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Comparative insight into soil mite biodiversity (Laelapidae: Mesostigmata) across varied land use patterns in green spaces and their margins

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Abstract
Soil mites in urban areas represent a key component of the microfauna, contributing significantly to urban biodiversity by expanding the range of species within the local fauna. During the period of 2018-2019, a comprehensive study was conducted in Isfahan to assess the abundance and diversity of soil mites in parks and farms. A total of 15 mite species from the Laelapidae family, belonging to nine genera, were collected and identified. Remarkably, seven of these species, namely *Hypoaspisella patagoniensis, Pogonolaelaps canestrinii*, *Hypoaspis quadridentatus, Gymnolaelaps obscuroides*, *Gaeolaelaps neoaculeifer*, *Cosmolaelaps claviger*, and *Hypoaspisella asperatus*, were newly identified in the fauna of Isfahan. To analyze the diversity of species in different regions and habitats, biodiversity indices were employed. The study covered five regions: north, south, west, east, and center, comprising two types of habitats, namely green spaces and agricultural fields. The results revealed significant variations in biodiversity indices based on vegetation type and sampling season. In green spaces, the Shannon Wiener index reached its highest value of 2.336, while the Margalef species richness index peaked at 2.741. In contrast, these indices were relatively lower in agricultural areas, with values of 1.542 and 1.490 for the Shannon Wiener and Margalef indices, respectively. Seasonal variation also played a crucial role in species diversity. The spring season demonstrated the highest biodiversity, with a Shannon Wiener index value of 3.919 and a Margalef index value of 2.796. On the other hand, the winter season exhibited the lowest biodiversity, with a Shannon Wiener index of 1.683 and a Margalef index of 1.729. One particular species, *Euanderolaelaps karawaiewi*, was observed in both habitats and all five investigated regions, underscoring its significance in biodiversity assessments. In conclusion, this study sheds light on the diverse population of soil mites in Isfahan's parks and farms, and it highlights the influence of vegetation type and sampling season on mite diversity, providing valuable insights for future biodiversity conservation efforts.

Key words: Fauna, Richness index, Isfahan parks, Field, Diversity.

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INTRODUCTION

Biodiversity refers to the community of plant and animal populations in a particular area (Heidari Latibari et al., 2022). It encompasses various aspects such as diversity, population structure, and abundance patterns. The purpose of measuring biodiversity is to establish a single quantity for comparing different communities and ecosystems. Higher biodiversity indicates a more complex and sustainable ecosystem

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(Jenkins and Parker, 1998). Recent studies emphasize that biodiversity is decreasing in urban areas (Knapp et al., 2021).

Three terms are commonly used to measure biodiversity: alpha diversity (intra-habitat diversity), beta diversity (inter-habitat diversity), and gamma diversity (regional diversity). Gamma diversity can be divided into two types: one based on the number of species present in a geographical area, which increases with the number of species, and the other expressing the similarity or dissimilarity of species composition in different regions (Maguran, 1988, Qian et al., 2020). Understanding biodiversity and species diversity in each region is crucial for comprehending natural and engineered ecosystems, as well as ensuring the sustainability and health of the environment (Speight et al., 2008, Heidari Latibari et al., 2023). Soil, being one of the most vital and diverse habitats on Earth, harbors an array of living organisms that play essential roles in the environmental system (Timmis and Ramos, 2021). These living organisms, including mites, can serve as indicators to evaluate soil quality and environmental protection strategies (Dostar sharaf et al., 2015; Schloter et al., 2003).

Agricultural ecosystems and natural habitats exhibit significant differences in terms of biodiversity and the relative abundance of predatory mites (Wu et al., 2005). Among arthropods, mites stand out as important representatives of soil fauna due to their species diversity, ecological niche, and behavior (Zhang et al., 2023), making them valuable indicators of soil quality and environmental conditions (Bedano et al., 2005; Speight et al., 2008).

