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ORIGINAL ARTICLE OPEN ACCESS

Vegetation Structure and Soil Composition Influence Opiliones Diversity Across Spatial Scales in Amazonia

Aléxia B. Rodrigues[1] | Elisa L. Abbad[2] | Pio A. Colmenares[3] | Ana L. Tourinho[4] | Fabrício B. Baccaro[5] | Cristian S. Dambros[2]

[1]Federal University of Pará, Belém, Brazil | [2]Department of Ecology and Evolution, Federal University of Santa Maria, Santa Maria, Brazil | [3]Division of Invertebrate Zoology, American Museum of Natural History, New York, USA | [4]Institute of Natural, Human and Social Sciences, Federal University of Mato Grosso, Sinop, Brazil | [5]Federal University of Amazonas, Manaus, Brazil

Correspondence: Aléxia B. Rodrigues (alexia.betina.rodrigues@gmail.com)

Received: 20 December 2024 | **Revised:** 19 August 2025 | **Accepted:** 29 August 2025

Associate Editor: Rhett D. Harrison | **Handling Editor:** Ignacio Escalante

Keywords: arthropods | beta diversity | biodiversity | community ecology | environmental gradients | vegetation structure

ABSTRACT

Understanding the ecological drivers of species diversity across spatial scales is essential for biodiversity conservation, particularly in highly complex ecosystems such as the Amazon. In this study, we investigate the influence of vegetation structure and soil composition on the diversity and distribution of Opiliones (harvestmen) in an upland forest in the Central Amazon. We developed a theoretical framework to investigate how the primary drivers of Opiliones composition, specifically microhabitat structure (e.g., leaf litter, decaying wood, shrubs, and trees) and soil components (e.g., sand and phosphorus content), differentially shape Opiliones assemblages at both local (tens of m^2) and regional (tens of km^2) scales. Locally, Opiliones show higher diversity and abundance in tree trunks, branches, and leaves, possibly due to the variety of microhabitats provided by large trees. Species composition was also influenced by microhabitat changes associated with trees and decomposing wood. Contrary to expectations, the association of Opiliones with trees did not scale up. Regionally, species diversity was associated with soil and sand content, but not with tree density. These results emphasize the scale-dependent nature of environmental drivers in shaping arthropod communities and caution against extrapolating findings from local-scale studies to broader geographic contexts. Conservation efforts should prioritize protecting diverse microhabitats, particularly mature forests and large trees, to support Opiliones and other arthropods, but should also take into account other factors that can affect species diversity across different geographic scales.

1 | Introduction

Understanding how habitat structure influences species distributions is a central objective of ecology. The species diversity of many taxa is strongly shaped by habitat elements such as soil nutrients, plant architecture, and environmental structural complexity (Gardner et al. 1995; Halaj et al. 2000). While several studies have examined how species change along environmental gradients (Høye et al. 2018; Tourinho et al. 2014; Kinlock et al. 2018; Nishizawa et al. 2022), many fail to explore how these habitat elements affect species distribution across different geographical scales. Ecological processes, such as dispersal and environmental filtering, are scale dependent (McGill 2010), meaning the same process may influence species distribution locally but not at broader scales. Understanding how these effects extrapolate across scales is essential for consistent comparisons between studies conducted in microhabitats and those covering extensive geographical regions.

Despite growing evidence that habitat influences diversity, a gap remains in understanding how these effects operate across different spatial scales, particularly in diverse ecosystems such as the Amazon (Burton et al. 2022; Vasconcelos et al. 2008; Donoso et al. 2010). In this context, specific habitat components influence faunal assemblages at multiple spatial and temporal scales. For example, litter mass and soil phosphorus content affect cockroach abundance and species richness across a 25 km^2 area (Tarli et al. 2014). In the same region, but at a finer spatial scale, forest sub-canopy structure influences Opiliones assemblages by shaping the availability of microhabitats (Tourinho et al. 2014, 2020). Although several studies have shown that arthropod species composition varies along environmental gradients (Salomão et al. 2022; Hipólito et al. 2023), they do not examine how assemblages change across spatial scales, from microhabitats to broader and more heterogeneous landscapes.

Arachnids constitute one of the most diverse groups of arthropods. Approximately 2% of the world's arachnid species are found in the Amazon basin (Adis and Harvey 2000). With over 6779 cataloged species (Kury et al. 2024), Opiliones exhibit a remarkable diversity of lifestyles and occupy a wide range of habitats associated with the vegetation, from the forest floor to the canopy (Pinto-da-Rocha and Bonaldo 2006). However, this diversity may be at risk due to changes in vegetation structure and microclimatic conditions (Gorneau et al. 2024). These arachnids are highly sensitive to humidity and temperature variations, which are essential for their survival (Pinto-da-Rocha and Bonaldo 2006). Different Opiliones species utilize distinct habitats within the vegetation, suggesting that the loss of specific structural elements could lead to a decline in Opiliones diversity. Microclimatic changes driven by deforestation or alterations in vegetation cover may impact their distribution and abundance. Consequently, the high diversity observed could be threatened by environmental degradation, making Opiliones valuable bioindicators of ecosystem changes in the Amazon (Tourinho et al. 2014, 2020).

