Study of population dynamics of the agricultural pest eobania vermiculata (o.f. müller,1774 gastropoda: helicidae) in kerbala, iraq

Israa N. Ghulam[1*]; Khansaa S. Farman[2]

Received: 28 March 2025; Revised: 21 April 2025; Accepted: 29 April 2025; Published: 20 May 2025

Abstract

Background: Eobania vermiculata is a species of land snail that is of great ecological importance as an agricultural pest and invasive pest that causes damage to agricultural crops, orchards and forests. It is characterized by its exceptional ability to adapt to diverse habitats and is native to the Mediterranean regions but is widely distributed in Karbala Governorate, Iraq. Al-Abbas Nurseries, Karbala University Gardens, and Al-Hussainiya Farms were the three different sites in Kerbala where the population density of E. vermiculata was measured. The investigation was conducted throughout the snail's breeding and growth season. Methods: Samples were collected manually using a wooden square of length (30×30) cm per square meter and for ten replicates from the collection areas specified according to the above-mentioned map for the period from November 2023 to April 2024. The samples were transferred to the laboratories of the College of Education for Pure Sciences. Shell length measurement: Using a standard ruler and dividing them into longitudinal categories, the samples were diagnosed according to the classification keys for snail diagnosis. In addition, the samples were sent to the Natural History Museum at the University of Baghdad to confirm the diagnosis. Results: Significant differences in snail density were observed between the studied areas, with Al-Abbas Nurseries showing the lowest density and Karbala University Gardens having the highest density (1732 individuals). In addition, monthly population density analysis revealed that for the majority of sites, March had the highest density, while January had the lowest density. To determine the total snail size, the study further divided snail populations according to shell length. The density of the smallest size class (0-5 mm) peaked in February and March after disappearing in December and January. These results provide important new information on the conservation of E. vermiculata. Conclusions: The sustainability of this species' populations within their native habitats can be improved by understanding their population dynamics and dispersal tactics. Most of the results were consistent with previous studies, and we recommend that further studies be conducted to understand the impact of this species on ecosystems and habitats.

1*- Department of Biology, College of Education for Pure Sciences, University of Kerbala, Iraq.
Email: esraa.naser@uokerbala.edu.iq, ORCID: https://orcid.org/0000-0002-2123-0396
2- Department of Biology, Collage of Education for Pure Science, University of Diyala, Iraq.
Email: khansaasf@uodiyala.edu.iq, ORCID: https://orcid.org/0000-0001-7550-7330
*Corresponding author
DOI: 10.70102/IJARES/V5I1/5-1-64

