

Differing Invertebrate Diversity and Composition in Grassy and Wooded Areas

By

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Abstract

Invertebrates are one of the largest and most important groups on the planet. This is true for all environments, including terrestrial ones in which invertebrates are often fundamental to the health and success of entire ecosystems. This makes it immensely important to understand the compositions, diversity, abundance, and richness of invertebrate communities in different environments. The goal of this study was to survey invertebrate communities at the University of Houston Coastal Center (UHCC) and test the hypothesis that community composition will vary with environment type. Two environments were chosen: a grassy environment with no trees, and a wooded environment with little to no grass. Environments were surveyed using eight traps total (four pitfall and four pan) per treatment, to capture a wide range of taxa, and compare the effectiveness of each trap type. Traps were collected and reset daily for four consecutive days (June 27-30), with invertebrates counted and categorized on the day of collection. Our data suggest significant differences in community composition between these two environments. Specifically, data show that Hemiptera (true bugs) dominate the grassy environment, which also showed significant increases in Orthoptera (grasshoppers, crickets, katydids) and Diptera (true flies) while Entognatha (springtails) dominate the wooded environment. The grassy environment also showed significantly higher diversity, while the wooded area showed higher richness at the order level. These results provide insight into the specific invertebrate communities located at the UHCC and insight into how these communities differ between environments.

Introduction

In terms of species, it is widely agreed that insects comprise the biggest and most diverse group on earth, accounting for over half of all described species (May 1988; Mayhew 2007). Terrestrial insect communities specifically, are known to increase in diversity and abundance in environments with increasing plant biodiversity and species richness (Wenninger, Richard. 2008). These communities are not only heavily affected by plant species diversity but also play key roles in the health of these environments. In grasslands for instance, invertebrate communities play important roles in nutrient cycling and pollination but are heavily dependent on plant diversity and production (Barnett, Facey 2016). Similarly, invertebrate communities also play important roles in forest environments like organic matter decomposition, seed and microorganism dispersal, and pollination (Kotze 2022).

The differences between grassland and forest environments are significant. Grasslands are composed of herbaceous plants and harbor high species diversity and richness (Petermann, Buzhdygan, 2021). On the other hand, forest environments are typically dominated by a few species of trees which results in a vastly different physical environment. A study to compare the invertebrate communities of these two environments was conducted at Mbeya University of Science and Technology in Tanzania and found significant differences in diversity, richness, and community composition between the two (Ojija 2016).

Do these differences in diversity, richness, and community composition between wooded and grassy environments hold for environments of the University of Houston Coastal Center? (UHCC) And what specific insights can we gain into the community compositions of these specific environments? These are the questions this study set out to answer. Based on previous research, the team hypothesized that wooded and grassy environments at the UHCC would show significant differences in invertebrate community composition. To evaluate this, we surveyed the invertebrate communities of a grassy site and a wooded site at the UHCC (independent variable) and compared the diversity, richness, and abundance, of invertebrates found (dependent variable). The data were analyzed using the Shannon Diversity Index and found the grassy environment to be more diverse than the wooded environment and showed significant differences in community composition.

Methods

Study Site. This survey was conducted at the University of Houston Coastal Center (UHCC) located in La Marque, Texas. The property consists of fields and areas of wooded vegetation. Within the property, two sites were selected. Site A was a field dominated by herbaceous vegetation located just southeast of the intersection between Road J and Road 10 (29.38171, -95.04911) (Fig. 1). Site B was a shallow drainage area dominated by small trees located just east of road eight between roads J and F (29.38314, -95.0448)(Fig. 1). Both sites were located on the West side of the property near the West Pond, 0.45 km from each other (Fig. 1). The study was conducted from June 26-30, 2023.

Sampling Design. To survey the invertebrate communities at these sites, given restrictions on time and workforce, the team decided on a combination of pitfall traps and pan traps. These two trap types are effective, inexpensive, and easy to use, and in combination would allow for the capture of a wide range of invertebrate taxa. Our pitfall traps consisted of a simplified version of the standard trap, using Signature Select 0.27L cups buried so the rim of the cup sat level with the ground (Fig. 2). To each cup was added ~120 mL of soap water. Our pan traps followed the widely used yellow plastic bowl design, specifically, 0.36L bright yellow plastic bowls made by Touch of Color, which were zip-tied on either side to wooden stakes to elevate the bowls (Fig. 2). To each bowl was added ~240 mL of soap water. Both trap types used the same soap water mixture of 1% soap.

