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Geographic and Local Plant Effects on Herbivorous Insects of *Juniperus* and *Pistacia* in Cyrenaica-Libya

Abdlrahman Alfitori[1*]
[1] University of Omer Al-Mukhtar, Libya

*** Corresponding author email address**: insecta2005@gmail.com

Abstract

This study investigates the effect of plant locality on insect herbivores associated with *Juniperus* and *Pistacia* species in Cyrenaica, Libya. Research was conducted across mountain and semi-arid regions to identify herbivorous insect species and their distribution patterns. Insects were sampled using sweep netting, light traps, and direct observation, followed by species-level identification. Statistical analyses were performed to evaluate the relationship between plant locality and herbivore diversity.
The results indicated that *Juniperus* hosts higher insect diversity in montane regions due to favorable microclimatic conditions, while *Pistacia* supports a more specialized community in semi-arid areas. These findings highlight the ecological significance of plant locality in shaping insect herbivore communities, providing insights for pest management and biodiversity conservation.

Keywords: Libya, insect herbivores, *Juniperus*, *Pistacia*.

1. Introduction

Herbivorous insects play vital roles in ecosystems by mediating plant dynamics, nutrient cycling, and interactions with other organisms. The diversity and distribution of herbivores are influenced by a range of factors, including host plant type, geographical locality, and environmental conditions. [1,2]. In Cyrenaica, Libya, the distinctive ecological zones offer a unique opportunity to study these interactions, particularly between local plant species like *Juniperus* and *Pistacia* and their associated insect communities [3,4].

Juniperus and *Pistacia* are essential components of the Cyrenaica flora, supporting a variety of ecological functions and providing habitats for numerous insect species. While these plants thrive in distinct ecological settings mountain regions for *Juniperus* and semi-arid areas for *Pistacia*, the variability in their associated insect communities remains understudied. Understanding these patterns is critical for ecological management, conservation, and pest control strategies [5,4].

Study aims to explore the impact of plant locality on the diversity and distribution of insect herbivores associated with *Juniperus* and *Pistacia* across Cyrenaica. By comparing insect communities in different ecological zones, this research seeks to contribute to a broader understanding of plant-insect interactions in arid and semi-arid environments.

2. Materials and Methods:

Field study:

The study was conducted in Cyrenaica, Libya, covering montane regions (e.g., Al-Jabal Al-Akhdar) and semi-arid zones. Study sites were selected to represent varying altitudes, climatic conditions, and vegetation types. Figure(1).

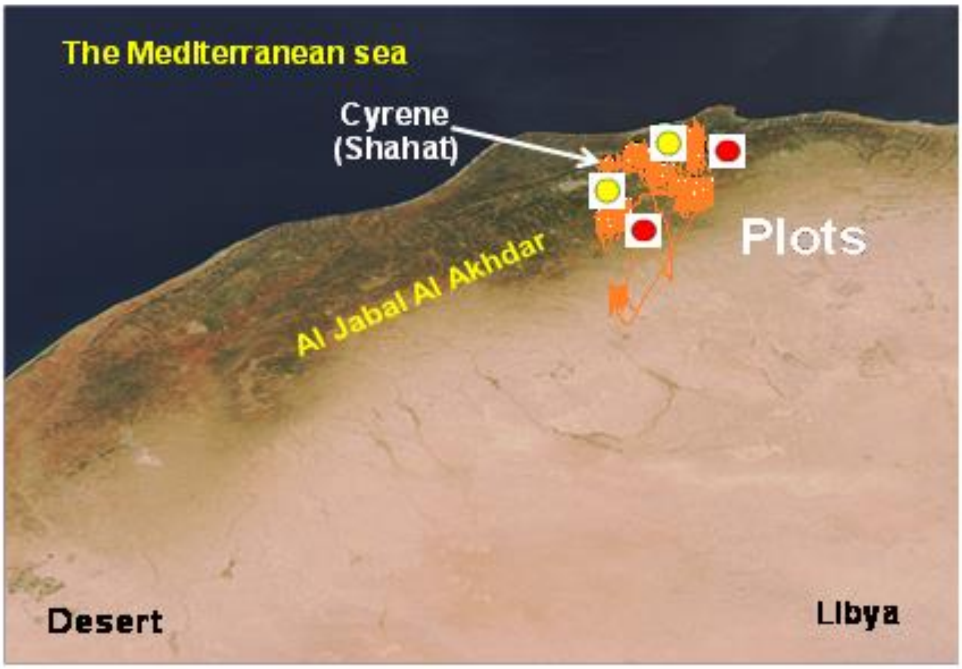


Figure (1): Study plots at two different locations (● high, and ● low) of of the Al Jabal Al Akhdar Mountain in Cyrenaica, Libya [4]