There are hypotheses suggesting that Opiliones may resort to trees as refuges in disturbance situations (Proud et al. 2012). However, this tendency appears to be more pronounced in locations with greater microhabitat diversity in the leaf litter (Tourinho et al. 2020). In two upland Amazon rainforests, the number of palms and trees was related to Opiliones assemblage composition at a larger scale (tens of km^2) (Porto et al. 2016; Tourinho et al. 2020). At local scales (tens of m^2), Opiliones richness remained unaffected by forest structure and area (Tourinho and Lo-Man-Hung 2021; Tourinho et al. 2014; Tourinho et al. 2020). Understanding the relationships between plant structure and Opiliones diversity is essential for assessing how these arachnids respond to disturbances and for guiding conservation efforts in dynamic habitats. However, how these relationships vary across spatial scales, particularly in the Amazon, remains poorly understood.

Soil properties influence biodiversity in both below-ground and above-ground communities, with variations in soil composition playing a crucial role in shaping plant communities (Hulshof and Spasojevic 2020). In tropical forests, soil composition—particularly soil granulometry and nutrient content—is a fundamental edaphic factor that affects key soil properties, including structure, water retention, nutrient availability, and microbial activity (Nottingham et al. 2017). These factors, in turn, shape the diversity and distribution of soil-dwelling arthropods (Illig et al. 2008). Soil organisms interact closely with plants, both directly through symbiotic relationships and herbivory, and indirectly through decomposition, nutrient cycling (Sylvain and Wall 2011), and the maintenance of nesting sites (SHIK and KASPARI 2010). Despite their vital role in maintaining soil health and biodiversity (Crowther et al. 2015; Ayres et al. 2009), the relationship between Opiliones distribution and soil composition in Amazonian forests remains largely unexplored.

The diversity of soil fauna is closely linked to the wide array of resources and microhabitats provided by the soil-litter system, a structurally complex and heterogeneous environment composed of stratified layers influenced by pore volume, moisture, ventilation, and temperature (Vannier 1983). The soil-litter interface forms a mosaic of microhabitats with varying degrees of humidity and temperature, shaped by the dynamic balance between water-filled and air-filled pores and galleries. These conditions create temporary aquatic microenvironments during rainfall or groundwater rise, as well as aerial-like environments during periods of dryness. Furthermore, desiccation caused by high temperatures and low humidity can lead to significant saturation deficits, forcing soil arthropods to migrate vertically or horizontally in search of suitable moisture conditions (Edney 1977; Eisenbeis 1983). Thus, the system does not only fluctuate between water saturation and aeration, but also includes gradients of aridity that are equally influential in shaping the structure of soil communities.

This structural complexity generates diverse microclimatic conditions, favoring a rich assemblage of associated functional groups (Lavelle et al. 1992; Lavelle 1996). Opiliones are an integral component of the soil fauna, with numerous species inhabiting the various microhabitats within the soil-litter. They typically exhibit cryptic behavior and low dispersal capacity, relying heavily on stable microhabitats such as the leaf litter and upper soil layers. Their physiological sensitivity to desiccation and water loss imposes strict ecological constraints, particularly concerning temperature and humidity, making them highly responsive to microclimatic variations and habitat structure (Giribet and Kury 2007; Gorneau et al. 2024). As a result, harvestmen often display limited distribution ranges and elevated levels of endemism, further emphasizing the ecological significance of microhabitat diversity within the soil-litter system (Pinto-da-Rocha and Bonaldo 2006; Gorneau et al. 2024). Therefore, with a more complex or heterogeneous soil-litter layer at local scales, more diverse Opiliones diversity is expected (Pinto-da-Rocha and Bonaldo 2006; Porto et al. 2016). Investigating how soil properties influence Opiliones may provide valuable insights into their ecological role and response to soil-driven processes.

This study aims to investigate how habitat structure, soil properties, and environmental variation shape the composition of Opiliones assemblages across different spatial scales. Specifically, we examine the relationship between soil components and fine-scale microhabitat structures associated with vegetation, such as leaf litter, decaying wood, shrubs, and trees, and their influence on Opiliones diversity in an upland forest of the central Amazon. We hypothesize that, at the local scale (within plots), Opiliones abundance, richness, and composition are primarily driven by vegetation structural features that define distinct microhabitats, and this association will partly scale up to the regional scale (among plots).

2 | Methods

2.1 | Study Area

The study area is located within the Adolpho Ducke Forest Reserve (Figure 1), a 100 km^2 fragment of upland forest administered and protected by the National Institute for Amazon Research (INPA). The reserve is situated in the Central Amazon region of Brazil and is geographically characterized by typical tropical rainforest vegetation, with a diversity of approximately 1700 tree species (Ribeiro et al. 1999). The average altitude of the reserve is 100 m, and the canopy height ranges from 30 to 35 m. The average annual temperature is 26°C, and the average annual precipitation varies between 1900 and 3300 mm. The rainy season usually starts in November and lasts until May (Baccaro et al. 2008).

