

Morphological Redescription and Monthly Variation in the Population Density of the Terrestrial Isopod *Porcellionides pruinosus* (Isopoda: Porcellionidae) in Southern Iraq

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Received: 08.08.2025

Revised: 02.12.2025

Accepted: 03.12.2025

Published: 02.02.2026

Abstract: This study provides an integrative ecological and taxonomic assessment of *Porcellionides pruinosus* (Brandt, 1833) from agricultural habitats in Dhi Qar Province, southern Iraq. Field sampling was conducted monthly from August 2024 to July 2025 across four agricultural stations: Al-Shatrah, Al-Rifai, Al-Nasr, and Qalat Sukkar. Morphological redescription confirmed key diagnostic traits including a subrectangular cephalon, pale reticulate patterning, and spear-shaped uropods consistent with previously published descriptions of the species. Population density exhibited clear spatial and seasonal fluctuations. The annual mean density was highest in Al-Rifai (281.3 ± 108.2 ind./m²) and Al-Nasr (257.1 ± 123.5 ind./m²) followed by Al-Shatrah (246.3 ± 91.2 ind./m²) and Qalat Sukkar (213.7 ± 92.3 ind./m²). Peak values were recorded during spring, especially in March and April, while the lowest densities occurred in winter months. These patterns reflect the species' ecological adaptability and seasonal responsiveness under semi-arid conditions. The findings highlight the potential of *P. pruinosus* to serve as a bioindicator of soil health and habitat stability in disturbed agroecosystems. This study also provides novel regional data to the limited body of knowledge on terrestrial isopods in the Middle East.

Keywords: Abundance, ecology, morphology, seasonality, diversity.

Güney Irak'ta Kara İzopodu *Porcellionides pruinosus*'un (Isopoda: Porcellionidae) Morfolojik Yeniden Tanımlaması ve Popülasyon Yoğunluğundaki Aylık Değişim

Öz: Bu çalışma, Irak'ın güneyindeki Dhi Qar ilindeki tarımsal habitatlardan toplanan *Porcellionides pruinosus* (Brandt, 1833) türüne ilişkin bütüncül ekolojik ve taksonomik bir değerlendirme sunmaktadır. Arazi örnekleme, 2024 Ağustos ile 2025 Temmuz ayları arasında, Al-Shatrah, Al-Rifai, Al-Nasr ve Qalat Sukkar olmak üzere dört tarımsal istasyonda aylık olarak gerçekleştirilmiştir. Morfolojik yeniden tanımlama, türün daha önce yayımlanmış tanımlarıyla uyumlu olarak, subrektangular sefalon, soluk ağsı desenlenme ve mızrak şeklindeki üropodlar gibi temel tanısal özellikleri doğrulamıştır. Popülasyon yoğunluğu, belirgin mekânsal ve mevsimsel dalgalanmalar göstermiştir. Yıllık ortalama yoğunluk, sırasıyla Al-Rifai'de ($281,3 \pm 108,2$ birey/m²) ve Al-Nasr'da ($257,1 \pm 123,5$ birey/m²) en yüksek, ardından Al-Shatrah ($246,3 \pm 91,2$ birey/m²) ve Qalat Sukkar'da ($213,7 \pm 92,3$ birey/m²) kaydedilmiştir. En yüksek değerler özellikle Mart ve Nisan aylarında, ilkbahar döneminde gözlenirken, en düşük yoğunluklar kış aylarında ortaya çıkmıştır. Bu desenler, türün yarı kurak koşullar altında ekolojik uyum yeteneğini ve mevsimsel tepkiselliğini yansıtmaktadır. Bulgular, *P. pruinosus*'un bozulmuş tarımsal ekosistemlerde toprak sağlığı ve habitat istikrarının biyogöstergesi olarak kullanılma potansiyelini vurgulamaktadır. Ayrıca, bu çalışma Orta Doğu'daki karasal izopodlar üzerine sınırlı birikimine yeni bölgesel veriler sağlamaktadır.

Anahtar kelimeler: Bolluk, ekoloji, morfoloji, mevsimsellik, çeşitlilik.

