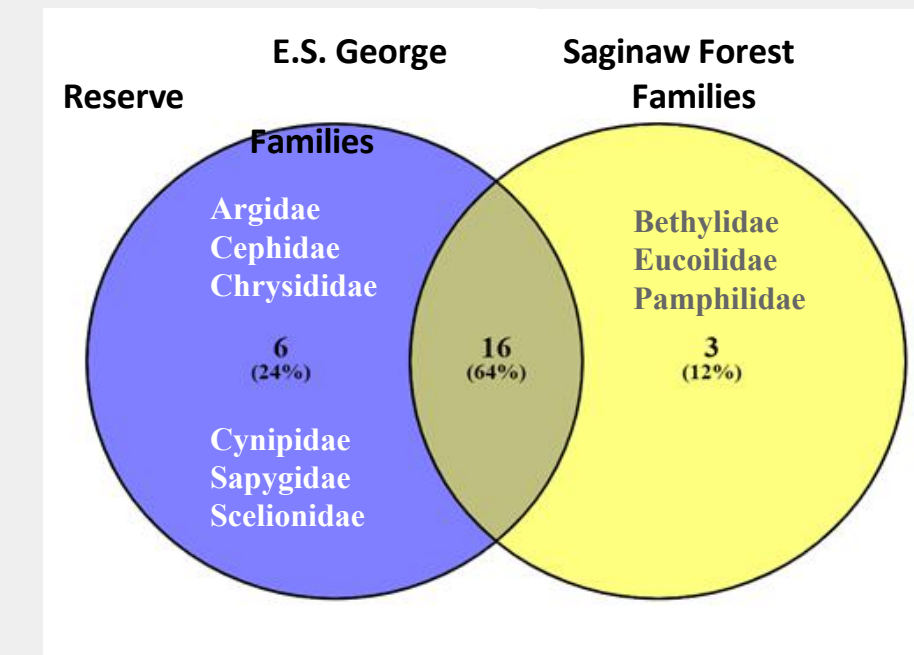


Figure 4. Comparison of families at each location. Sixty-four percent of the 25 Hymenopteran families collected were found in both the ESGR and Saginaw Forest. Families unique to one location are listed in the appropriate circle.

- More parasitoids were found at Saginaw Forest than at the ESGR, while a greater number of all other guilds were found at the ESGR (Fig. 5).
- Only the family Halictidae was found to be significantly different in abundance between the two locations ($p = 0.05408$), although the proportion of families found at each location was substantially different visually (Fig. 6-7).

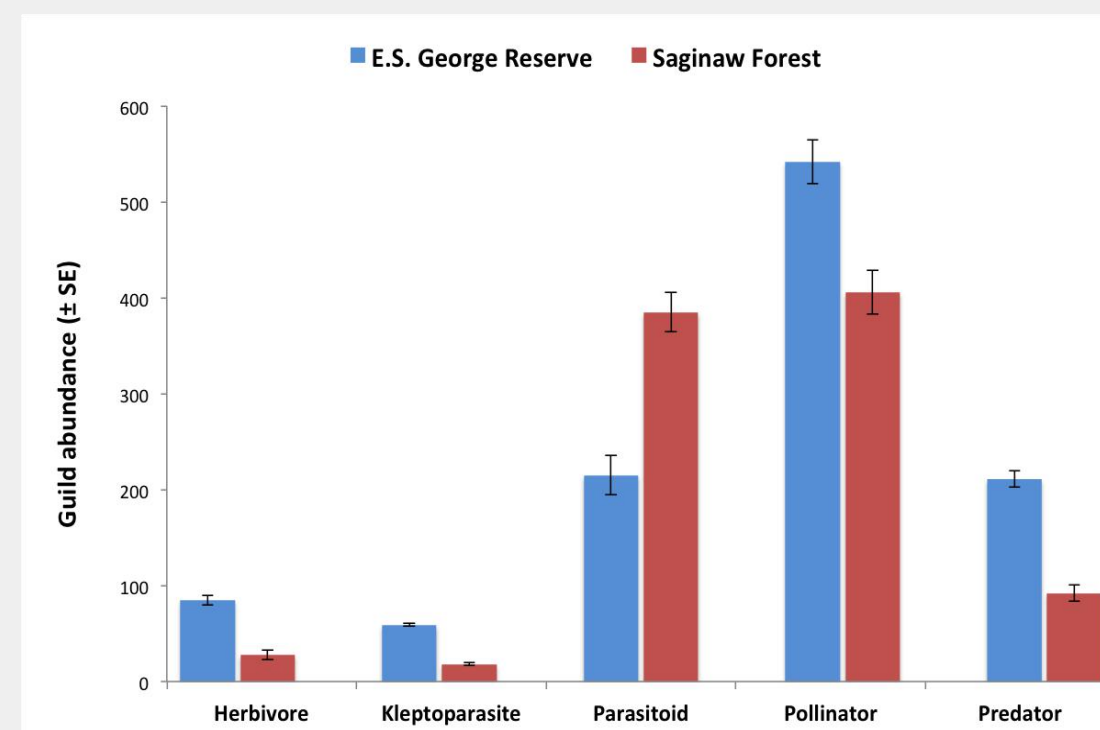


Figure 5. Comparison of guilds found at the ESGR and Saginaw Forest. More parasitoids were found at Saginaw Forest ($p = 0.2131$), while more herbivores ($p = 0.4731$), parasitoids ($p = 0.2131$), pollinators ($p = 0.9981$), and predators ($p = 0.1694$) were found at the ESGR. Significantly more kleptoparasites were found at the ESGR ($p = 0.002259$).