Plot Setup:

- **Location Selection**: Three plots were selected at each elevation, resulting in a total of nine plots. The locations were chosen based on proximity to the Cyrene site to capture variations in environmental conditions while considering historical significance.
- **Plot Dimensions**: Each plot measured 50 meters by 50 meters. The dimensions were chosen to ensure that the plots were large enough to house at least 30 individuals of each focal plant species, especially in the least-dense areas. Figure (2).

- **Plot Corners**: The first corner of each plot was selected randomly with the coordinates determined via GPS. The remaining corners were positioned so that one side of the plot was parallel to the sea to minimize variations caused by directional gradients. Figure (3).
- **Survey Markers**: Permanent red-painted corner posts were installed to help identify the plot corners during subsequent visits. Temporary markers were placed at 10-meter intervals within the plot to create a grid for further data collection. A sighting compass was used to ensure the lines between markers were straight. [6]

Environmental Data Recording:

- **Conditions Measured**: During the survey, various environmental variables were recorded to help analyze their impact on plant distribution and diversity. These variables included:
    - Aspect (direction the plot faces)
    - Gradient (steepness of the slope)
    - Altitude (elevation relative to sea level)
    - Soil Type (e.g., sandy, clay, rocky)
    - Soil Depth (measured at multiple points within the plot)

These factors were crucial for understanding how environmental gradients, both horizontal (such as aspect) and vertical (such as elevation), influenced the plant communities. [6]

Plot Setup Illustration:

If you'd like to visually represent the plot setup in your manuscript, here's how you can do it:

1. Plot Diagram:
    - Draw a simple 50m x 50m grid, marking the four corners and labeling the distance between markers.
    - Include an arrow to represent the orientation of the plot with respect to the sea (i.e., parallel alignment).
    - Use labels for important elements such as permanent corner posts, temporary markers, and the direction of environmental factors (such as the gradient. [6].
2. GPS and Measurement Data:
    - Show how the corners were located using GPS and include a sample of coordinates for one plot to show the precision of location selection.
3. Environmental Conditions:
    - Use additional symbols or icons to represent the measurement of environmental conditions (e.g., thermometer for temperature, shovel for soil depth, compass for [4].

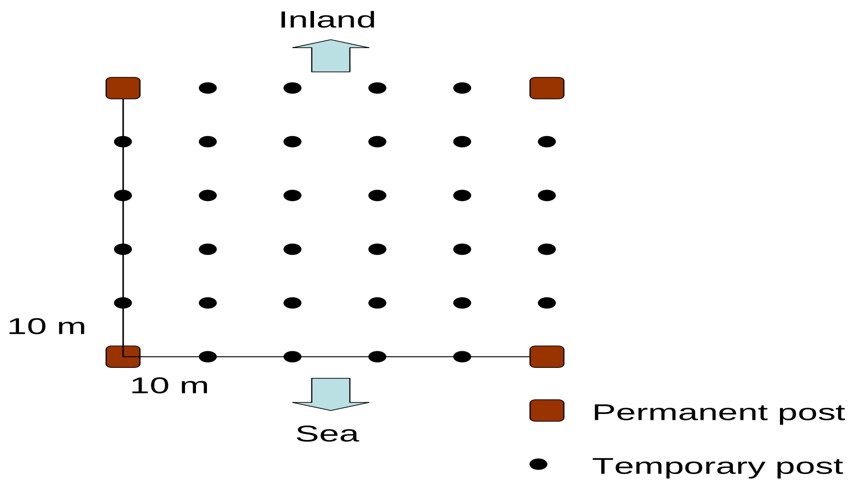
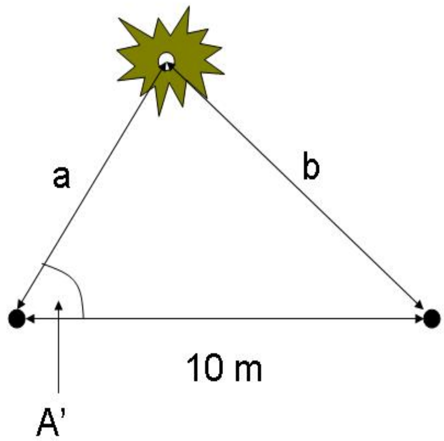


