Available Online at EScience Press
Plant Protection
ISSN: 2617-1287 (Online), 2617-1279 (Print)
http://esciencepress.net/journals/PP

DIVERSITY AND DISTRIBUTION OF HEMIPTERAN SPECIES ASSOCIATED WITH CROP ECOSYSTEMS IN NORTHWEST MOROCCO

[a]Hanae El Harche, [a]Dalale Mansouri, [a]Samiha Kaioua, [b]Guy Chavanon
[a] *University Ibn Tofail, Faculty of Sciences, Department of Biology, Laboratory of Plant, Animal and Agro-Industry Productions, Kenitra, Morocco.*
[b] *University Mohamed First, Faculty of Sciences, Department of Biology, Oujda, Morocco.*

ARTICLE INFO

Article history
Received: 17th September, 2023
Revised: 3rd November, 2023
Accepted: 8th November, 2023

Keywords
Bugs
Agroecosystems
Pest
North-West
Morocco

ABSTRACT

Agriculture plays a crucial role in Morocco, as it not only contributes significantly to the economy but also enhances food security. Within the realm of agriculture, the order Hemiptera encompasses a diverse range of species and behaviors, some of which are notorious for wreaking havoc on crops worldwide. By gaining a deeper understanding of the bugs associated with agroecosystems, we can effectively identify both pests and beneficial species, thereby improving agricultural production. The findings of our study hold immense importance in implementing effective control measures. This paper aims to present a comprehensive checklist of bugs associated with agroecosystems in the north-west region of Morocco. Our study was conducted between the spring and summer of 2019 and 2020, encompassing three different crop fields that represent the major plant formations of the area, namely cereal, broad bean, and alfalfa fields. To ensure a thorough examination, we employed two distinct sampling techniques: mowing net and sight hunting. A total of 6 families of Hemiptera were identified: Reduviidae, Lygaeidae, Pentatomidae, Cercopidae, Scutelleridae, and Alydidae. The information presented in this paper serves as a valuable resource for future studies on Hemiptera associated with agroecosystems in Morocco. By harnessing this data, we can delve into the realm of potential control strategies and craft effective measures to tackle the challenges presented by these insects. This deeper understanding of the bugs within agroecosystems will serve as a catalyst for the development of sustainable and highly productive agricultural practices in Morocco.

Corresponding Author: Hanae El Harche
Email: hanae.elharche@yahoo.com
© 2023 EScience Press. All rights reserved.

INTRODUCTION

In Morocco, agricultural activity represents one of the main pillars of the country's economy (Saidi and Diouri, 2017) with a production value of 10 billion MAD (Moroccan Dirhams). It is the first sector of the domestic industry and one of the best development strengths of the country. Morocco has around 30 million hectares of agricultural land area, this sector provides an important source of foreign currency per year and generates significant effects in employment through the creation of job (43%), particularly in rural areas where agriculture is the main employer (78%) and source of income (15 million farmers) (Saidi and Diouri, 2017). In Sidi Kacem region, agriculture plays an important role, because of the strategic location of the city close to the major towns (Fez, Meknes, Kenitra and Rabat). The study area is covered within a radius of 16 kilometers by cultivated land (70%) and pasture (11%). The majority of the

vegetation landscape of the territory is made up of cultivated land including cereal crops such as durum wheat (*Triticum turgidum* L. subsp*. durum* (Desf.) Husn., 1899), soft wheat (*Triticum aestivum* L., 1753), barley (*Hordeum vulgare* L., 1753) and corn (*Zea mays* L., 1753, or *Zea mays* subsp. *mays* L., 1753). Other crops include alfalfa (*Medicago sativa* L., 1753) (Fabaceae), leguminous crops: fava beans (*Vicia faba* L., 1753), chickpeas (*Cicer arietinum* L., 1753) and tree crops such as citrus. We also note market gardening crops such as: tomatoes, onions, artichokes, watermelons. In order to protect this sector, productivity must be further encouraged, and production must be continually improved. However, a few obstacles could hinder the growth and productivity of this industry. One of these elements is the pest, which poses major issues with production. Agroecosystems in Morocco are plagued by a variety of insects, especially those belonging to the hemipteran order, which have a negative impact on the quality and quantity of the fields by destroying plants. The order Hemiptera comprehends several species that are pests in agriculture (Quirós et al., 2009). Reasoning the hemipteran combat is required to contain this issue. Only complete knowledge of the entomofauna related to the fields, particularly those with high negative impact, can make this possible.