2.2 | Sampling Design

The sampling design followed the RAPELD protocol (Magnusson et al. 2005). Each plot consisted of a 250-m-long, 2-m-wide transect, with at least 1 km between plots (Figure 1). The study employed a sampling design that involved the selection of 30 plots between July and November 2014, covering a total area of 25 km^2.

The Opiliones were sampled through cryptic nocturnal manual searching (Tourinho and Lo-Man-Hung 2021), a method involving the systematic search for these arachnids in cryptic locations within their habitat. During a 1-h visit, two collectors sampled each plot. Sampling occurred along 1 m on each side of the main transect line, resulting in a sampled area of 500 m^2 per plot (2 × 250 m). All Opiliones found within the plot's sampling area were collected. This approach enabled the collection of a greater number of species and individuals. During capture, the type of habitat where each individual was found was recorded and noted according to the following groups: trees, decomposing wood, palms, shrubs, herbs, and leaf litter. We distinguished trees from shrubs based on diameter at breast height (DBH). Trees were defined as woody plants with a DBH greater than 30 cm, while shrubs were characterized as smaller woody plants with multiple stems or a DBH below this threshold. This information was used to compare Opiliones diversity measures (such as abundance, species richness, and composition) across different microhabitats in the local scale analyses.

Data for the regional scale variables in each plot (sand and phosphorus relative content, number of trees, and number of palms) were obtained from previous studies conducted in the reserve (available at https://ppbio.inpa.gov.br/ and https://ppbiodata.inpa.gov.br/metacatui). These variables exhibited substantial variation across the 30 plots, with coefficients of variation (CV) of 77.6% for sand content, 76.0% for phosphorus content, 22.7% for the number of trees, and 12.7% for the number of palms. While tree and palm densities showed lower relative variation, their influence remains ecologically significant in Amazonian forests, where small differences in vegetation complexity can drive faunal distribution patterns (Lamarre et al. 2016). This variability allows us to explore how

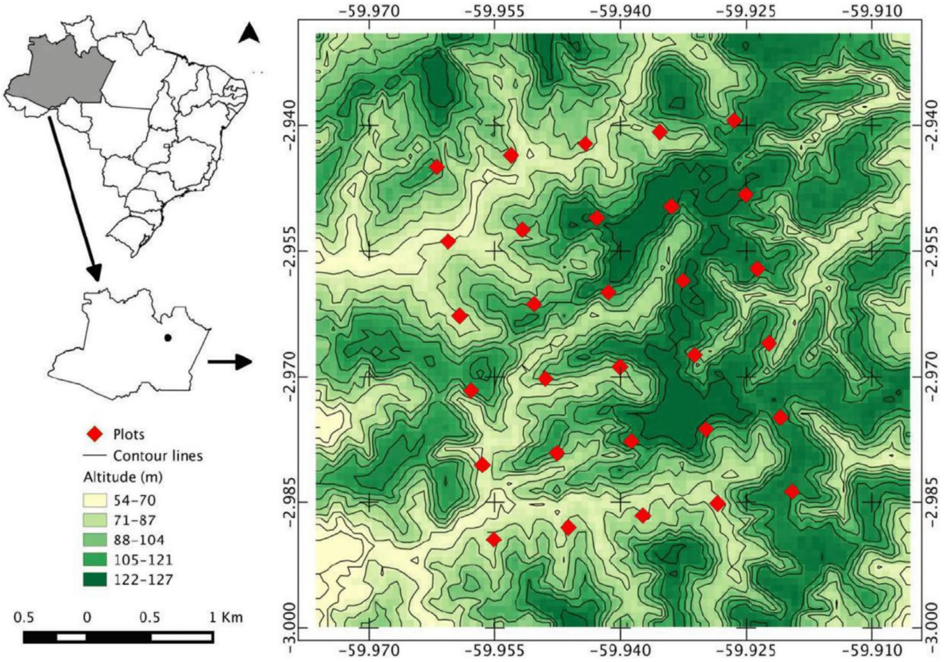

FIGURE 1 | Adolfo Ducke Forest Reserve, located in the state of Amazonas, Brazil. The figure shows the relative position of all sampled plots, representing the data collection areas. The plots were strategically distributed to encompass different environmental gradients and the variability of microhabitats within the reserve. In this study, we used the 30 plots from PPBio, highlighted in red. The background map displays the terrain of the areas, as indicated in the legend.

these factors shape Opiliones diversity, reinforcing the relevance of our analysis.

2.3 | Species Data

We used the method of Acosta et al. (2007) to determine the species identity. External morphology was examined using a stereomicroscope and compared to original descriptions from the literature, type material, or images of type material. We excluded nymphs because they do not possess the somatic or genital diagnostic characters developed yet and cannot be identified or morphotyped below family level; sometimes they cannot even be placed at family level. The nymphs represented less than 0.1% of the total number of individuals collected. In cases where groups exhibited conservative external morphology and/or poorly understood taxonomy (such as families Cosmetidae, Sclerosomatidae, Zalmoxidae), male genitalia were examined to ensure proper species delimitation. All material was appropriately labeled and deposited in the arachnology collection at INPA.