Keywords: Dynamic, Vermiculata, Gastropoda, Kerbala, Agricultural pest

Introduction

Land snails are agricultural pests that cause serious damage to crops or economic and environmental damage and may also transmit parasites to humans, animals and plants (Borkakati, Gogoi, and Borah, 2009). The brown or chocolate snail E. vermiculata is a species of land snail belonging to the family Helicidae (Heller, 2001). This species is widespread in the Mediterranean region, including Iraq (Hwai *et al.*, 2023), and this species of snails has a important impact on terrestrial ecosystems as it acts as an significant environmental decomposer and is an pointer of environmental health (Gómez, Martínez-Solano, and Morand, 2019; Ponder and Lindberg, 1997). This snail lives and is widely distributed in the Middle East, Turkey, Syria, Lebanon, Jordan, Palestine and Egypt (Goljanin, Demirović and Žiko, 2024; Schmidt-Nielsen, 1984). The most important areas of its spread are coastal areas such as the Syrian coast or the Mediterranean coasts of Egypt and Jordan, or in areas with abundant vegetation, where suitable factors are available for the spread of this snail, such as climate, humidity levels, and hot, dry summers (Barker 2002; (Chan, *et al.*, 2013). These snails are available in Areas of high humidity, such as gardens, nurseries or farmland. These snails are characterized by their good adaptation to environmental factors, especially in the hot summer months when the harsh environment resorts to hibernation (Bansal and Naidu, 2024). Because of the flourishing of this snail in various terrestrial environments, from wet coastal to dry inland, we have not found research or studies that directly indicate the population dynamics of E. vermiculata in Iraq, and this causes a large gap in our understanding of the population structure of such snails and the mechanism (Barker, 2004; Giusti and Manganelli, 1991). Reproduction, reproduction, and interaction with the local environment, as most studies were on the impact of human activities such as urbanization on this snail environmentally (Yildirim and Güçlü, 2002; Cowie, 1992). These activities often cause fragmentation and damage to habitats (Gonzalez and El-Sayed, 2024). Therefore, the study of the population density of E. vermiculata made the subject of its study of environmental importance in addition to the previous characteristics mentioned above (Neubert, 1998). The brown or chocolate snail E. vermiculata can also be considered an agricultural pest as it feeds on a wide range of field crops, causing significant losses in crops (Gittenberger, 1991). The brown snail reproduces by laying eggs in large numbers under suitable conditions for this snail. In addition to the smooth and rapid hatching of eggs, this snail leads to the formation of large populations in places with abundant food, which increases its environmental and agricultural impacts (Sathyanarayana and Laxmana Rao, 2024; Barker, 2001; Al-Qaisi and Farman, 2022) this snail in Greece and found densities of up to 80 individuals per square meter under conditions, especially in areas with high vegetation cover and humidity levels. The density of snails

varies depending on the habitat, for example, they are found in high densities in Mediterranean habitats with abundant vegetation. Agricultural practices may increase snail densities if irrigation is continuous or decrease them if pesticides are used to control agricultural pests (Dhiman, *et al.,* 2020). In addition, urbanization factors have an impact on the extinction or increase in density of land snails (Ramachandran and Naik, 2024; Çelik and Şahin, 2020). showed that the land snail Helix aspersa was found in urban gardens in Britain at densities of 10 to 50 individuals per square meter, depending on the availability of food and shelter (Abed, 2015).

Material and Methods

Sample collection: E.vermiculata Sample collection manually using a wooden square (30 x 30) cm in length per square meter and for ten replicates from the designated collection areas according to the map mentioned above for the period from November 2023 to April 2024. The samples were transferred to the laboratories of the College of Education for Pure Sciences in boxes designated for collection, with all information related to the day, month, year and collection area recorded (Hemasree and Kumar, 2022).

Measure the length of the shell: The length of the snail shell, which represents the length of the snail itself, was recorded using a special standard ruler, and it was divided into length categories according to Figure 3 (Hassan, 2023; Wilbur and Owen, 1964).

Diagnosis of samples: The samples were diagnosed according to the classification keys for diagnosing snails (Lim et al., 2016). In addition, samples were sent to the Natural History Museum at the University of Baghdad to confirm the diagnosis. ecological factor was measured monthly in all study sites, as temperature and Soil moisture according to (Staikou, Lazaridou, and Sarikou, 2021; Kemp and Bertness, 1984).