Heteroptera constitute a significant portion of the global insect fauna in many crops, primarily due to their abundance rather than biomass. In Morocco, various pests have been documented, some of which can inflict severe damage. Studies on insect pests have been conducted throughout the country, particularly focusing on those belonging to the hemipteran order. Notably, research has been carried out in Kenitra, Sidi-Slimane, Sidi-Kacem, Meknes, and the Settat region (Boujaouâne) on *Medicago sativa*, targeting bugs of the genus *Lygus* spp. (Hemiptera: Miridae) (Coutinot et al., 2008). In the North-West of Marrakech, Bouharroud et al. (2016) and El Aalaoui et al. (2019) examined the primary pest of the cactus *Opuntia ficusindica* (Hemiptera: Dactylopiidae). Near Essaouira, in the west of Morocco, studies focused on *Saissetia oleae* (Hemiptera, Coccidae), a pest affecting olive trees (Ouguas and Chemseddine, 2011). Smaili et al. (2020) investigated the cottony cushion scale (*Icerya purchasi*) (Hemiptera: Monophlebidae) in association with citrus orchards. In the Gharb area, research addressed several aphid species (Hemiptera, Aphididae) attacking citrus orchards, including *Toxoptera aurantii*, *Aphis spiraecola*, *A. gossypii*, *Myzus persicae*, *A. fabae*, *A. craccivora*, and *Toxoptera aurantii* (Benziane et al., 2001; Smaili et al., 2001, 2009).

The purpose of this study was to address the gaps in our knowledge regarding insect populations in unexplored regions associated with agricultural crops. Our aim was to shed light on the ecological roles of these insects and their potential impact on agroecosystems. To achieve this, we conducted extensive field surveys, collecting specimens from various agricultural sites across the north-western region of Morocco. The resulting catalog from this study represents a significant milestone for entomologists and researchers interested in the insect fauna of Morocco. It offers a comprehensive overview of the hemipteran species that are associated with agricultural crops in this specific region. By documenting their presence and distribution patterns, it provides valuable insights into the diversity and abundance of these insects.

Moreover, this study not only fills the gaps in our understanding of insect populations in unexplored regions but also provides a valuable resource for researchers and professionals in the field. By elucidating the ecological roles and potential impact of these insects, we can work towards sustainable agricultural practices and ensure the success of crop production in Morocco.

MATERIALS AND METHODS

Study area

The study was carried out in three different fields at the region of Sidi Kacem (34°13’00” N, 5°42’00” E) in northwest Morocco (Figure 1). **Station 1**: 34°12’35” N – 5°42’31” E. It is a field of *Vicia faba* L. beans (Fabaceae). **Station** 2: 34°14’41” N – 5°42’14” E. This is a field of cereal crops: soft wheat: *Triticum aestivum* L. (Poaceae). **Station 3:** 34°15’19” N – 5°44’01” E. This is an alfalfa *Medicago sativa* L. (Fabaceae) field and a wasteland dominated mainly by *Dittrichia viscosa* L (Asteraceae). The region experiences a semi-arid climate characterized by moderate winters and hot, dry summers. During autumn, the minimum temperature drops to 6°C, while in summer, the mercury soars above 40°C. Precipitation primarily occurs from the end of September until the last day of May.