Four traps of each trap type were used at both sites. The specific location of traps was randomized to account for placement bias. This was accomplished by walking in each cardinal direction a random number of steps between 1-10 and then turning to the right and walking a random number of steps between 1-10 (Fig. 3). Each trap location had a pan trap, and a pitfall trap 0.5 meters to the north, to allow for a location-independent comparison between trap types. All traps were initially set up on June 26th at approximately 10:45 AM. The traps were then reset each following day at 8:00 AM until June 30th when the traps were collected.

The contents of each trap were collected into pre-labeled jars. These jars were then taken to the UHCC lab building. One at a time, each jar was filtered through a fine sieve, then the contents of the sieve were rinsed into a petri dish to be examined under a dissection microscope. Unique taxa and their abundance within the sample were recorded on paper and later digitally.

Analysis. To analyze the abundance, richness, and Berger-Parker Dominance Index of each taxon at each site, identifications were first categorized to the order level. The data for each unique trap were

summed across the four collection days, and then the location-independent trap pairs were summed together. This resulted in four replicates per site, which were compared using mean and standard deviation, and analyzed using 2-tail unequal variance T-tests. To measure the Shannon Diversity Index at each site, identifications were not grouped to the order level, but rather calculations were done at the identification level. However, the data for trap pairs and between days were summed together as before. Results were compared using mean and standard deviation and analyzed using a 2-tail unequal variance T-test. The effectiveness of each trap type at each site was examined by separating the pan and pitfall trap data giving four replicates of each trap type to compare at each site. Results were again compared using mean and standard deviation and analyzed using 2-tail unequal variance T-tests.

Results

Across the 16 traps used in this survey, 608 identifications were made from 24 unique taxa with a Sorenson Similarity Index of 0.757 between sites. These identifications were sorted into 10 larger taxon groups Arachnida (spiders), Coleoptera (beetles), Diptera (flies), Entognatha (springtails), Hemiptera (true bugs), Hymenoptera (ants/bees/wasps), Isopoda (pill bugs), Orthoptera (grasshoppers / crickets / katydids), Phasmatodea (walking sticks), and Thysanoptera (thrips). Of these groups, the most abundant groups recorded were Hymenoptera, Hemiptera, and Entognatha (Fig. 4). The least abundant groups were Phasmids and Isopods, which consisted of only one and two observations respectively (Fig. 4). These groups differed greatly between environments with Diptera, Hemiptera, and Orthoptera all showing significantly higher numbers in the grassy environment, and Entognatha showing significantly higher abundance in the wooded area (Fig. 4).

Between the two sites, significant differences in richness and diversity were found. The sites showed no significant differences in richness at the identification level, but when identifications were grouped to the order level, data show that the wooded environment contained significantly higher taxon richness compared to the grassy environment (Fig. 5). However, this was not the case for the mean Shannon Diversity Index, which showed no significant differences at the order level, but when calculated at the identification level data show that the grassy site had significantly higher diversity (Fig. 6).

The relative proportions of each taxon at each site differed in a few key groups. While groups like Arachnida and Hymenoptera made up equal proportions in both environments, other groups like

Diptera, Orthoptera, Thysanoptera, and Hemiptera made up greater proportions at the grassy site (Fig. 7). This is especially true for Hemiptera which made up ~30% of observations at the grassy site, but only ~4% at the wooded site (Fig. 7). On the other hand, Entognatha were found almost exclusively in the wooded environment and made up ~40% of observations (Fig. 7). No significant difference in the mean Berger-Parker Dominance Index was found between sites (Fig. 8)

The effectiveness of each trap type on insect groups was found to be similar between both sites. In both environments, pan traps were more effective against Diptera, Hemiptera, and Arachnida, and pitfall traps were more effective against Hymenoptera and Entognatha (Fig. 9 and Fig. 10). Other groups were not recorded in enough volume to confidently determine trap effectiveness.