1. Introduction

Porcellionides Miers, 1878 is a large and widely distributed genus within the family Porcellionidae (Brandt, 1831). Over the years, this genus has undergone multiple taxonomic revisions resulting in fluctuating numbers of recognized species. According to the open-access database by Boyko et al. (2008), *Porcellionides* originally included approximately 93 nominal species, encompassing both valid and doubtful names. However, a more recent taxonomic reassessment by the same authors in 2023 recognized only 49 species as valid based on rigorous morphological criteria and detailed anatomical descriptions (Boyko et al., 2023). This significant reduction underscores the persistent taxonomic challenges

associated with the genus, particularly the prevalence of poorly defined diagnoses and the frequent absence of diagnostic illustrations. Such issues have led to repeated misidentifications and multiple descriptions of the same taxon under different names thereby complicating the delineation of closely related species (Lefebvre & Marcadé, 2005).

Although most *Porcellionides* species are concentrated in the western Palearctic region, *Porcellionides pruinosus* (Brandt, 1833) has attained a nearly cosmopolitan distribution. Its widespread presence is largely attributed to anthropogenic dispersal, enabling colonization across diverse biogeographic zones. Within the family Porcellionidae, which currently comprises around 331

described species, *Porcellionides* ranks as the second most species-rich genus after *Porcellio* Latreille, 1804 which includes 191 known species (Sfendourakis & Taiti, 2015; Boyko et al., 2023).

In Iraq, recent faunistic investigations have documented at least four members of the Porcellionidae: *Porcellionides pruinosus*, *Porcellio scaber*, *Porcellio laevis*, and *Porcellio spinicornis*. The first record of *P. pruinosus* in Iraq was reported in Baghdad and Basra by Al-Moussawi (2009) and more recently in wetland habitats in Basra by Al-Baghdadi et al. (2024). *P. scaber*, a widely distributed species, has been observed in Baghdad and other central regions (Al-Doori et al., 2021), while *P. laevis* was identified in both Basra and Najaf (Al-Fatlawi et al., 2022; Al-Baghdadi et al., 2024). *P. spinicornis* was recorded in Baghdad and Al-Najaf by the same authors. Despite this growing record, the terrestrial isopod fauna of Iraq remains poorly understood particularly in southern arid and semi-arid regions.

The taxonomy of *Porcellionides* remains hindered by overlapping phenotypic characters, intraspecific morphological variation, and the scarcity of high-resolution diagnostic descriptions. These obstacles limit accurate species identification and comparative ecological assessments. Addressing these challenges necessitates integrative approaches that combine precise morphological analysis with quantitative ecological data.

In this context, the present study aims to redescribe the external morphology of *P. pruinosus* based on adult female specimens collected from agricultural habitats in Dhi Qar Province, southern Iraq. In parallel, we evaluate the seasonal dynamics of its population density across four distinct stations to provide insights into its spatiotemporal patterns and ecological adaptability. This work offers regionally novel data on terrestrial isopods and contributes to the broader understanding of soil arthropod diversity in Middle Eastern arid agroecosystems.

2. Material and Method

Fieldwork was conducted in Dhi Qar Province, southern Iraq, from August 2024 to July 2025. Four agricultural districts situated along the banks of the Al-Gharraf River were selected for sampling: Qalat Sukkar (31.858754°N, 46.073014°E), Al-Rifai (31.669189°N, 46.118789°E), Al-Nasr (31.534582°N, 46.120739°E), and Al-Shatrah (46.178582°N, 46.131874°E) (Fig. 1). These sites are characterized by dense clay soil, seasonal moisture, and moderate vegetation dominated by grasses and *Medicago* spp.

Terrestrial isopods were collected monthly using a standardized quadrat sampling method. On each site, three replicate quadrats (0.25 m² each) were examined by manually inspecting microhabitats such as under stones, within leaf litter, and among decaying plant material. All individuals encountered were counted and transferred into containers lined with moist paper for transport to the laboratory. To estimate population density per square meter (ind/m²), the total number of individuals per quadrat was multiplied by four. Adult specimens were preserved in 75% ethanol and identified morphologically using a dissecting microscope based on external somatic characteristics and following standard taxonomic keys (Cifuentes & Da Silva, 2024). The monthly average

population density of *P. pruinosus* was calculated for each site and across all sites combined. Monthly means from three replicated quadrats per station were used in all analyses.