Mesostigmata mites, with approximately 12,000 identified species, are among the most diverse orders of mites and inhabit various environments, including soil, leaf soil, rotten plants, manure, animal nests, and plant surfaces (Walter and Proctor, 1999; Lindquist et al., 2009). The Laelapidae family of mites is particularly diverse in appearance and ecological characteristics, consisting of predatory and parasitic species, with 1316 species reported so far (Beaulieu et al., 2011). These mites play a crucial role in the soil food chain by feeding on nematodes, invertebrates, and arthropods, and their global distribution, high abundance, and predatory behavior make them excellent indicators for studying environmental conditions (Zhang, 2003). Biodiversity and the abundance of predatory mites vary significantly between agricultural ecosystems and natural habitats (Zhang et al., 2003). Protecting biodiversity is essential for maintaining ecosystem functioning in the long term (Dostar sharaf et al., 2015). Higher biodiversity indicates a healthier and more stable environment with better self-regulating conditions, emphasizing the importance of biodiversity for the health and sustainability of any region (Hajizadeh et al., 2009). Various factors, such as soil type, moisture, pH, and geographical location, influence the density of mites in the soil (Manu et al., 2022). Management strategies, forest vegetation, and human activities can also affect the quantitative and qualitative aspects of mite populations, including species diversity and numbers (Sabbatini et al., 2011).

Given recent agricultural practices and the use of pesticides, this study aims to compare the biodiversity of soil mites in agricultural areas and green spaces, as determining mite diversity can indicate soil quality and evaluate ecosystem management practices (Manu, 2013).

MATERIAL AND METHODS

To investigate the species diversity of soil mites belonging to the Laelapidae family in two distinct habitats, namely green spaces and agricultural lands, a comprehensive study was conducted in Isfahan. The research encompassed five regions (North (32°40'53" N, 51°38'22" E), South (32°35'42" N, 51°39'11" E), East (32°38'32" N, 51°42'50" E), West (32°38'17" N, 51°38'16" E), and Center (32°38'19" N, 51°38'50" E)), with each region containing two selected areas - one green space and one agricultural land, both measuring 100 square meters. Seasonal sampling was conducted at random intervals in these selected areas.

The sampling process involved placing collected samples from each area in a Burles funnel for 48 to 72 hours. The mites were encouraged to escape by exposing them to light, heat, and reduced humidity. Subsequently, the mites were collected in a container containing AG solution (a mixture of 70% white alcohol and 1-3% glycerin). Special brushes and needles were used to separate the mites from the AG solution, and they were then transferred to containers containing a lactic acid clarifying agent for further processing. To prepare microscopic slides, Hoyer's fixing solution was utilized, ensuring the space under the lamellae was adequately covered with water to prevent the formation of air bubbles. The slides were placed in an oven at 45 degrees Celsius for one to ten days to achieve a permanent mixture of dry Heuer and transparent samples. Identification of the mite samples was carried out using valid taxonomic keys and the entomology book authored by Krantz and Walter (2009).

The study focused on several aspects, including determining the abundance of ticks by species, investigating the distribution of different species across different seasons, and exploring the relationship between soil and environmental conditions and the relative number of mite individuals. To quantify the diversity in each area and all sampled areas, various indices and biodiversity formulas were employed, such as the Shannon Winner index, Simpson index, Margalef index, and pit index. In order to calculate the species diversity indices, the number of species and the number of individuals were recorded based on the sampling time. The data analysis and graphs plotting was conducted using SPSS and SDR software.