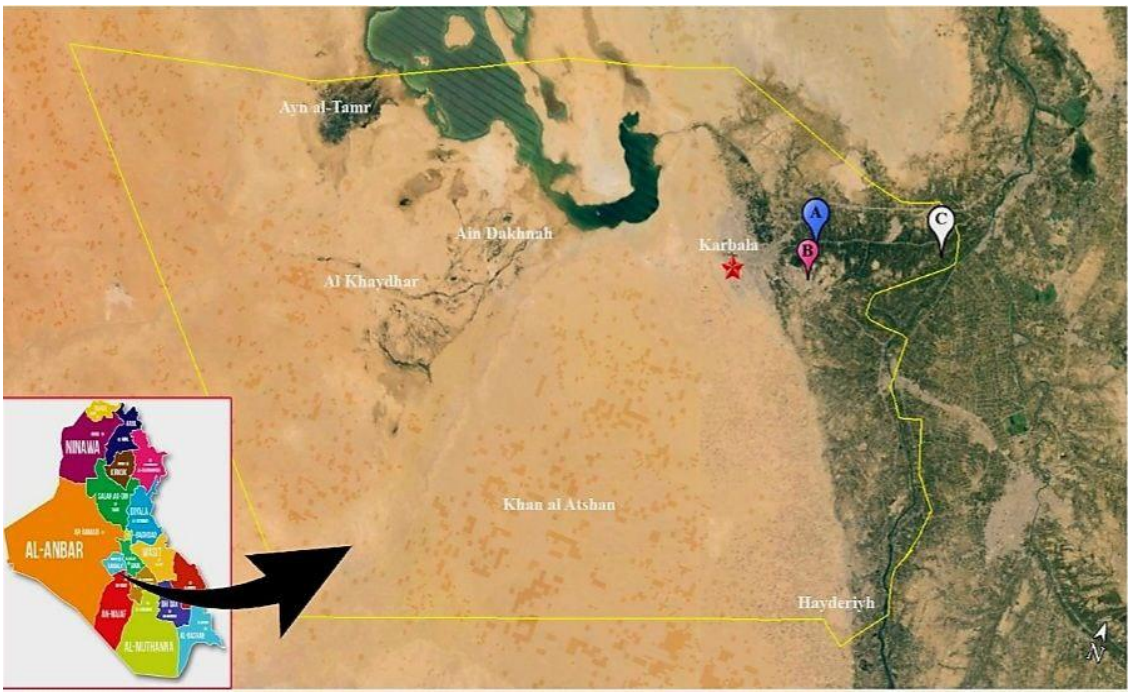

Figure 1: A map showing eobania vermiculata collection areas.

As shown in Figure (1), a map showing the areas of spread of the agricultural pest *E. vermiculata* in Karbala Governorate (Al-Abbas's Shrine Nurseries / Karbala University Gardens / Al-Hussainiya Farms), and the selection of these sites came based on the presence and availability of environmental factors suitable for the spread of this pest (snail), and the study included the selection of areas in which this pest is abundantly infected,

Table 1: Showing the latitude and longitude of the eobania vermiculata sampling areas

Area name	Longitude	Latitude
Al-Abbas Nurseries	44.095256°	32.636560°
Karbala University Gardens	44.089152°	32.604255°
Al-Hussainiya Farms	44.227710°	32.674417°

Results

The ventral and dorsal surfaces (Figure 2) indicate the most important parts from a taxonomic point of view, such as the shell aperture, growth lines, and the apex, the lips of the shell aperture.

According to the areas (Figure 3) of snail spread as shown on the map above, the gardens of the University of Karbala are infested with the study snail and represent the highest percentage among other snail collection areas, as 1732 snails were recorded, while the nurseries of the Al-Abbas's Holy Shrine had the lowest number, with 281 snails.

Figure 2. Eobania vermiculata.

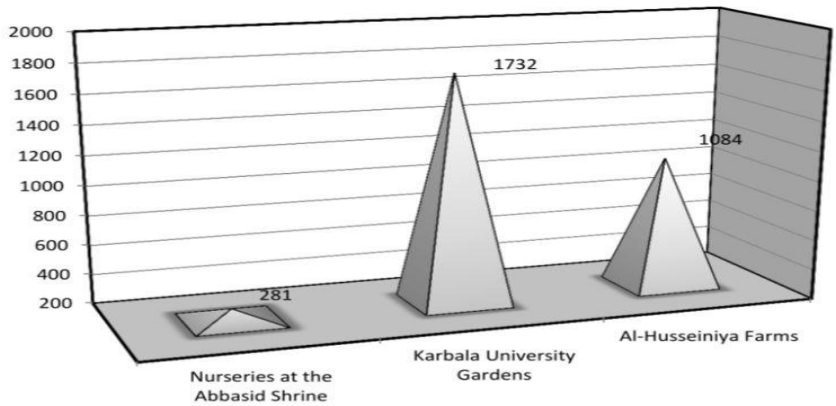

Figure 3: Total number of eobania vermiculata according the collection areas and study period.