Figure (2) Pattern of permanent and temporary posts established each plot in order to map each plant within each study plot.



$$\cos A' = \frac{(z^2 + a^2 - b^2)}{2za}$$

$$x = a\cos A'$$

$$y = \sqrt{(a^2 - x^2)}$$

Figure (3) : Calculating the position of each mapped shrub within the plot from bearings and distances from the two nearest seaward posts Here, z = 10, and a, b and the angle A' are measured. The xy coordinates from the reference post of the subplot are then calculated as shown. XY coordinates can then be calculated with reference to the bottom-left permanent post of the plot [4].

Sample Collection Methods:

1. Sweep Netting: Insects were collected using a sweep net by sampling foliage along 10-meter transects around each plant species.
2. Light Trapping: UV light traps were deployed during evening hours near Juniperus and Pistacia to attract nocturnal herbivores.
3. Direct Observation: Insects observed on the foliage or around the plants were recorded manually to include less mobile species [7].

Identify the species: Collected insects were identified to the species level using taxonomic keys and reference literature. Voucher specimens were preserved for confirmation by entomological experts [8].

Data analysis: Species richness and Shannon-Weiner indices were calculated to assess insect diversity. Statistical tests, including ANOVA and multivariate analysis, were performed to compare insect communities across plant species and locations [9,6,10].

Environmental factors: Environmental variables such as temperature, humidity, and soil characteristics were recorded for each site to assess their influence on insect populations.

3. Results:

3.1. Diversity of insects:

Juniperus supported a higher diversity of herbivorous insects in mountain regions, with species richness peaking at sites with moderate altitude and dense vegetation. *Pistacia* was associated with fewer but more specialized insect species, particularly in semi-arid zones. Table (1) and figure (4): Insect Diversity and Diversity Indices This table shows the number of insect species, the Shannon-Weiner diversity index, and the percentage of specialist insect species for *Juniperus* and *Pistacia* across different locations.

Table 1: Insect Diversity and Diversity Indices

Location	Host Plant	Number of Species	Shannon-Weiner Index	Specialist Insect Percentage (%)
Montane Region 1	*Juniperus*	25	2.85	20%
Montane Region 2	*Juniperus*	22	2.67	18%
Semi-Arid Zone 1	*Pistacia*	15	1.92	40%
Semi-Arid Zone 2	*Pistacia*	18	2.10	35%