RESULTS

Surveys conducted between 2018 and 2019 in Isfahan, covering five regions (North, South, East, West, and Center) and two habitats (green spaces and agricultural lands), revealed a diverse community of mites (Tables 1-6, 9). A total of 15 mite species from nine genera within the Laelapidae family were identified. Notably, four species—*Hypoaspis quadridentatus*, *Hypoaspisella patagoniensis*, *Hypoaspisella asperatus*, and *Gaeolaelaps neoaculeifer*—were previously unrecorded in Iran. Seven species, including *Pogonolaelaps canestrinii* and *Gymnolaelaps obscuroides*, were new to the region of Isfahan. Among the species, *Euandrolaelaps karawaiewi* had the highest frequency in both habitats, making up 19.39% of the population in green spaces and 44.64% in agricultural lands. Conversely, *Gymnolaelaps obscuroides* had the lowest frequency in agricultural lands at 1.78%, while three species tied for the lowest in green spaces at 1.21% (Figures 1 and 2). These results highlight the richness of soil mite diversity in Isfahan and the importance of green spaces and agricultural lands as habitats (Tables 7, 8,10). The discovery of previously unknown species adds to the scientific understanding of mites in Iran.

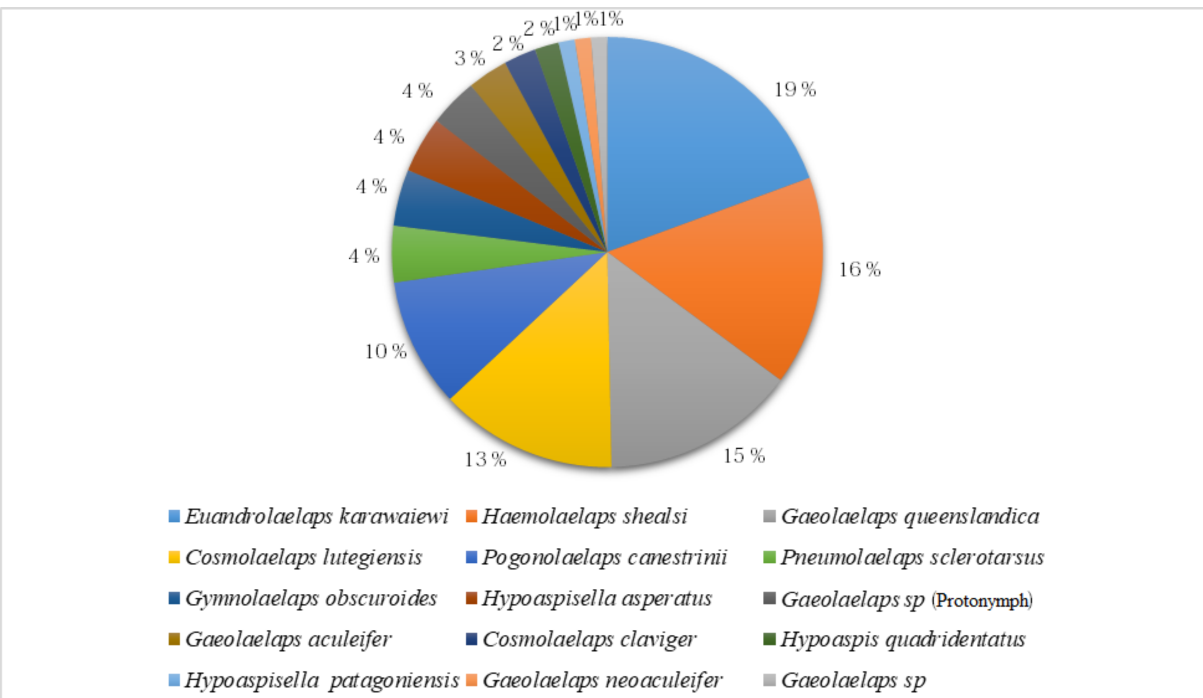

FIGURE 1. Relative frequency of various mites species found in Isfahan parks.