2.4 | Data Analysis

To conduct data analysis, we generated two data matrices: one for the local scale analyses and one for the regional scale analysis. In the local matrix, our sampling unit was the vegetation microhabitat per plot ($n = 6$ microhabitats $\times 30$ plots $= 180$), and in the regional scale matrix, our sampling unit was the 250 m-long plots ($n = 30$). Species richness was measured as the total number of species found in each sampling unit. We measured species composition separately for the local and regional scale analyses by calculating the pairwise Bray–Curtis dissimilarity between all pairs of sampling units. The Bray–Curtis index measures the percentage of species shared between each pair of sites, weighted by species abundances (microhabitats or plots). The pairwise dissimilarity matrix was used in an ordination analysis in order to attribute scores to each sampling unit based on the dissimilarity between them. We performed a Principal Coordinates Analysis (PCoA), and the PCoA axes were used as a measure of species composition. We used all PCoA axes that explained at least 10% of the variation in the Bray–Curtis index as response variables representing changes in species composition (the first PCoA axis for the local scale analysis and the first two PCoA axes for the regional scale analysis).

2.5 | Local Scale Analysis

We compared the abundance, species richness, and composition among the six distinct microhabitats (trees, decomposing wood, palms, shrubs, herbs, and leaf litter). To analyze abundance and species richness, we used Analysis of Variance (ANOVA), given the categorical nature of the predictor (microhabitats). This allowed us to assess whether there were significant differences in Opiliones abundance and richness across the different microhabitats. We visually inspected the model residuals to make sure they followed ANOVA assumptions—namely, independence, normality of residuals, and homogeneity of variances—were met. To further explore the differences between the microhabitats, we employed the Tukey test, which allowed pairwise comparisons of means. This post hoc test enabled us to identify specific microhabitats that exhibited significantly different levels of abundance and species richness compared to each other.

To analyze species composition while accounting for the nested structure of the data (microhabitats within plots), we used a Linear Mixed Model (LMM) with microhabitat as a fixed effect and plot identity as a random effect. The first PCoA axis, based on Bray-Curtis dissimilarities, was used as the response variable in this model, as it represented the major gradient of variation in species composition.

2.6 | Regional-Scale Analysis

In the regional scale analysis, we examined the influence of soil components, including the amount of sand, the amount of phosphorus content, as well as vegetation structure, such as the number of trees and palms, on the abundance, species richness, and composition of Opiliones. For each of the response variables (abundance, richness, and composition), we conducted multiple linear regressions, including all predictors in the same model.

All statistical analyses were carried out in the R statistical environment (R Development Core Team 2020) using the following packages: vegan (Oksanen et al. 2022), ggplot2 (Wickham 2016), and gridExtra and grid (R Core Team 2024).

3 | Results

A total of 689 adult Opiliones were collected during the study, representing 27 species from 12 different families (Appendix S1). The most abundant families were Cosmetidae (constituting 37.44% of the total abundance) and Sclerosomatidae (with 22.78% of the total abundance). The most common species were *Eucynortella duapunctata* (with 183 individuals), *Caluga* sp.1 (with 83 individuals), and *Cynorta* sp.1 (with 75 individuals). Abundance per plot ranged from nine to 54 individuals, while species richness per plot varied from four to 13 species. These data reflect a wide diversity of species and a heterogeneous distribution of Opiliones across the studied areas.

3.1 | Local Scale Results

Species abundance varied among microhabitats ($F_{(5,133)} = 5.60$, $p < 0.001$; Figure 2). The difference among microhabitats was caused by the highest number of individuals in trees compared to other microhabitats ($p < 0.01$; Figure 2), except for the comparison between trees and herbs, in which we could not detect a difference in abundances. Shrubs did not differ significantly from herbs, leaf litter, palms, or decaying wood (Tukey HSD, $p > 0.05$; Figure 2). Similarly, we also observed a higher species richness in trees compared to all other microhabitats ($F_{(5,133)} = 13.06$, $p < 0.01$; Figure 3). Shrubs had the lowest species richness (Tukey HSD, $p < 0.01$ for the comparison with trees, herbs, and leaf litter; Figure 3). We did not find differences in