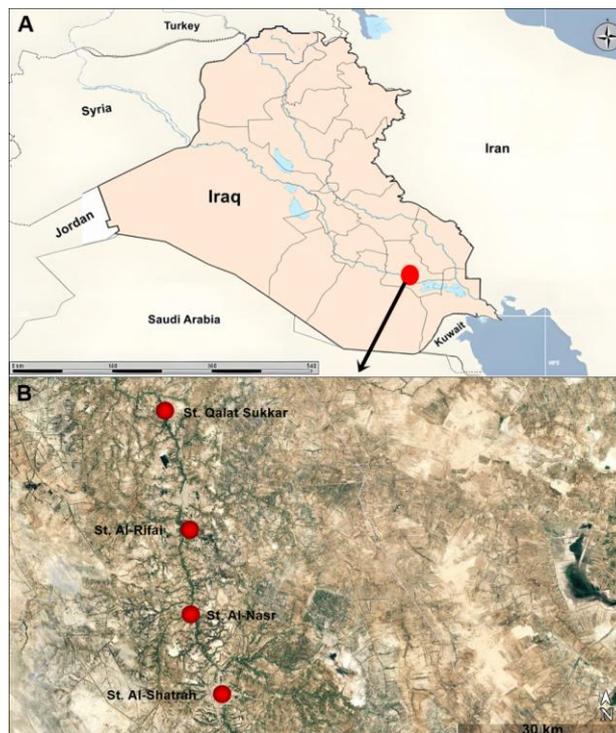


Figure 1. Map of Iraq showing the study area in Dhi Qar Province (A) and the four sampling stations (B) where *Porcellionides pruinosus* specimens were collected: St. Qalat Sukkar, St. Al-Rifai, St. Al-Nasr, and St. Al-Shatrah.

2.1. Statistical Analysis and Data Visualization

All statistical analyses and data visualizations in this study were conducted using the Python programming language within the Google Colab environment. Field data on the monthly population density of *P. pruinosus* from four agricultural stations were organized and processed using the pandas library. Descriptive statistics, including mean and standard deviation, were calculated to summarize density trends across months and stations. To illustrate temporal and spatial patterns in population dynamics, boxplots and line graphs were generated using matplotlib. Boxplots were used to represent the distribution of monthly density values for each station including median, interquartile range, and extreme values. Line plots with error bars (\pm standard deviation) were employed to depict seasonal changes in mean population density across the study period.

3. Results

3.1. Morphological Characterization

Family Porcellionidae Brandt & Ratzeburg, 1831

Genus *Porcellionides* Miers, 1877

Porcellionides pruinosus (Brandt, 1833)

Material examined. Iraq: Dhi Qar Province, Qalat Sikar, Al-Rifai, Al-Nasr and Al-Shatra Districts, agricultural lands on the banks of the Al-Gharraf River (Fig. 1B). Collected by M. A. Abd Al-Sahib (CBEUS).

Description

General morphology: The adult female presents an ovate body form measuring approximately 6.5 mm in length and 3.5 mm in width. The dorsal surface is rough due to small tubercles and flat granulations with pale reticulate maculation on the cephalon and pereonites. The body narrows progressively toward the posterior end terminating in a triangular telson flanked by spear-shaped uropods that are similar in colour to the body or slightly darker (Fig. 2A-D).



Figure 2. General habitus of *Porcellionides pruinosus* (Brandt, 1833): dorsal and ventral views of an adult female (A, B) and dorsal and ventral views of a juvenile individual (C, D), respectively.

Morphometrics: The morphometric parameters of adult females of *P. pruinosus* are summarized in Table 1. The total body length ranged from 5.12 mm to 7.55 mm with a mean of 6.45 ± 0.75 mm. The width of the cephalon measured between 1.68 mm and 2.24 mm, averaging 1.88 ± 0.18 mm. The telson length exhibited relatively low variation ranging from 1.03 mm to 1.34 mm (mean 1.18 ± 0.08 mm). Antenna II length varied from 2.37 mm to 3.46 mm with a mean of 2.88 ± 0.31 mm. The lengths of Pereopod I and Pereopod VII ranged between 2.69–3.87 mm and 3.76–4.56 mm respectively with average values of 3.48 ± 0.30 mm and 4.16 ± 0.18 mm. These values represent the size spectrum observed among adult females during the study period.