Discussion

Overall, the results of this study found that the grassy environment had significantly more diversity, along with non-significant increases in richness and overall abundance. It seems likely that these increases in richness and the overall abundance would show to be statistically significant with a refinement of the identification methodology given the results for diversity. This would make sense given that the grassy environment in this study certainly had higher plant species richness, and diversity, which is understood to increase insect diversity and richness (Wenninger, Richard. 2008). These results are also similar to previous research on this matter such as the study at the Mbeya University of Science and Technology in Tanzania, which also found invertebrate communities to be more diverse in grassland compared to a wooded environment (Ojija 2016).

Hemiptera, a group comprised of predators and herbivores, showed a sharp decline in the wooded environment compared to the grassy environment (Fig. 4). This is likely explained by the large decrease in vegetation in the wooded environment due to its location and tree cover. Interestingly, with this decrease in predators and herbivores we see a substantial increase in the detritivorous Entognatha in the wooded environment (Fig. 4). This suggests this environment is more suited for detritivorous invertebrates while the grassy environment is more suited to herbivores. This may further explain the increase in richness at the order level in the wooded environment as the groups contributing to this increase, pill bugs, stick bugs, beetles, and springtails, are mostly detritivorous or specifically adapted for wooded environments in the case of the stick bug.

The two trap types used in this study (pan and pitfall) were cheap and effective, but on their own are not likely to catch the range of taxa present in these environments (Montgomery, Belitz 2021). Future surveys may consider combining these traps with more trap types such as Malaise traps, and light traps, or perhaps trapping in combination with an active visual survey to capture a wider range of taxa. Additionally, it would be recommended for any future survey to refine the identification and counting of insect taxa. This study was heavily limited by the size of the workforce, which resulted in methods that knowingly omitted small taxa by using a sieve and underrepresented the full diversity of these environments by not categorizing unique taxa as such. One example of this is assassin bugs (Family: Reduviidae. Order: Hemiptera) from which multiple identifications were made, highly likely of distinct species, but all were recorded simply as assassin bugs. A future survey with a larger workforce could eliminate this issue by spending more time per sample to record more unique taxa, with greater accuracy.

The University of Houston Coastal Center is a refuge for many of the species that inhabit coastal Texas. This study provides insight into some of the environments on this property and the invertebrate communities that inhabit them. It is our hope that this insight can contribute to the preservation, maintenance, and understanding of these environments and their inhabitants.

Acknowledgements

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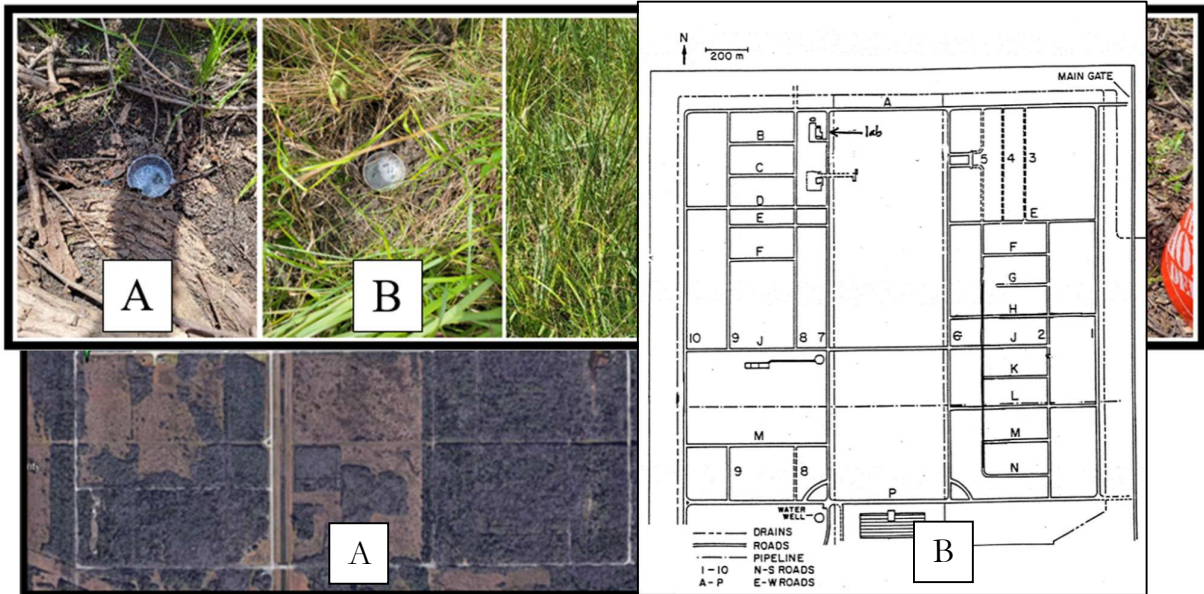