Through, it can be seen that the gardens of the University of Karbala are the highest in numbers of snails during the study months in general (Figure 4), but what is distinctive is that the highest and lowest number of samples of snails were collected during the months of March, 494 snails and 81 snil in January in the university gardens. While the lowest number recorded in general was only 20 snails in the nurseries of the al-Abbas Shrine during the month of January.

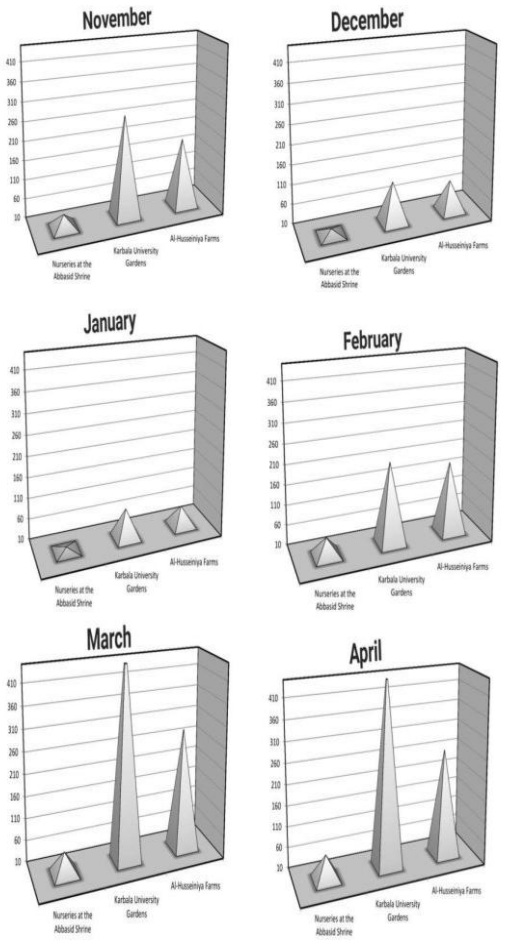

Figure 4: Number of eobania vermiculata collection areas, according months of reproduction and growth

The population density was divided into five longitudinal categories, each category representing specific lengths of snails at a specific age stage (Figure.5) for the purpose of facilitating knowledge of the types of snail populations and their distribution. It was found that the first and second categories were at their peak during the months of March and April and very low in the remaining months of the study, while the last category was It peaks during December.

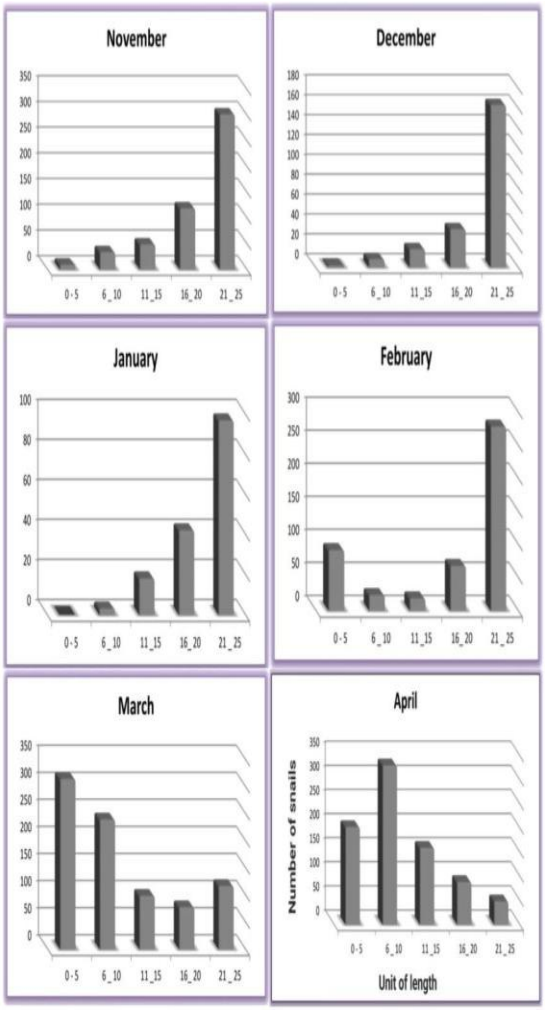

Figure 5: Density of snails according to length of snails

The study showed an increase in the number of snails in December and January, which were the two months that recorded the highest humidity levels (Figure 6) during the study period. The results also showed a positive correlation with temperatures, as their highest density was reached during March and April, coinciding with their breeding season.