Cephalon and compound eyes: Cephalon subrectangular, markedly wider than long. The dorsal surface is smoothly convex. Anterior margin lacking median projection; two reduced, gently rounded anterolateral lobes present. Surface with well-defined pale reticulate maculation; pattern of irregular, elongated, pigment-free patches bordered by darker brown cuticle. Maculation is evenly distributed across the cephalon. Cuticle slightly roughened by minute tubercles and flat granulations, denser near lateral margins and antennal bases. No transverse ridges or carinae. Lateral margins merging seamlessly with pereonite 1 epimera, forming a continuous outline (Fig. 3A).

Compound eyes are lateral, at the junction of the dorsal and lateral cephalic surfaces. Each eye has an oval to subtriangular cluster of 20–21 ommatidia. Ommatidia are round, slightly convex, and darkly pigmented. Surface is smooth, glossy, and individual ommatidia are outlined by thin sutures. Eyes are slightly protruding, prominent in dorsal and have oblique views (Fig. 3B).

Antennae: Antennules are small, located medially at the base of the second antennae. They are composed of two peduncular articles and a short flagellum bearing sensory

aesthetascs. The second antennae are long, slender, exceeding the anterior margin of pereonite 1. The peduncle with five articles. Flagellum is two-articulated, first segment about twice the length of the second. The cuticle is smooth, setation sparse, short (Fig. 4A, B).

Table 1. Monthly population density (individuals/m² /m²) of *Porcellionides pruinosus* across four study stations (Al-Shatrah, Al-Rifai, Al-Nasr, and Qalat Sukkar) from August 2024 to July 2025.

Morphological Parameter	Mean \pm SD	Range (Min-Max)
Total body length	6.45 ± 0.75	5.12–7.55
Cephalon width	1.88 ± 0.18	1.68–2.24
Telson length	1.18 ± 0.08	1.03–1.34
Antenna II length	2.88 ± 0.31	2.37–3.46
Pereopod I length	3.48 ± 0.30	2.69–3.87
Pereopod VII length	4.16 ± 0.18	3.76–4.56

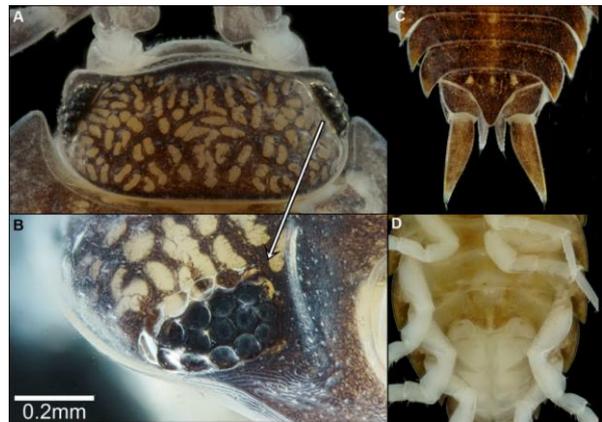


Figure 3. *Porcellionides pruinosus* (Brandt, 1833): (A) Lateral and median lobes of cephalon; (B) Ommatidia of compound eye; (C) Dorsal view of pleon; (D) Ventral view of pleon.