Figure 1. Maps of the University of Houston Coastal Center in La Marque, Texas. Pan and pitfall traps were set up at a grassy site and wooded site at the UH Coastal Center in La Marque, Texas from June 26 to June 30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. Image A shows a satellite view of the Coastal Center. Image B shows a road map of the property. Green markers represent survey sites, (W) Wooded (29.38314, -95.0448) , (G) Grassy (29.38171, -95.04911).

FIGURE 1

Figure 2. Invertebrate survey trap types at grassy and wooded sites. Pan and pitfall traps were set up at a grassy site and wooded site at the UH Coastal Center in La Marque, Texas from June 26 to June 30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. Images A&B show pitfall traps set up in wooded and grassy sites respectively. Images C&D show pan traps set up in grassy and wooded sites respectively.

FIGURE 2

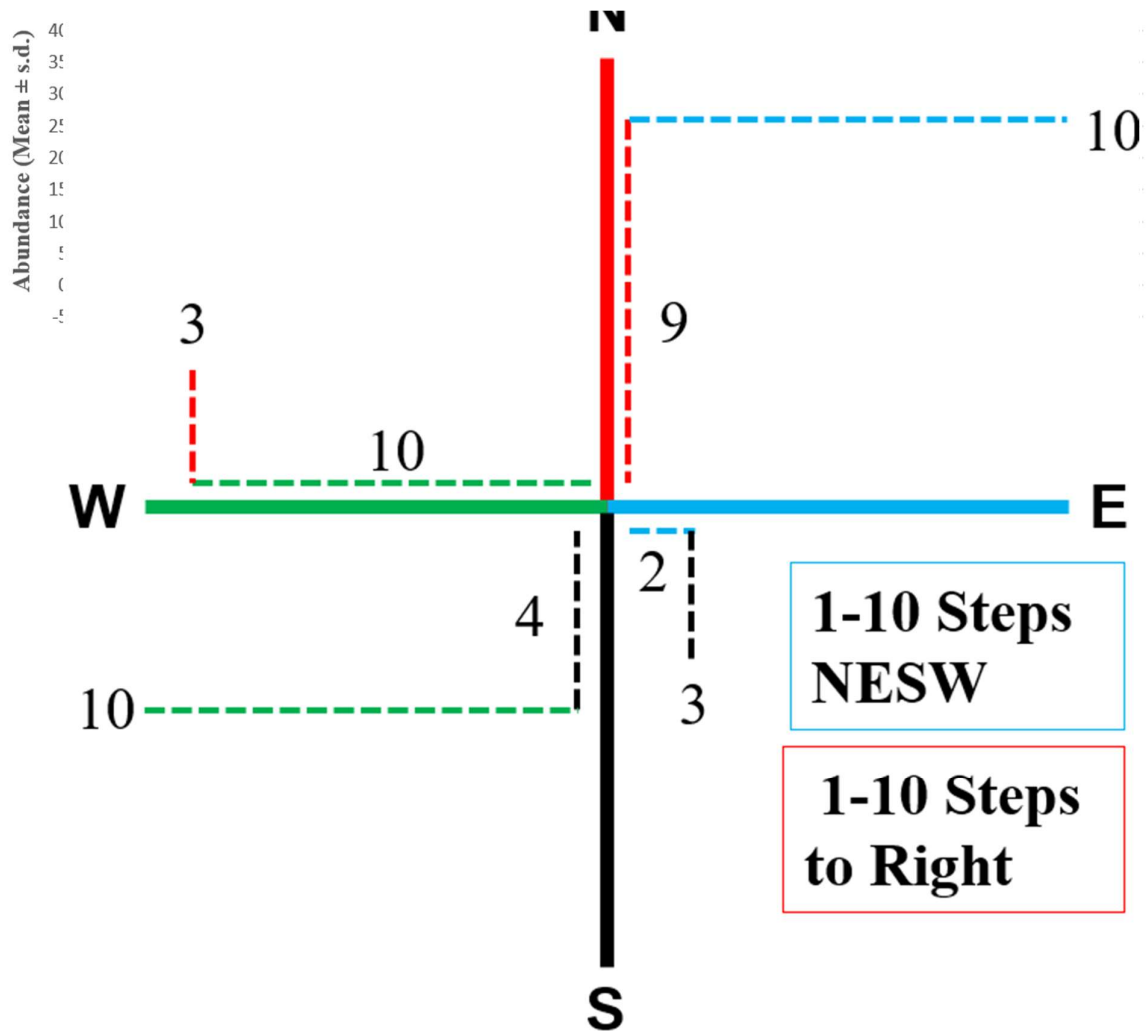
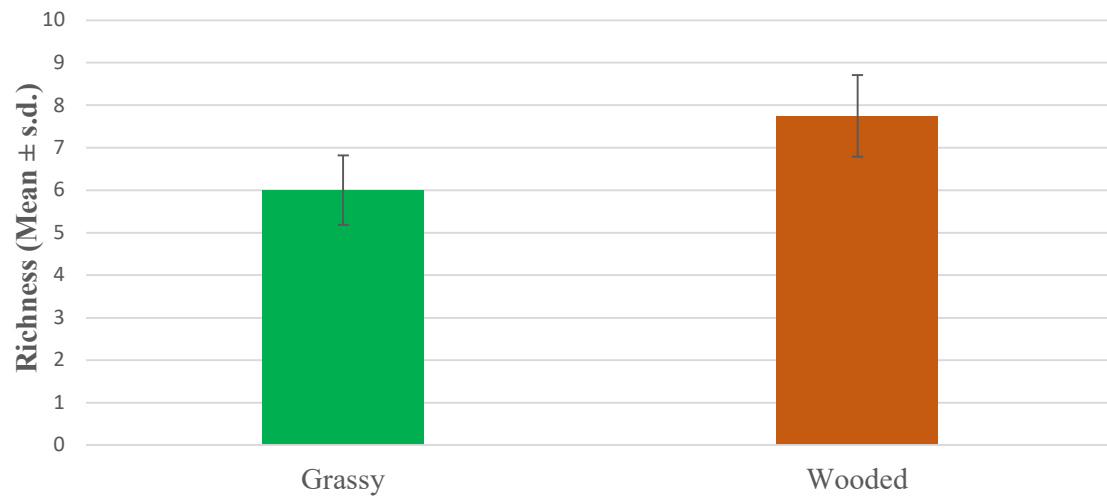


Figure 3. Overview of trap placement at grassy site La Marque, Texas. (29.38171, -95.04911). Pan and pitfall traps were set up at a grassy site and wooded site at the UH Coastal Center in La Marque, Texas from June 26 to June 30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. A random number of steps 1-10 were taken in each cardinal direction and then a random number of steps 1-10 were taken to the right, randomizing trap placement.

FIGURE 3



30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. Values represent abundance (Mean $\pm$ 1 s.d.) of replicates after summing paired traps and all four collection days.