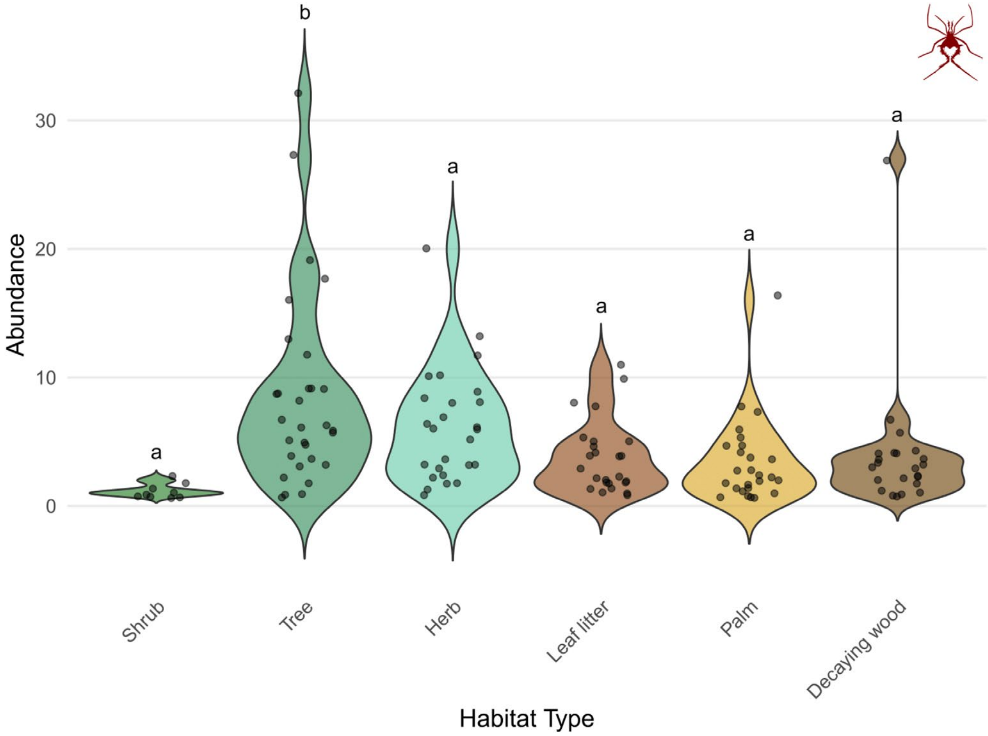

FIGURE 2 | Opiliones abundance across different microhabitats at the plot scale. The shapes represent the distribution of abundance, while points indicate individual samples. The microhabitats include Shrub, Tree, Herb, Leaf litter, Palm, and Decaying wood. Letters indicate significant differences based on the post hoc test (groups sharing the same letter are not significantly different), showing statistically significant differences in abundance between microhabitats. Only Trees differ significantly from all other microhabitats, which do not differ from each other. Differences in Opiliones abundance across habitats highlight potential ecological preferences and habitat associations.

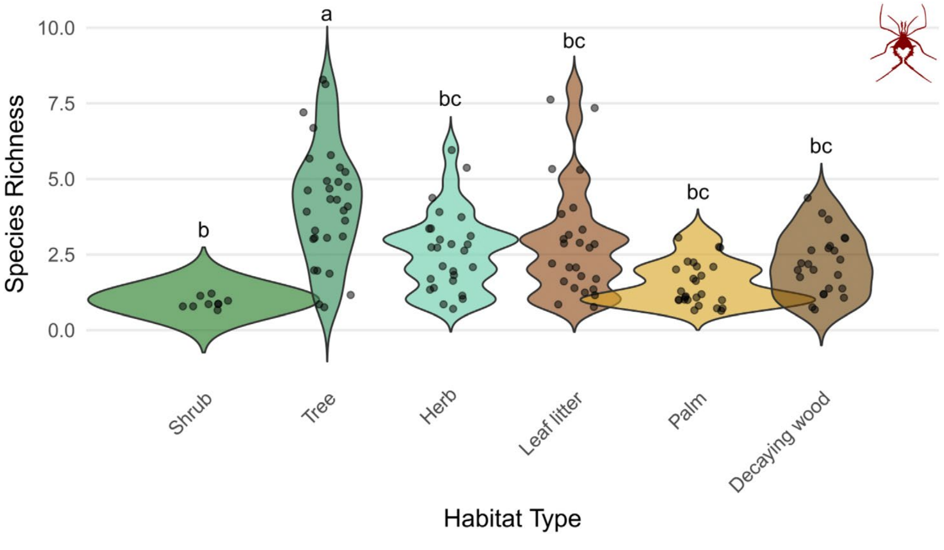

FIGURE 3 | Number of Opiliones species sampled per microhabitat at plot scale. The shapes in the plot represent the distribution of the number of species observed across different microhabitats, while individual points show the data collected from each microhabitat type. Each sampling unit corresponds to a specific plot within each microhabitat type (Shrub, Tree, Herb, Leaf litter, Palm, and Decaying wood). The number of species (richness) represents the total count of Opiliones species found in each of these sampling units. Letters above bars indicate significant differences based on the post hoc test (groups sharing the same letter are not significantly different).

species composition between trees and decaying wood (Tukey HSD, $p > 0.9$; Figure 4). However, these microhabitats greatly differed in species composition compared to herbs and palms (Tukey HSD, $p < 0.01$; Figure 4).