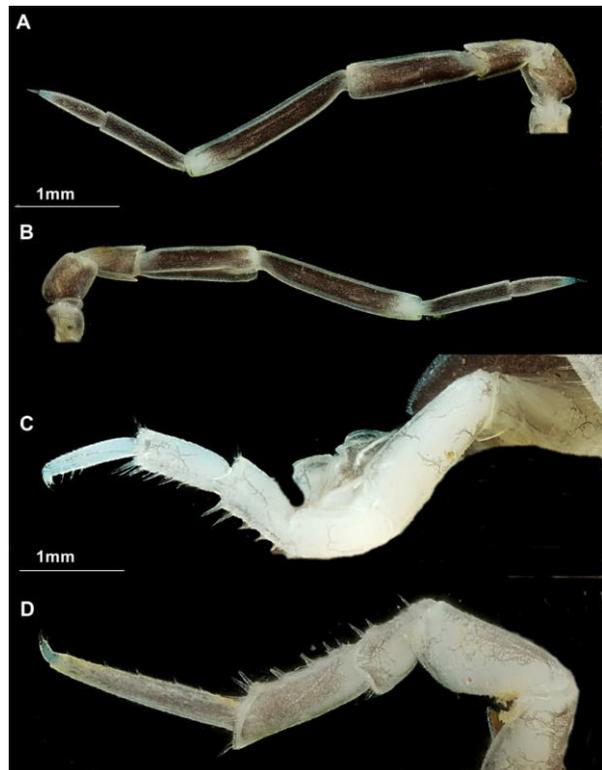


Figure 4. *Porcellionides pruinosus* (Brandt, 1833): (A, B) Antenna II in dorsal and ventral views, respectively. (C, D) Seventh pereopod in dorsal and ventral views, respectively.

Pereon and Pereopods: The pereon is composed of seven segments. Epimera are laterally expanded, forming a continuous outline with the pleon. They are no transverse ridges on pereonites. Pereopods are slender, seven-segmented, ending in a sharp dactylus without an accessory spine (Fig. 4C, D). Setae are sparse, short, occurring mainly on propodus and dactylus. Female pereopods are uniform and lack brush-like setae

Pleon, Pleopods, and Uropods: The pleon is composed of five free pleonites plus pleotelson. Pleopods 1 and 2 are biramous with well-developed exopodites and endopodites. Pleopods 3–5 have reduced endopodites. Pleopod 1 exopodite is broad, subrectangular, distal margin is weakly convex, with marginal setae; endopodite is narrow and tapers distally. Pleopod 2 exopodite is similar, slightly narrower; endopodite slender, linear. Uropods extend beyond the telson; exopodites and endopodites are spear-shaped. Telson is triangular, lateral margins are slightly concave, apex is narrowly rounded (Fig. 3C, D).

Distribution

P. pruinosus (Brandt, 1833) exhibits a cosmopolitan distribution as documented by GBIF (2024). The species has been recorded across Europe (including Spain, Portugal, France, Italy, Germany, the United Kingdom, Belgium, the Netherlands, Switzerland, Austria, Hungary, the Czech Republic, and Poland), North Africa (Morocco, Algeria, Tunisia, Egypt), parts of Asia (Turkey, Israel, Iran, Iraq, India, Japan), the Americas (United States, Canada, Mexico, Brazil, Argentina, Chile), and Australia. The species typically inhabits human-modified environments such as agricultural lands, gardens, urban areas, and greenhouses.

3. Population Density and Seasonal Fluctuations

The monthly density data of *P. pruinosus* across the four surveyed stations, Qalat Sukkar, Al-Rifai, Al-Nasr, and Al-Shatrah, exhibited clear temporal and spatial variation (Table 2; Figs 5-6). The species exhibited distinct seasonal fluctuations in abundance, with notably low densities during the winter months (December: 44.0 ± 11.78 individuals/m²; January: 57.0 ± 20.49 individuals/m²) and a pronounced peak in spring particularly in March (452.0 ± 51.95 individuals/m²) and April (450.75 ± 52.72 individuals/m²). Among the four stations, Al-Nasr recorded the highest monthly density (463 ind./m² in April) followed closely by Al-Rifai and Al-Shatrah. Qalat Sukkar generally exhibited lower densities, especially in December (32 ind./m²). During the spring season (March–May), population densities across all sites ranged between 263.0 and 452.0 individuals per square meter, suggesting a seasonal pulse of activity and potential reproduction. The boxplot analysis revealed variability in density distribution among stations, with Al-Nasr showing the highest median and interquartile range, indicating sustained abundance across months. Meanwhile, line plot analysis of monthly means confirmed the sharp rise in density during spring followed by a gradual decline during summer and a clear drop in winter. These patterns suggest a consistent annual cycle in the population dynamics of *P. pruinosus* under the semi-arid conditions of southern Iraq.

Table 2. Monthly average environmental parameters recorded on the study sites in Dhi Qar Province, southern Iraq including air temperature (°C), soil temperature (°C), relative humidity (%), and soil moisture content.