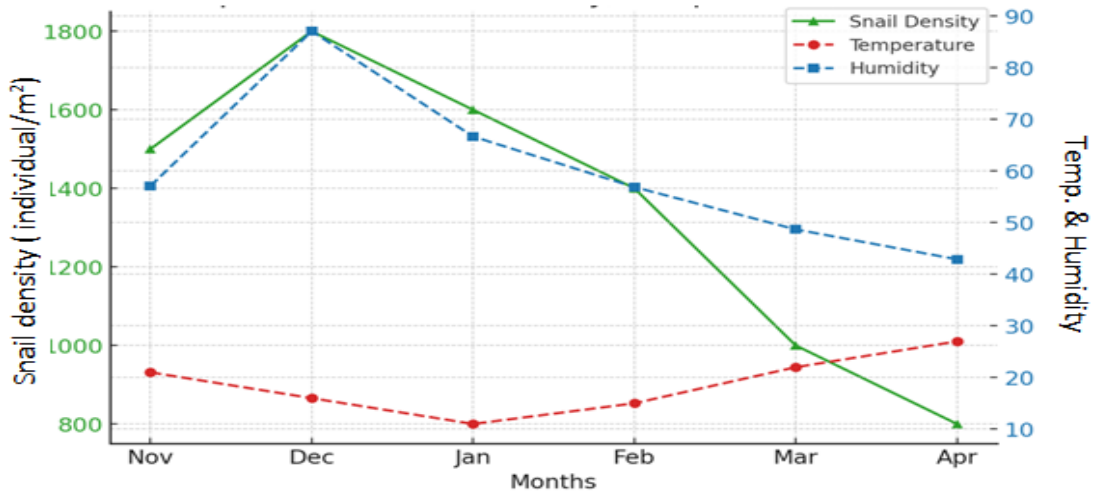

Figure 6: Showing the relationship between snail density and temperature and humidity.

Discussion

The external appearance of the snail is of great importance in classifying and understanding the behavior and evolution of the snail. The shell opening, the presence of its outer lips, the column, growth lines and many other characteristics contribute to identifying different types of other snails. as the external shape of the shell contributes to helping the snail in various environmental conditions, for example, increasing the thickness of the shell contributes to preventing the internal drying of the snail. It also resists predation by other animals, as it is one of the types of adaptation. The snail also chooses its partner according to the size or shape of the shell, as the shell plays a role in sexual attraction (Bicak *et al.*, 2020; Giokas and Mylonas, 2002). From the results of this study, the reasons for the increased spread of this snail in the gardens of the University of Kerbala can be explained by several factors, including first the soil factor, as the quality of the soil affects the spread of snails, as they prefer soft, fertile soil rich in calcium or need calcium to build their shells, factors of high and available humidity, as irrigation is continuous and by sprinklers, which contributes to the presence of moist and soft soil, in addition to the university's large and diverse plant cover, which increases the chances of food and nutrition, in addition to other important factors, which is the absence of extermination or attempts to get rid of snails, as it resembles a natural reserve. All these reasons have increased the chances of increasing the number of snails significantly in imposing their population group. In contrast, the nurseries of the Al-Abbas's Holy Shrine and the Al-Hussainiya farms are rentier farms and not a natural reserve, so they are exposed to pesticide control every reproductive season and traditional methods of collecting snails manually. Irrigation dates at specific times may reduce the humidity of the region's climate, Not combating or hunting snails or even oysters in the aquatic environment, for example, or keeping them in a protected environment, increases the population density and makes it higher than it is in other unprotected areas or areas exposed to combating and hunting (Khan and Vardhan, 2024). This was consistent with

what researchers have proven (Phil *et al.*, 2018; Mthembu and Dlamini 2024) that the availability of climate, food, soil and its quality, in addition to advanced environmental adaptation and factors of human intervention or not, all contribute to increasing or decreasing the population group of the snail and giving the snail opportunities to live or not.