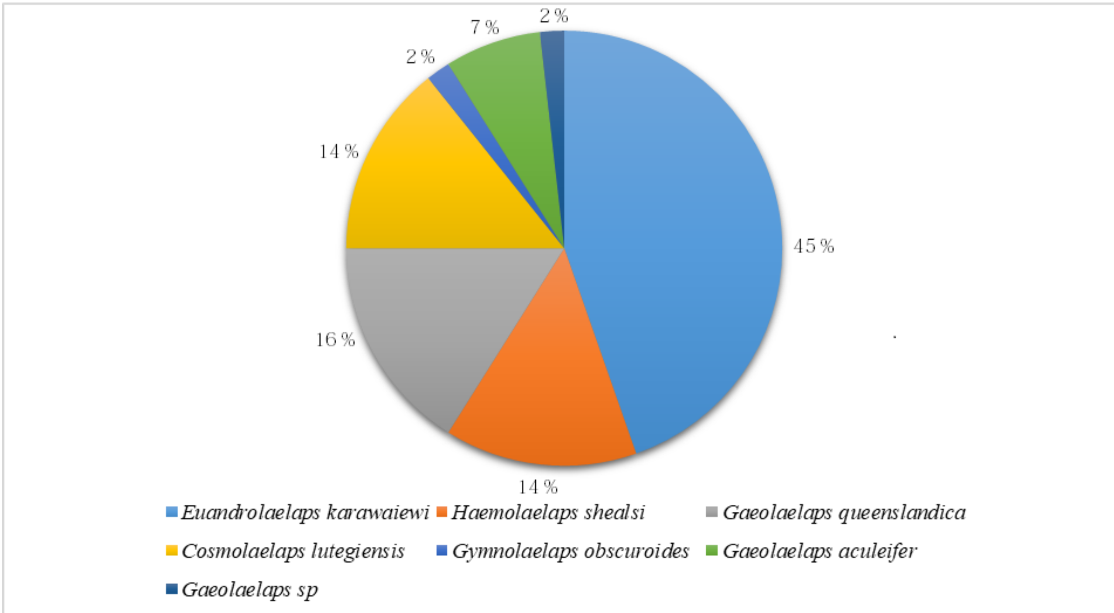

FIGURE 2. Proportional abundance of different mite species collected from Isfahan Agriculture lands.