Month	Qalat Sukkar	Al-Rifai	Al-Nasr	Al-Shatrah	Mean \pm SD
August	202	197	210	187	199.0 \pm 9.63
September	100	136	138	180	138.5 \pm 32.72
October	272	224	292	268	264.0 \pm 28.66
November	128	216	312	268	231.0 \pm 79.09
December	32	56	36	52	44.0 \pm 11.78
January	80	68	44	36	57.0 \pm 20.49
February	292	236	244	252	256.0 \pm 24.87
March	464	492	476	376	452.0 \pm 51.95
April	416	404	463	520	450.75 \pm 52.72
May	304	292	216	240	263.0 \pm 41.87
June	292	244	296	264	274.0 \pm 24.55
July	292	244	296	264	274.0 \pm 24.55

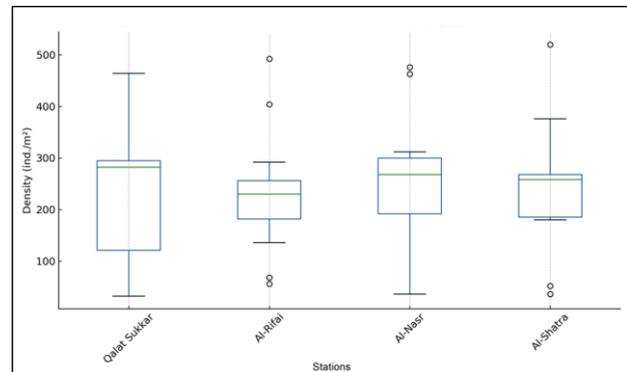


Figure 5. Boxplot displaying the monthly variation in the population density of *Porcellionides pruinosus* (ind./m²) across four stations in Dhi Qar Province. The horizontal line inside each box indicates the median, while the green line shows the mean. The box extends from the first quartile (Q1) to the third quartile (Q3), with whiskers reaching the minimum and maximum values within the normal range. Open circles represent outliers.

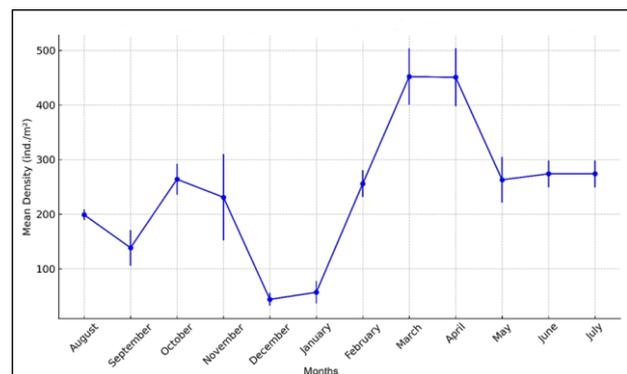


Figure 6. Line graph showing the monthly mean population density of *Porcellionides pruinosus* (ind./m²) across all four stations combined from August 2024 to July 2025. The blue line represents the average density per month and vertical bars denote the standard error.

4. Discussion

4.1. Morphological Characterization

The morphological redescription of *P. pruinosus* in this study confirms many of the diagnostic traits reported in

previous studies from other regions including the subrectangular cephalon with reduced anterolateral lobes, the pale reticulate maculation pattern, and the spear-shaped uropods. These characters are consistent with descriptions by Cifuentes & Da Silva (2024), who emphasized the integument with flat granulations, small lateral lobes on the cephalon, and the absence of transverse ridges on the pereonites.

Our findings further document the detailed growth rates under controlled environmental parameters, contributing valuable data on the species' biology under semi-natural conditions. In terms of habitat, the collection of specimens from moist, shaded agricultural soils with rich organic content mirrors previous records from various parts of Iraq and the Mediterranean basin, where *P. pruinosus* has been found under stones, leaf litter, and in soils rich in decomposing organic matter (Vandel, 1962; Schmalzfuss, 2003; Al-Doori et al., 2021). Our study also supports the view that *P. pruinosus* is a highly adaptable species capable of thriving in human-modified environments, further affirming its cosmopolitan distribution. This observation corresponds with the distribution patterns reported globally and in the Iberian Peninsula and North Africa (Cifuentes & Da Silva, 2024).