3.2 | Regional-Scale Results

Species were heterogeneously distributed at the regional scale. However, neither species abundance nor species richness was

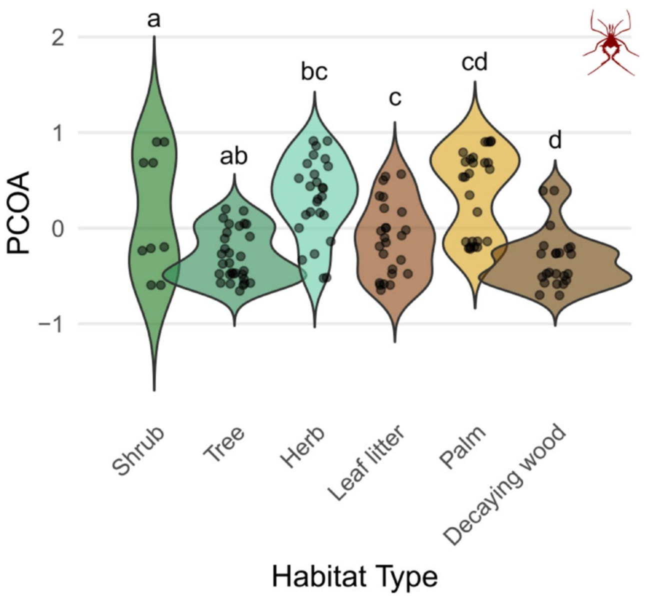

FIGURE 4 | Composition of Opiliones (PCoA axis) assemblages in microhabitat type at plot scale. Letters indicate significant differences based on the post hoc test (groups sharing the same letter are not significantly different): Shrub (a), Tree (ab), Herb (bc), Leaf litter (c), Palm (cd), and Decaying wood (d). All shown comparisons were highly significant ($p < 0.001$).

related to sand and phosphorus content, number of trees, or number of palms, suggesting that other factors may be influencing these patterns. Nevertheless, the first PCoA axis, which represents major variations in species composition, was correlated with soil sand content ($F_{(4,22)} = 3.29$, $R^2 = 0.37$, adjusted $R^2 = 0.26$, $p < 0.001$; Figure 5).

4 | Discussion

Our data suggest that the effects of environmental factors on Opiliones diversity differ depending on the scale of analysis. At the local scale, where a variety of microhabitats with abundant organic matter are available, Opiliones can select favorable sites for feeding and shelter, such as trees. In contrast, at the regional scale, where vegetation variation structure between plots is more homogeneous, factors like soil sand content appear to play a more relevant role. These results suggest that patterns observed at one spatial scale may not necessarily apply at another. For instance, while tree presence is a strong predictor of Opiliones richness, abundance, and composition at the local scale, it is not related to any diversity metric at the regional scale. This highlights the risks of extrapolating findings from one scale to another, as it may lead to misleading conclusions about species-habitat relationships.

4.1 | Implications at Local Scale

Our findings indicate that trees serve as rich habitats for Opiliones species, hosting a significantly high number of individuals compared to other habitats studied. Specifically, we observed that out of the 27 identified species, 23 were exclusively found foraging on trees, highlighting the importance of arboreal structures in the ecology of Opiliones. Large trees offer a diverse array of microhabitats, including decomposing bark pockets and trunk recesses, making them particularly suitable for supporting Opiliones populations. Certain tree characteristics, such as highly corrugated bark and large roots, create distinct microenvironments comprising crevices, hollows, and cavities within the bark, serving as shelters and potential prey sources for Opiliones (Tourinho et al. 2020). Due to their larger mass, large-diameter trees also provide temperature-buffering microhabitats (Brower et al. 2009), and also more surface area for foraging and nesting. In addition, some species, such as *Phareicranaus manauara*, have been found using trees for their reproduction (Colmenares and Tourinho 2014). Although only a few species in our study region have been individually studied, other Opiliones species have also been identified feeding on tree sap, fungus, seeds, fruits, and lichens in other studies (Nyffeler et al. 2023). The results may demonstrate that an arboreal preference is common among multiple species, resulting in a higher diversity of species in the whole assemblage in trees compared to other habitats.

Although trees harbor much more diverse Opiliones assemblages, other microhabitats also supported Opiliones species and, in some cases, exhibited distinct species composition from trees. Species of Sclerosomatidae were more generalist, occupying almost all habitats. For example, *Caluga* sp1 was distributed across all available habitats. Other Opiliones can also show a high degree of specialization to occupy other microhabitats (Colmenares et al. 2016). Previous studies have shown that some species are specialized as active hunters in the leaf litter and shrubs (Halaj et al. 2000), which could explain the existence of species unique to these microhabitats. Although some species are known to specialize in leaf litter and decaying wood (Nyffeler et al. 2023), we found several species restricted to certain microhabitats (e.g., palms), and the causes for this high degree of specialization are not completely clear.