Sampling

The field surveys conducted between the spring and summer of 2019 and 2020 had a primary objective of gathering comprehensive data on the hemipteran fauna, a

diverse group of insects. To ensure a thorough sample collection, we meticulously employed two distinct sampling techniques. The first technique involved the use of a mowing net, which was carefully swept across the vegetation to capture flying or hopping hemipteran species. This method enabled us to collect a wide range of specimens residing in various plant species and habitats. The second technique employed was sight hunting, which entailed visually searching for hemipteran species in their natural habitats. This method proved particularly valuable in capturing elusive or cryptic species that cannot be easily caught using nets.

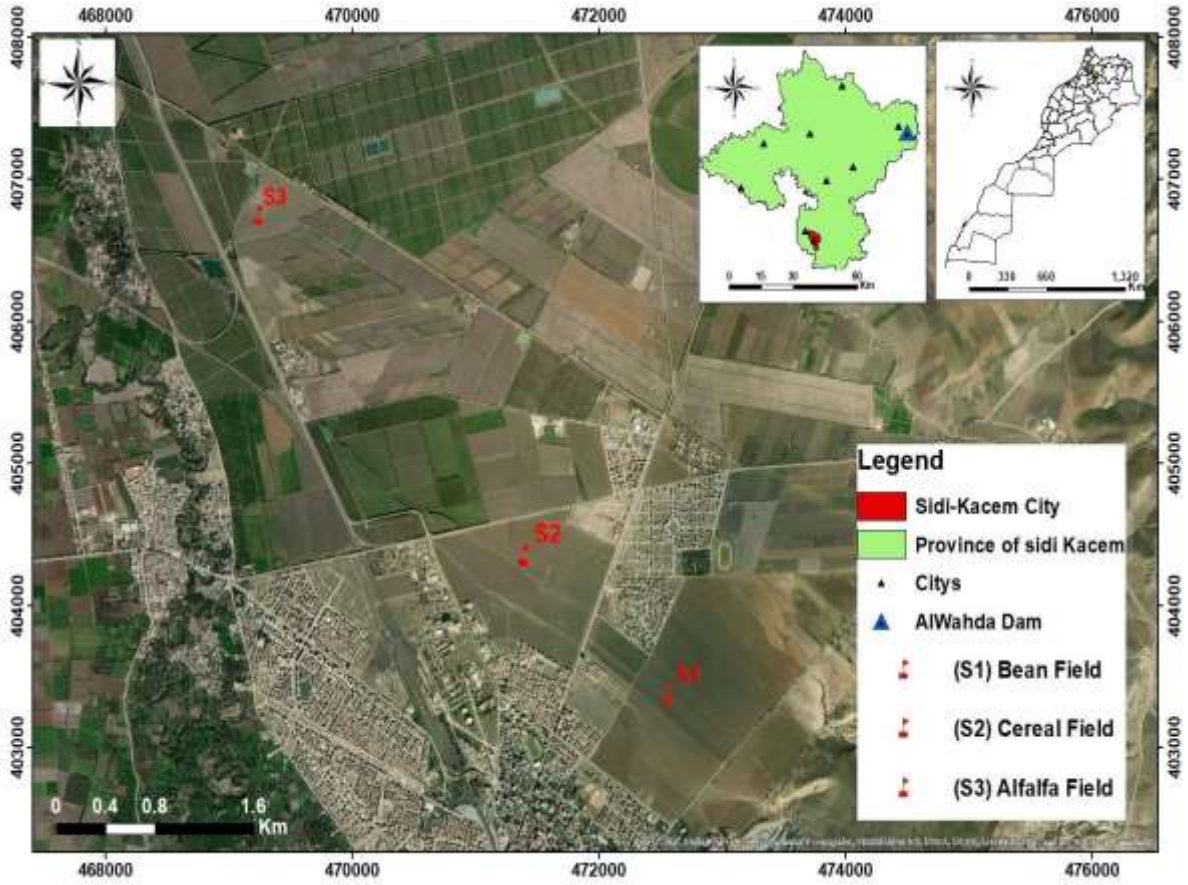

Figure 1: Geographic location of the study area and the sampling stations.