4.2. Population Density and Seasonal Fluctuations

The observed population dynamics of *P. pruinosus* across the four surveyed stations reveal a clear pattern of seasonal and spatial variation. The pronounced increase in density during the spring months (March-May), followed by a moderate summer decline and low winter abundance, is consistent with the general activity cycles documented for terrestrial isopods inhabiting semi-arid agroecosystems. Similar seasonal trends have been reported in previous studies, particularly in Mediterranean and Middle Eastern contexts, where spring conditions often favor molting, reproduction, and active foraging (Warburg et al., 2010; Al-Baghdadi et al., 2024).

Among the four stations, Al-Rifai and Al-Nasr recorded the highest densities, especially during April and May. These differences may be attributed to microhabitat characteristics such as soil structure, vegetative cover, and organic content, which influence shelter availability and food resources. Qalat Sukkar consistently exhibited lower densities possibly due to less favorable local conditions or higher disturbance levels such as tillage or reduced organic matter.

The density values reported in this study (ranging from 32 to 463 individuals/m²) fall within the typical range for *P. pruinosus* in cultivated landscapes, although they remain lower than densities observed in undisturbed, humus-rich habitats where populations may exceed 1000 individuals/m² (Paoletti & Hassall, 1999). This suggests that while *P. pruinosus* is a highly adaptable and resilient species, its abundance remains constrained by local land-use practices and habitat structure.

Furthermore, the seasonal shifts in population size support the characterization of *P. pruinosus* as an ecologically responsive species, well-suited to functioning as a biological indicator. Its dominance in spring, when moisture retention and moderate temperatures are presumed optimal, reflects its reliance on stable

microhabitats with sufficient shelter and organic resources. The ability of this species to maintain moderate densities across disturbed agricultural fields further underscores its ecological plasticity and its potential utility in bioindication.

5. Conclusion

This study provides a comprehensive redescription and ecological assessment of *P. pruinosus* (Brandt, 1833) based on specimens collected from agricultural habitats in Dhi Qar Province, southern Iraq. The morphological characterization of adult females confirmed key diagnostic features consistent with previously published records, supporting the accurate identification of the species and its cosmopolitan distribution in human modified environments. Field observations revealed distinct seasonal and spatial variation in population density with peak abundance occurring during the spring months and marked declines during winter. These patterns reflect the species' ecological responsiveness and adaptability to fluctuating habitat conditions in semi-arid agroecosystems.

The findings reinforce the ecological plasticity of *P. pruinosus* and its potential utility as a bioindicator of soil health and habitat quality. Maintaining vegetative cover, organic matter, and microhabitat stability in agricultural zones is recommended to support the persistence of this species and the essential ecosystem functions it provides, including organic matter decomposition and nutrient cycling.

As reported in other regions, including the Iberian Peninsula and North Africa, *P. pruinosus* appears to tolerate a broad range of environmental conditions, though its reproductive output and survival likely depend on seasonal cues and resource availability (Souty-Grosset et al., 2018; Cifuentes & Da Silva, 2024). This adaptability explains its global cosmopolitan status and continued success in human-modified habitats. The findings of this study align with the ecological conclusions drawn from previous surveys in southern Iraq and reinforce the importance of conserving soil-dwelling macroinvertebrates through environmentally sensitive agricultural practices. The authors recommend enhancing vegetation cover, reducing soil disturbance, and maintaining organic matter inputs as strategies to promote the persistence of *P. pruinosus* populations and the ecological services they provide, particularly nutrient cycling and decomposition of organic matter.

Acknowledgement: Special thanks are extended to the local farmers in Dhi Qar Province for granting access to agricultural lands during the sampling period. This study was conducted as part of a Master's thesis project by the first author under the supervision of Prof. Dr. Azhar M. Al-Khazali. The research was fully self-funded, with no financial support from the university or any external sources.

Ethics committee approval: Ethics committee approval is not required for this study.

Conflict of interest: The authors declare that there is no conflict of interest.

Author Contributions: Conception - A.M.A.; Design - A.M.A.; Supervision - A.M.A.; Fund - M.A.A.A.; Materials - M.A.A.A.; Data Collection or Processing - M.A.A.A.; Analysis Interpretation

- A.M.A.; Literature Review - A.M.A.; Writing - A.M.A.; Critical Review - M.A.A.A.

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