FIGURE 4

Figure 5. Mean Order richness at grassy and wooded site. Pan and pitfall traps were set up at a grassy site and wooded site at the UH Coastal Center in La Marque, Texas from June 26 to June 30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. Values represent order richness (Mean $\pm$ s.d.) of replicates after summing paired traps and all four collection days. p-value = 0.033

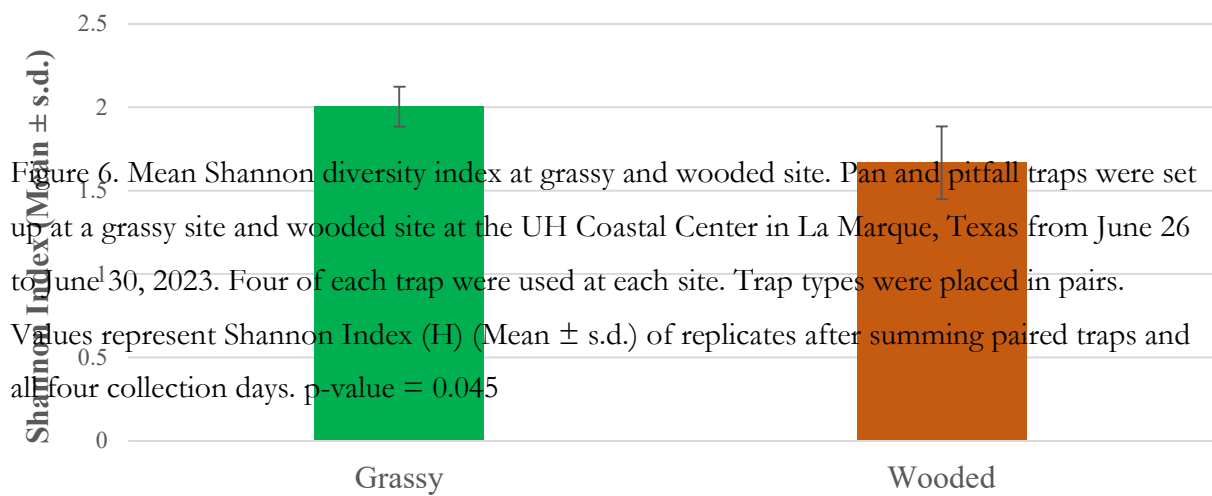


FIGURE 5

FIGURE 6

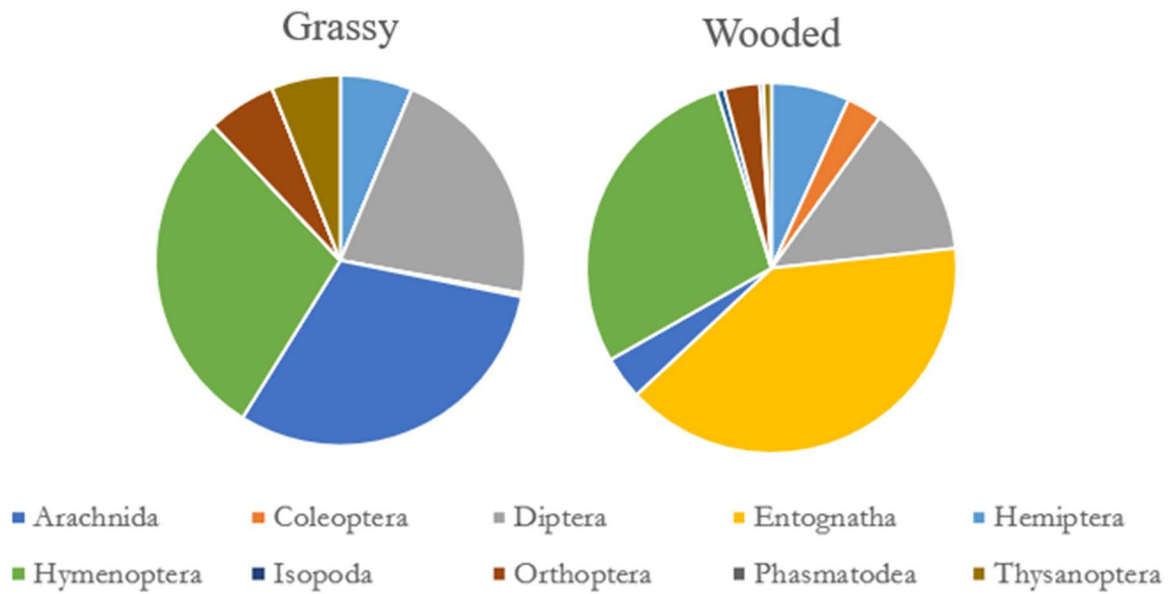


Figure 7. Taxon proportion at grassy and wooded sites. Pan and pitfall traps were set up at a grassy site and wooded site at the UH Coastal Center in La Marque, Texas from June 26 to June 30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. Charts represent mean taxon proportion in each environment after summing paired traps and all four collection days.