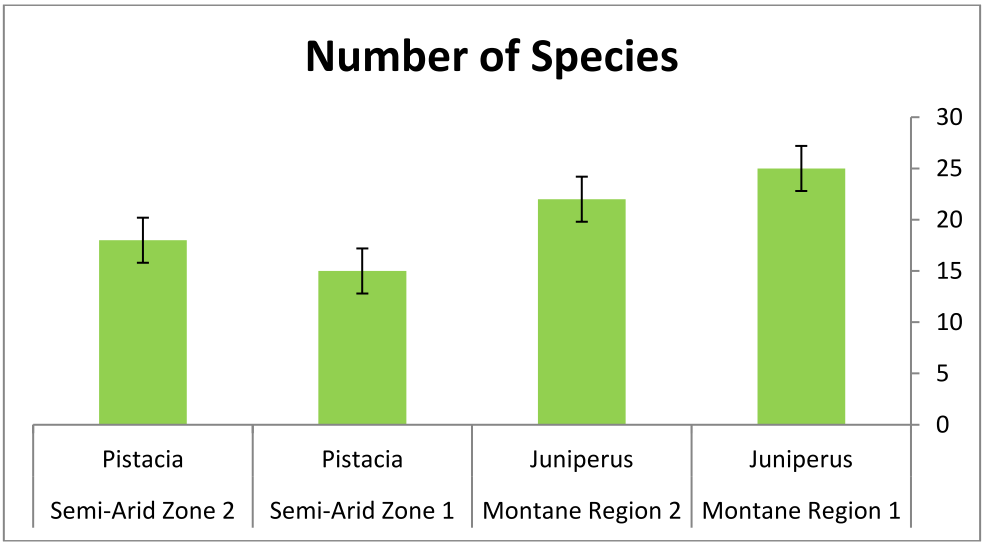
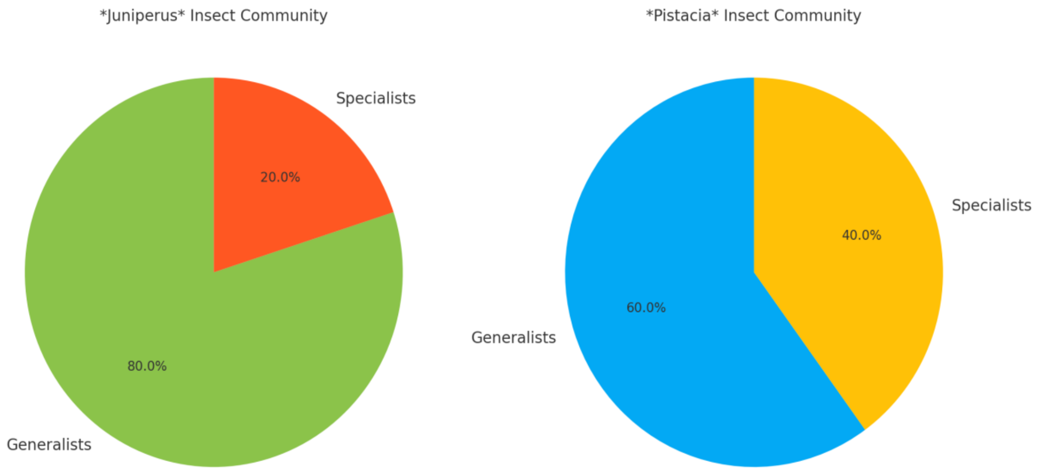


Figure (4) The number of insect species according to location and plant host

3.2. Geographical distribution:

Insect communities on *Juniperus* were dominated by generalist herbivores, while *Pistacia* exhibited a higher proportion of specialist species. The pie chart shows the distribution of generalist and specialist insect species for both *Juniperus* and *Pistacia*. **For *Juniperus*:**80% Generalists and 20% specialists **For *Pistacia*:**60% generalists40% Specialists, Figure (5).



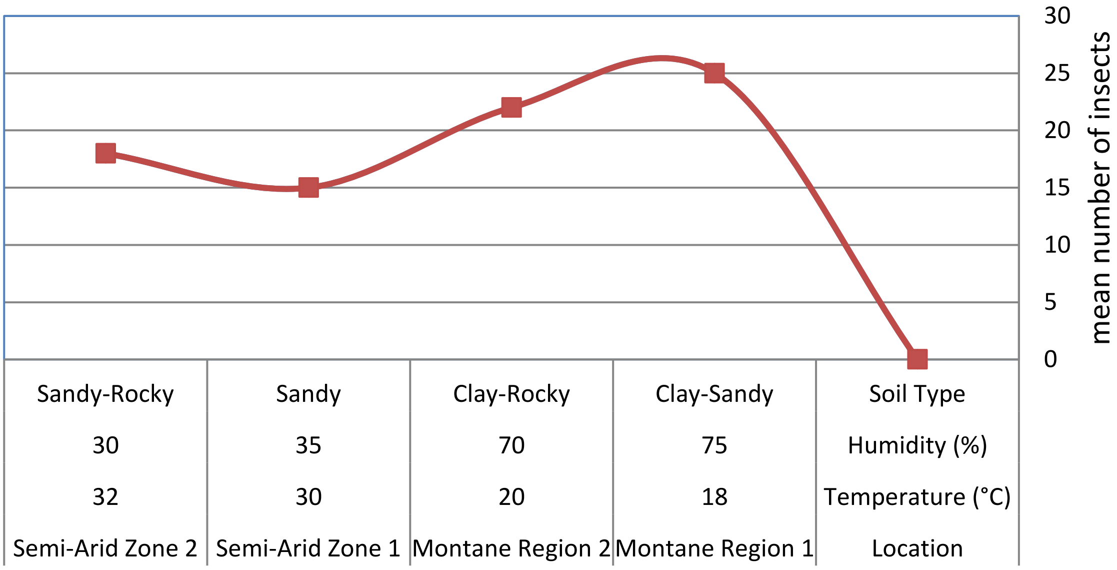
Figure(5) Specialist and Generalist Insect Distribution for *Juniperus* and *Pistacia*