The results showed a negative relationship between snail density and temperature. This is due to the fact that high temperatures and low relative humidity have a significant impact on the activities and distribution of terrestrial gastropods, which may cause a complete cessation of terrestrial gastropod activity. In the event of low temperatures, this will lead to increased activity and vital activities. This is consistent with the study of (Cameron and Pokryshko, 2005; Rajput, 2024), as climate change causes fluctuations in temperatures, which directly affects the life cycle of terrestrial gastropods, their ability to reproduce, and their population dynamics (Bailey, 1975). In general, Iraq enjoys a moderate climate and a spring atmosphere during the months of March and April, and the spring season is short, and because these months in particular represent the ideal conditions for the growth of snails and increasing their activity, according to. as humidity levels increase and temperatures are moderate, in addition to it representing a season Increasing vegetation cover after rains means an abundance of food. All of this weather helps make these spring months the beginning of a new and strong reproductive season, especially since the hatching of eggs for this type of snail does not exceed two weeks with the availability of appropriate conditions, and this leads to an increase in the population density of snails. In addition to the reproductive nature of the snail and the mechanism of laying eggs in abundant numbers, while what we see of a severe decrease in the number of snails in the rest of the months of the year, which represents the summer and winter seasons, these are not ideal conditions for the snail and are harsh, as they resort to decreased activity and begin to hibernate to preserve their species This is what researchers confirm that climate factors, optimal conditions, and even snail adaptation methods are used to get rid of the negative effects of the environment (Narang and Kulkarni, 2023; Ghulam, 2019).

The length of the snail can be an indicator of the snail's age. There are several factors that make the length of the shell related to age. Snails continue to grow throughout their lives, and as they get older, the length of the shell gradually increases. Therefore, larger snails usually live longer than smaller snails. However, the growth rate varies depending on the species and snail's environment (Ghulam, 2015). The population size distribution of snails was characterized by the appearance of the first size classes represented by the young in large numbers, especially the first and second classes in the months of March and April, as they represent the spring season. The reason is attributed to the beginning of a new reproductive season, where the conditions and factors for reproduction are available, and the numbers of the same two classes decrease due to the end of the reproductive season and the large size of the young snails. The research

matched what (Hassan, 2023; Harasewych and Moretzsohn, 2010; Rayen, Stephen and Rashid, 2003). In addition to the morphological changes that occur in shells and their sizes during development in growth This research examines the morphological changes in shells and how they can change with growth, which affects the relationship between length and age (Hickman *et al.*, 2017).

The results indicated a negative correlation between temperature and snail density. This is because the activities and distribution of terrestrial gastropods are greatly impacted by high temperatures and low relative humidity, which can lead to a total halt in terrestrial gastropod activity. When temperatures are low, this will result in more activity and essential tasks. This is consistent with the study of as climate change causes variations in temperatures, which directly affects the life cycle of terrestrial gastropods, their ability to reproduce, and their population dynamics.

Conclusion

The intricate relationship between biological and environmental factors allows us to understand the dynamic population of *E. vermiculata*. We must constantly study and examine the particular snails, as well as their population size and reproduction strategy, in order to comprehend these dynamics. Protecting environmental safety and agricultural productivity requires the use of sustainable management and development techniques.

Acknowledgments

I am grateful to the Department of Biology at the College of Education for Pure Sciences, University of Karbala, its laboratories, and those in charge of us for using the laboratories to produce this research. I also extend my thanks to some of those whose research I cited through this research.

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