Due to the correlative nature of our study, differences in Opiliones abundance and richness across microhabitats may be influenced not only by species preferences or habitat suitability, but also by the uneven availability of those microhabitats within each plot. Since we did not control the relative cover or frequency of each microhabitat type per plot, our results may partially reflect the natural availability of the microhabitats, rather than true avoidance or preference by the species. This sampling limitation should be considered when interpreting habitat associations, and future studies should incorporate quantitative measures of habitat availability to better disentangle habitat selection from habitat availability.

4.2 | Implications at Regional-Scale

Our data show a wide diversity of species and a heterogeneous distribution of Opiliones in the studied area. However, among the environmental variables examined (number of trees, number of palms, soil phosphorus, and soil sand content), only the sand content showed a significant relationship with the variation in species composition. One possible explanation for this pattern is that tree and palm abundance do not vary enough between plots to drive differences in Opiliones diversity, as their high and

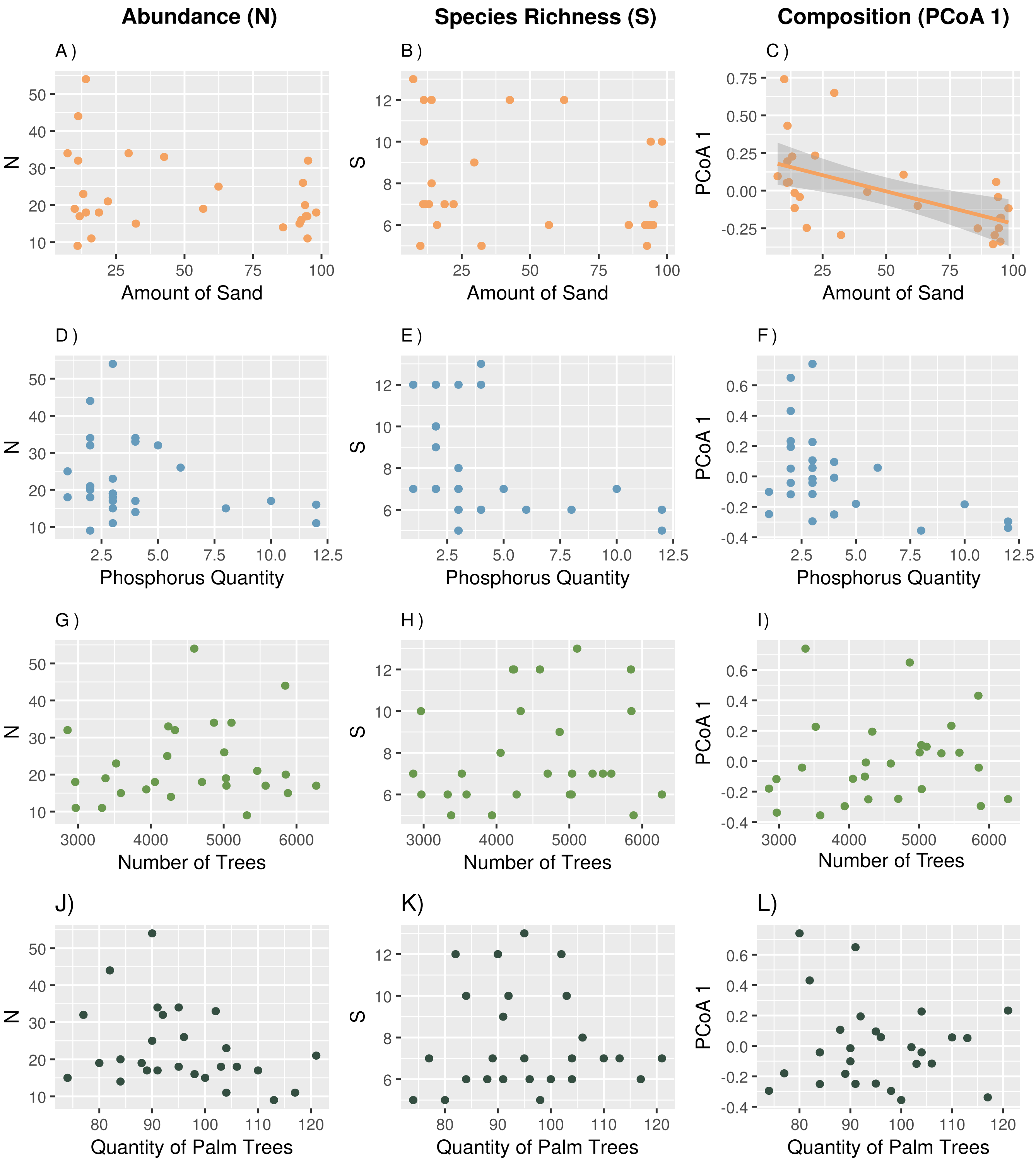

FIGURE 5 | Partial regressions of the most supported effects on Opiliones abundance (N), species richness (S), and community composition turnover (measured by the first PCoA axis, PCoA 1). The first column shows results for the abundance model, the second for the species richness model, and the third for the community composition model. Graphs A, B, and C show the relationships between soil sand content and N, S, and PCoA 1, respectively. Graphs D, E, and F present the relationships between soil phosphorus content and N, S, and PCoA 1. Graphs G, H, and I illustrate the relationships between the number of trees and N, S, and PCoA 1. Finally, graphs J, K, and L show the relationships between the quantity of palm trees and N, S, and PCoA 1. Among the 12 analyses conducted at the regional scale, only soil sand content was a significant predictor of community composition turnover.

relatively uniform presence across the study area likely provides similar microhabitat availability in most plots. In contrast, the variation in soil sand content seems to play a more dominant role at a larger scale, likely because it works as a proxy of soil moisture availability and microhabitat stability. In Amazonian forests, sandy soils are often found in lower topographic areas closer to streams (Emilio et al. 2013), providing more stable humidity conditions that may favor Opiliones diversity.