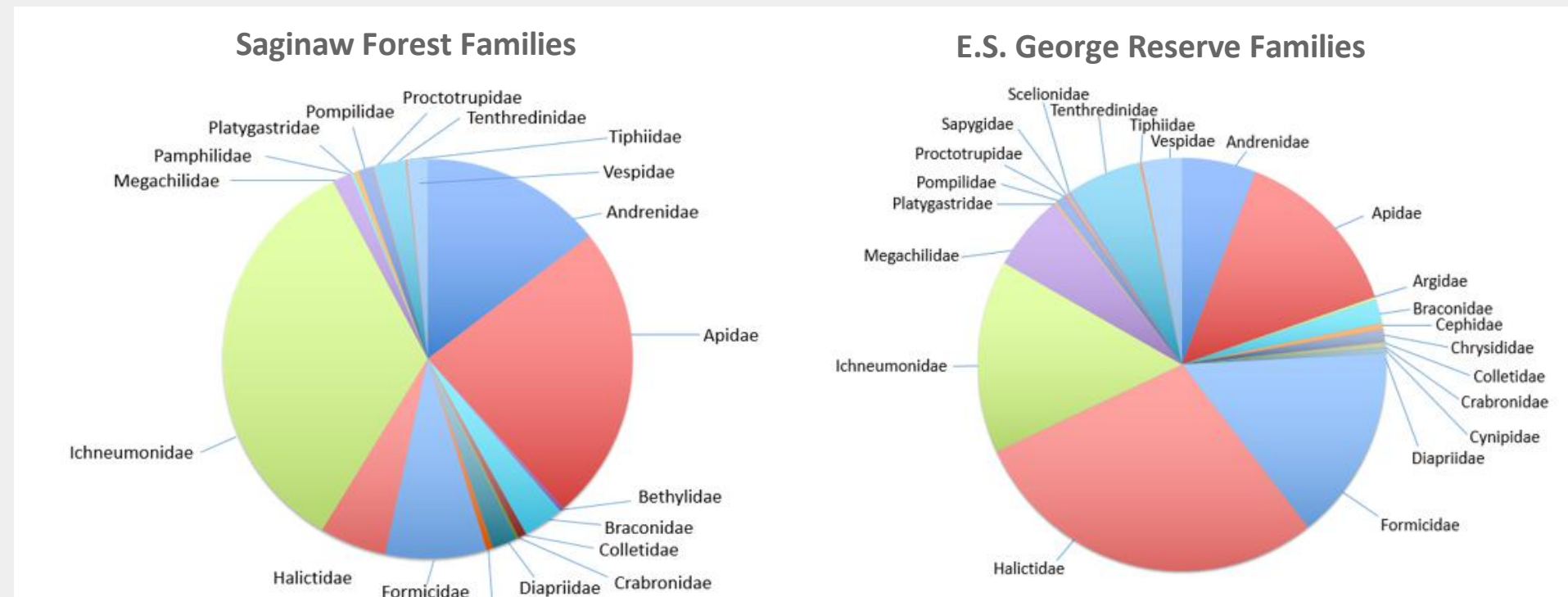


Figure 6. Composition of different families found at Saginaw Forest (left pie chart) and those found at the ESGR (right pie chart). Proportion of Halictidae specimens was significantly different between locations ($p = 0.05408$), but non-significant for all other families.

Discussion & Conclusion

This study found a total of 25 different Hymenopteran families and revealed a greater familial level diversity at the ESGR (22 families) than at Saginaw Forest (19 families). While Saginaw Forest had a much higher percent of Ichneumonidae (parasitoids), Andrenidae (pollinators), and Apidae (pollinators), the ESGR had a much higher percent of Halictidae (pollinators), Formicidae (predators), Megachilidae (pollinators), and Tenthredinidae (herbivores). Of the families found during this study, three were only found at Saginaw Forest and six were only found at the ESGR. In addition to family level analyses, specimens were categorized by biological guild (pollinators, parasitoids, kleptoparasites, predators, and herbivores). Hymenoptera at the guild level were visibly different between the two locations as Saginaw Forest had greater numbers of parasitoids than the ESGR, while the ESGR had greater amounts of pollinators, predators, and kleptoparasites.

One possibility for the differences observed between the two sites may be that larger, more protected areas of land further away from major cities (like the ESGR) allow a greater abundance and diversity of Hymenoptera to persist. Previous studies have found patches with larger areas or with a greater number of corridors are incredibly important to maintaining high levels of biodiversity (Beninde, et al., 2015). Protected areas are also much more widely biodiverse (Gray et al., 2016). Saginaw Forest has also had notable water pollution, which have directly or indirectly negatively impacted the survival and reproductive success of certain Hymenopterans (Saginaw Forest, 2019). Differences in the composition of families and guilds between the two sites may also be due to floral composition, sampling method, incomplete sampling (i.e. this is part of a larger project still in progress), or other unknown factors.

The most recent study on general Hymenoptera biodiversity by the University of Michigan in the Michigan region was conducted almost 30 years ago (O'Brien, 1989). Future studies may encompass population changes, plant-pollinator network analyses, or how climate change has affected particular species by comparing data sets. The data collected for this project represents two months of data from a much larger biodiversity study still in progress. Future studies needed include additional sampling and analysis of associated floral data, examining distributions as they relate to climate change over time, as well as continued study on current species present in Michigan, the habitats they live in, and food and hosts sources required.

References

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