FIGURE 7

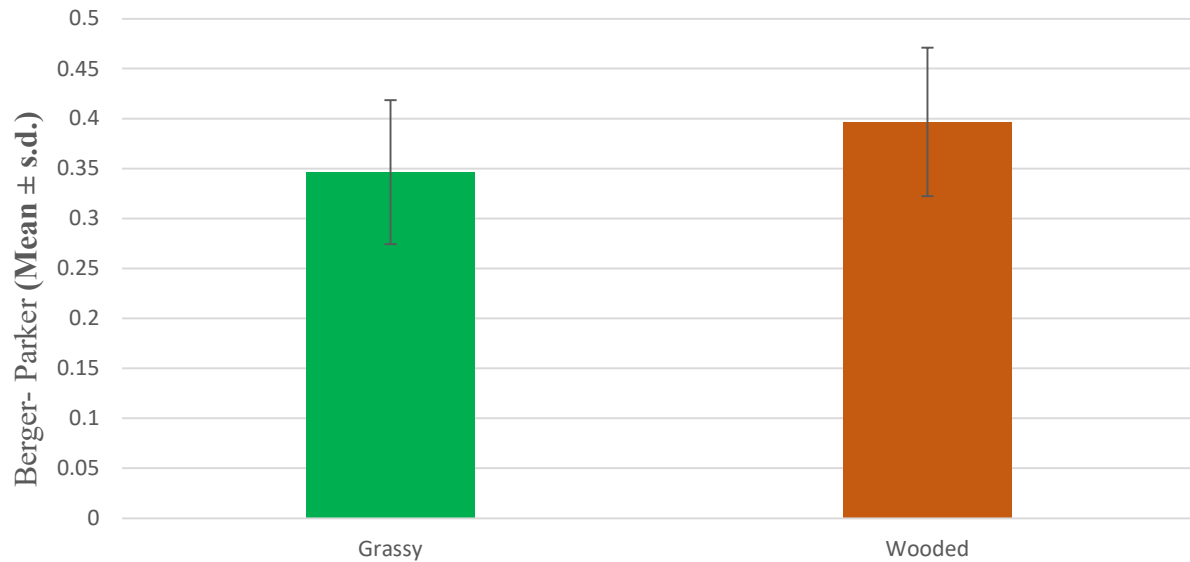


Figure 8. Mean Berger-Parker Dominance Index at grassy and wooded sites. Pan and pitfall traps were set up at a grassy site and wooded site at the UH Coastal Center in La Marque, Texas from June 26 to June 30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. Values represent Berger-Parker Dominance Index (Mean $\pm$ s.d.) of replicates after summing paired traps and all four collection days. p-value = 0.37