These field surveys were conducted with utmost precision and attention to detail, ensuring the accuracy and reliability of the data collected. The use of the mowing net allowed us to capture hemipteran species that were in flight or hopping, providing a comprehensive understanding of their distribution across different plant species and habitats. Additionally, the sight hunting technique proved to be an effective approach for identifying and capturing species that are adept at hiding or blending into their surroundings.

By employing these two complementary techniques, we were able to overcome the limitations of each method and obtain a more holistic view of the hemipteran fauna in the study area. This comprehensive data will serve as a valuable resource for further research and conservation efforts aimed at understanding and protecting these diverse insect species. The resulting data provides a more complete representation of the hemipteran fauna in the study area.

Reference literature and treated species selection

The species were identified based on their external morphological characteristics, including the shape and ornamentation of the pronotum, head, and wing venation. These characteristics were carefully observed using a binocular magnifier with a maximum magnification of ×35. The external morphological characteristics observed through the binocular magnifier provided initial identification, but to confirm

the taxonomic classification, we referred to various keys authored by renowned researchers in the field. The keys mentioned, including those by Moulet (1995), Pericard (1998), Derreumaux (2012), and Weirauch (2014), are widely recognized and trusted resources in entomology. These keys likely contain detailed descriptions, illustrations, and diagnostic features that aid in accurate species identification.

RESULTS

The Hemiptera checklist is meticulously organized in a hierarchical structure, encompassing order, suborder, family, subfamily, genus, and species levels. This systematic arrangement facilitates the organization and identification of the various species encountered during our investigation, ensuring accurate classification.

Throughout our investigation, we had the opportunity to study six distinct families: Reduviidae, commonly known as assassin bugs, Lygaeidae, referred to as seed bugs, Pentatomidae, recognized as stink bugs, Cercopidae, known as spittlebugs, and Scutelleridae, identified as shield bugs.

By employing this comprehensive classification system, we were able to effectively categorize and differentiate these families, enabling a more precise understanding of their characteristics and behaviors. This meticulous approach not only enhances the professionalism of our research but also contributes to a more comprehensive and insightful analysis of the Hemiptera species.

Taxonomic hierarchy

Order : Hemiptera

Suborder : Heteroptera Latreille, 1810

Family : Reduviidae Latreille, 1807

Subfamily: Peiratinae Amyot and Serville, 1843

Genus : *Peirates* Serville, 1831

1. *Peirates stridulus* (Fabricius, 1787)

Collection data

One specimen collected from Station 2, *Triticum aestivum* L, (Poaceae). Measurements: L (length) = 12 mm, 34°14’41” N, 5°42’14” E on 10th Jun, 2020.

Distribution in Morocco

In a large part of Morocco, this species is mentioned in particular from Oujda and the Berkane region (Vidal, 1937) and from the daya of Dar Bouazza (Joseph-Edouard, 2019).

Distribution outside Morocco

This is a Western Mediterranean species (Dursun and Salur, 2013).

Ecological notes

The species is a well-known predator and feeds mainly on other heteropterans. It is a species that is regarded as useful in biological control (Amokrane, 2020).

Subfamily: Harpactorinae Amyot and Serville, 1843

Genus: *Rhynocoris* Hahn, 1833

2. *Rhynocoris erythropus* (Linnaeus, 1767)

Collection data

Fourteen specimens were collected at Station 3, consisting of ten species on *Medicago sativa* L. (Fabaceae) and four specimens from *Dittrichia viscosa* L. (Asteraceae). Measurements: L (length) = 13 mm, 34°1519 N, 5°4401 E, on August 15th, 2020.