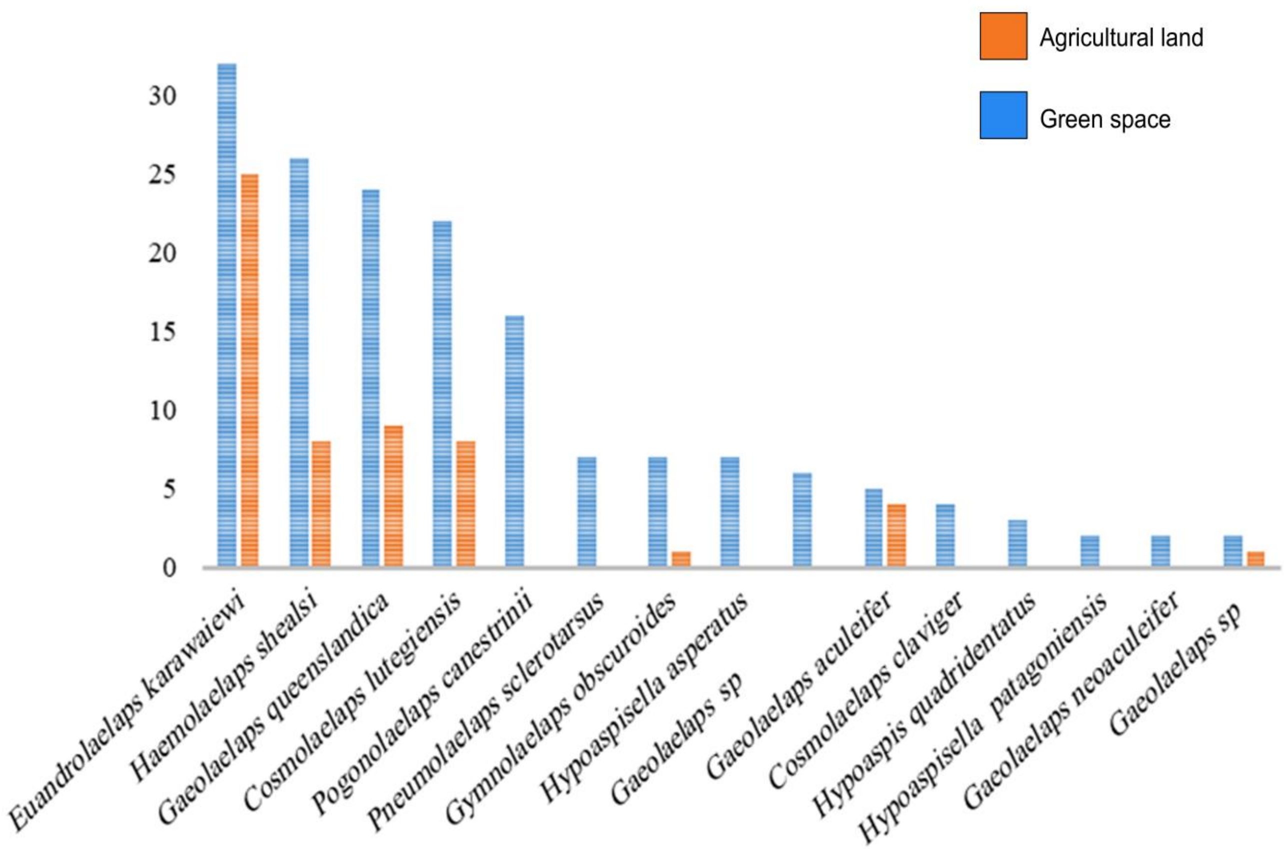

FIGURE 3. The relative abundance of different species of mites of the Laelapidae family collected from green and agricultural lands in Isfahan.

DISCUSSION

In ecosystems, stability and diversity are closely linked. Stability is often measured using the Shannon-Wiener index, with higher values indicating greater stability. The index typically ranges between 1.5 and 3.5. In this study, the Shannon-Wiener index was higher in green spaces (2.336) than in agricultural lands (1.542), a statistically significant difference. The greater intensity of agricultural activities, like pesticide use, likely contributed to lower biodiversity in agricultural lands. The seasonal analysis showed the highest diversity in spring, with a Shannon-Wiener index of 3.919, while winter had the lowest at 1.683, another statistically significant difference. Seasonal variations in biodiversity were likely influenced by changes in temperature and moisture, as previously noted by Salman (2000). The Simpson index, which focuses on dominant species, showed a higher value in green spaces (0.885) than in agricultural lands (0.741), indicating greater diversity in green spaces (Figure 3). Spring had the highest dominance index at 0.882. The Simpson index helps evaluate the likelihood that two randomly selected samples belong to different species.

The Margalef index, used to measure species richness, showed significant differences between green spaces and agricultural lands. Species richness and population size were lowest in winter. The Pit index, which measures species uniformity, was highest in green spaces during summer and lowest in agricultural lands during winter.

Overall, higher biodiversity in green spaces can be linked to similar climatic conditions, temperature, and humidity across habitats. The use of pesticides and agricultural activities like plowing may decrease mite populations in agricultural lands, reducing biodiversity. These findings align with Amani et al. (2014), who reported higher biodiversity in gardens due to fewer agricultural operations. Jenkins et al. (1998) also found that agricultural activities like plowing can compact soil and destroy food sources, reducing biodiversity. The species *Euandrolaelaps karawaiewi* was present in all areas, indicating its importance in biodiversity assessments. Area 4, which had dense vegetation and was farther from urban pollution, showed the highest number of mites, suggesting that vegetation cover plays a key role in biodiversity. Both green spaces and lands in Area 4 and Area 2, which had more trees and shrubs, had higher biodiversity, consistent with findings from Maleki et al. (2015).

Overall, the reduction in biodiversity in areas with intense agricultural activities highlights the importance of proper ecosystem management. Stable ecosystems with more vegetation cover show greater biodiversity, making them crucial indicators of ecosystem stability.

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