FIGURE 8

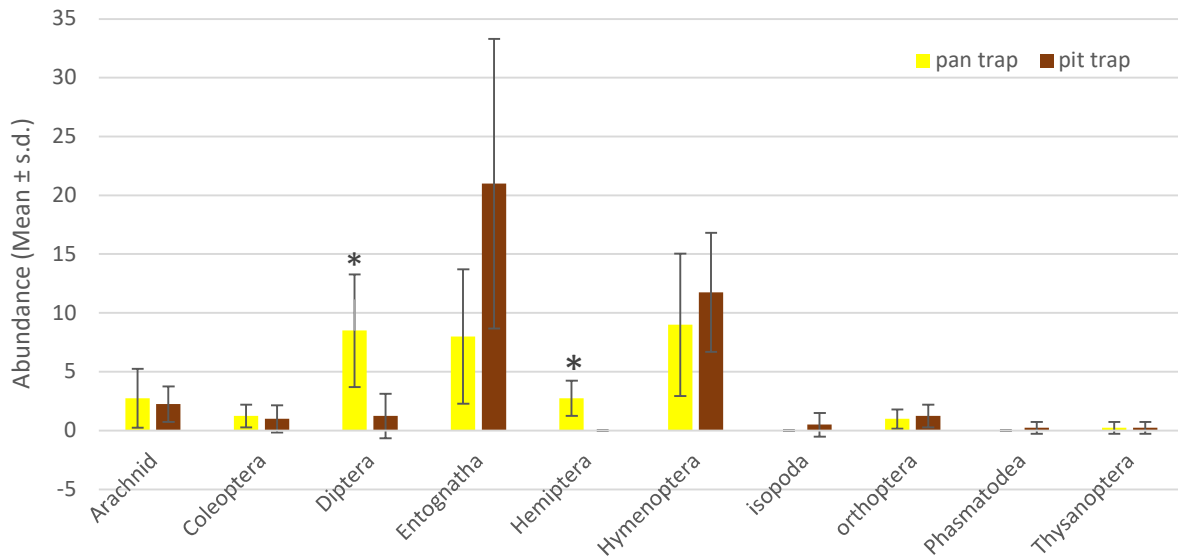


Figure 9. Location-independent comparison of trap type in wooded area. Pan and pitfall traps were set up at a grassy site and wooded site at the UH Coastal Center in La Marque, Texas from June 26 to June 30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. Values represent abundance (Mean $\pm$ s.d.) of replicates after summing all four collection days. (*) represents p-value < 0.05.

FIGURE 9

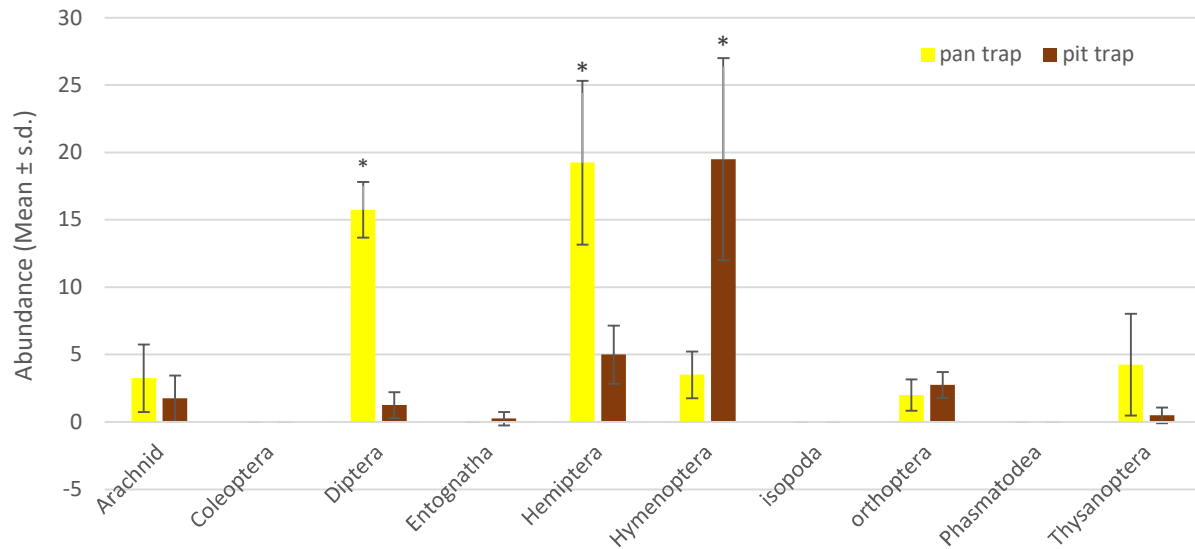


Figure 10. Location-independent comparison of trap type in grassy area. Pan and pitfall traps were set up at a grassy site and wooded site at the UH Coastal Center in La Marque, Texas from June 26 to June 30, 2023. Four of each trap were used at each site. Trap types were placed in pairs. Values represent abundance (Mean $\pm$ s.d.) of replicates after summing all four collection days. (*) represents p -value < 0.05 .

FIGURE 10