Interestingly, the absence of a direct relationship between Opiliones species richness and vegetation structure has also been reported in another Amazonian region (Tourinho et al. 2020), suggesting that the importance of vegetation may depend on the spatial scale considered. Despite the strong relationship between Opiliones diversity and vegetation structure at a local scale, the number of trees and palms in the plots is not indicative of higher species richness or changes in the composition of arthropod assemblies at a larger scale. We hypothesize that this difference is due to the high abundance of trees and other microhabitats across all plots at the regional scale, which allows most species to occupy a variety of microhabitats in each plot. This results in a high redundancy of available niches across plots. Trees and decaying wood provide diverse niches and resources that support specialized Opiliones species, and these microhabitats are also consistently present in all plots. However, this does not imply that all plots are identical or support the same Opiliones species. The variation in soil characteristics was more pronounced than differences in vegetation structure at the regional scale, likely explaining why soil sand content, rather than vegetation, was related to Opiliones diversity. The differential response to environmental variables at different spatial scales highlights the complexity of the ecological interactions that govern Opiliones species distributions (Poisot et al. 2014).

4.3 | Implications for Conservation

Our findings improved our understanding of the distribution and abundance of Opiliones in different microhabitats and across regional scale environmental gradients, providing valuable insights into the ecological preferences of these organisms. These results may have implications for biodiversity conservation, aiding in the direction of management and preservation efforts toward areas with greater potential for maintaining these species. Based on our findings, it becomes evident that maintaining diverse local microhabitats along larger areas to cover a broad soil variation is critical for conserving Opiliones diversity.

The complexity of soil structure is instrumental not only for Opiliones but also because soil forms some of the most species-rich habitats within terrestrial ecosystems. Despite the essential ecosystem services that soil provides, its inherent value is frequently neglected in economic decision-making processes, thereby exacerbating degradation pressures (Jónsson and Davíðsdóttir 2016). Moreover, current models and frameworks for monitoring and preventing biodiversity loss are still inadequate, as they often lack consideration of soil biota and structure, which are essential to maintaining ecosystem functionality.

Microhabitats have a major importance for Opiliones; a reduction in environmental heterogeneity directly impacts several Opiliones species (Tourinho et al. 2020). Based on our data, areas with a balance between the number of large trees and palms are suitable for maintaining a comprehensive assemblage of Opiliones species. Consequently, medium and major disturbances resulting in the reduction of the number of large trees will have a strong impact on Opiliones diversity, especially by limiting the occurrence of tree-dweller species. Previous results from areas of upland forest and islands formed by the mega-dam in Balbina, Amazonas state, showed a strong relationship between the Opiliones community and forest cover, and the importance of keeping larger island areas to avoid rapid tree decay, maintaining viable Opiliones communities (Tourinho et al. 2020).

Acknowledgments

This work was only possible due to the Programa Brasileiro de Pesquisa em Biodiversidade (PPBio), the Instituto Nacional para a Biodiversidade Amazônia (INCT-CENBAM), and the 20 years of research conducted under the Brazilian LTER, funded by national (CAPES, CNPq) and regional (FAPEAM) Brazilian Science Foundations, including the latter: –CHAMADA PÚBLICA N° 021/2020–PELD/CNPq/FAPEAM. We also thank the Instituto Nacional de Pesquisas da Amazônia (INPA) for their financial and logistical support, which was essential for the maintenance and monitoring of several plots used in this study. F.B.B. is continuously supported by CNPq grant #312878/2023-0. The material for this study was obtained under collecting permit 39557, granted by SISBIO to Pio Antonio Colmenares. The Article Processing Charge for the publication of this research was funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) (ROR identifier: 00x0ma614).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are openly available in GitHub at https://github.com/eeabbad11/Soil-and-vegetation-drive-diversity-and-distribution-of-Opiliones-a.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Appendix S1:** btp70108-sup-0001-AppendixS1.docx. **Table S1:** Abundance of harvestman taxa across different vegetation types in the local scale. **Table S2:** Distribution of Opiliones at the local scale in Reserva Ducke. **Table S3:** Summary of the linear mixed-effects model evaluating the effects of microhabitats on Opiliones diversity. **Table S4:** Pairwise comparisons between microhabitat types. **Table S5:** Summary of linear model results for PCoA axis in regional scale analysis.