3.3. Influencing factors:

Temperature and altitude were strongly correlated with herbivore diversity on *Juniperus* (Montane region 1 and Montane 2), while soil composition and plant density influenced *Pistacia* (Semi- Arid zone 1 and Semi- Arid zone 2) communities. See table 2 and figure 6.

Table 3: Environmental Factors and Their Impact on Insect Populations

Location	Temperature (°C)	Humidity (%)	Soil Type	Number of Insect Species
Montane Region 1	18	75	Clay-Sandy	25
Montane Region 2	20	70	Clay-Rocky	22
Semi-Arid Zone 1	30	35	Sandy	15
Semi-Arid Zone 2	32	30	Sandy-Rocky	18



Figure(6) Effect of temperature, relative humidity and soil type on the average number of insect species associated with *Juniperus* and *Pistacia* shrubs.

4. Discussion:

Overall Trends and Ecological Implications Montane regions support higher insect diversity due to their favourable environmental conditions (cooler temperatures, higher humidity, and stable vegetation.). Semi-arid zones have fewer species but more specialists, as harsher conditions favour insects adapted to specific host plants. Shannon-Weiner Index values decrease from montane to semi-arid zones, indicating that community evenness declines in harsher environments. The host plant affects species diversity and specialization, with *Juniperus* supporting more generalists and *Pistacia* favouring more specialists. Geographical Influence and Ecological Considerations, Geography plays a significant role in shaping insect herbivore communities in Al Jabal Al Akhdar within the Mediterranean ecosystem. The number of recorded species generally increases with elevation, while middle elevations support the highest overall insect abundances [1,2].

The results emphasize the importance of plant locality and environmental conditions in structuring herbivorous insect communities. The greater diversity of herbivores on *Juniperus* in montane regions can be attributed to favourable microclimatic conditions and habitat complexity, which provide essential resources and refuges for various insect species [11]. Conversely, the semi-arid environment of Pistacia may encourage the evolution of specialized herbivores, which are adapted to harsher conditions and limited resources [6]. Implications for Ecological Management that These findings have significant ecological management implications:

The high herbivore diversity on *Juniperus* suggests a greater potential for ecological interactions, but also increased vulnerability to pest outbreaks. The specialized herbivores on *Pistacia* highlight the need for targeted conservation strategies to protect these unique insect-plant interactions in semi-arid zones.

5. Conclusions:

This study demonstrates that plant locality significantly influences the diversity and distribution of insect herbivores associated with *Juniperus* and *Pistacia* in Cyrenaica, Libya. The findings underline the ecological importance of geographic and environmental variability in shaping herbivore communities. [1,11]. Key conclusions include:

1. *Juniperus* in montane regions supports higher insect diversity due to favorable climatic and habitat conditions.
2. *Pistacia* in semi-arid zones attracts a more specialized herbivore community adapted to harsher environments.
3. Environmental factors such as temperature, altitude, and soil properties play a critical role in determining insect-plant interactions.

These insights can inform pest management strategies, particularly for conserving economically important plant species in the region. Future research should focus on the long-term monitoring of plant-insect interactions and their responses to environmental changes, with emphasis on the potential impacts of climate change and habitat degradation [2,6].

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