Distribution in Morocco

Common throughout Morocco, this species was recorded, in particular, in north-eastern region (Oujda, Taforalt, Berkane) (Vidal, 1937), in Fes (Oulad Hamid), Taza (Ajdir, Jbel Kouime), Tetuan (Tarehra), Nador (Kariet Arekmane) and Mamora forest (Dethier and Wahis, 1997), in the Middle Atlas associated with the holm oak tree (Arahou, 2008) and also in the daya of Dar Bouazza (Joseph-Edouard, 2019).

Distribution outside Morocco

This is a Western Mediterranean species (Baena, 2011; Dursun and Salur, 2013).

Ecological notes

Rhynocoris erythropus can be found in herbaceous vegetation and shrubs hunting on several insects: aphids, bugs, flies, beetles, bees and other Hymenoptera. Also, *R. erythropus* may be observed feeding on larvae and adults of several phytophagous insects (Baena, 2011), which allows him to be considered as useful in biological control for some field pest.

Family: Alydidae Amyot and Audinet-Serville, 1843

Subfamily: Alydinae Amyot and Audinet-Serville, 1843

Genus: *Camptopus* Amyot, 1843

3. *Camptopus lateralis* (Germar, 1817)

Collection data

Five specimens collected in station 2, *Triticum aestivum* L, (Poaceae), Measures: L (length) = 11-13.5 mm, 34°14'41" N, 5°42'14" E; Three specimens on May 25, 2019 and two specimens on June 12, 2020.

Host plants

On various plants like**:** *Astragalus* sp., *Sambucus nigra* (Dursun et al., 2010).

Distribution in Morocco

Recorded in Oujda (Debdou) (Dethier and Wahis, 1997)**,**

in the Middle Atlas (Ifrane) and High Atlas (Marrakech and Amizmiz) (Arahou, 2008), in North-Eastern region (Oujda, Ahfir, Taforalt and Berkane) (Vidal, 1937) and in the daya of Dar Bouazza (Joseph-Edouard, 2019).

Distribution outside Morocco

This is a Palaearctic species (Dursun et al., 2010; Kment et al., 2013).

Ecological notes

This is a phytophagous species. Larvae and adults feed by biting the plants to take their juice.

Family: Lygaeidae

Subfamily: Lygaeinae Schilling, 1829

Genus: *Lygaeus* Fabricius, 1794

4. *Lygaeus equestris* (Linnaeus, 1758)

Collection data

Thirteen specimens collected in station 2, *Triticum aestivum* L, (Poaceae), Measures: L (length)= 8-13mm, 34°14'41" N, 5°42'14" E; Ten specimens on July 10, 2019 and Three specimens on August 12, 2020. Eleven specimens collected at station 1, beans *Vicia faba* L. (Fabaceae), Measures: L (length)= 7.5-12 mm, 34°12'35" N, 5°42'31" E; Six specimens on May 20, 2019 and Five specimens on June 25, 2020.

Host plants

Frequent in plants of the families Apocynaceae, Ranunculaceae, Asteraceae, Fabaceae like: *Vincetoxicum hirundinaria, Taraxacum* sp*., Adonis* sp*., Artemisia* sp., *Astragalus mareoticus, Dorycnium* sp*., Nerium oleander, Medicago* sp., *Trifolium* sp., *Cannabis* sp*.., Cynanchum* sp., and *Gossypium* sp. (Malenovský et al., 2011; Matocq et al., 2014; Yazici et al., 2015).

Distribution in Morocco

Mentioned in particular from Tetuan and Larache (bord oued Sakh-Sock) (Dethier and Wahis, 1997), from the Middle Atlas (Azrou), the High Atlas (Asni), the Rif (Tizi-Ifri) and the North-Eastern region (Oujda, Berkane) (Arahou, 2008).

Distribution outside Morocco

This is a Palaearctic species (Péricart, 2001; Arahou, 2008; Linnavuori, 2011).

Ecological notes

The species is a seed predator, it can, also, feeds on other plant parts, such as stems and leaves (Laukkanen et al., 2018). It can cause a rolling or a wilting of the plant by their feeding. They are most often pests of crop plants (Triplehorn, 2005; Amokrane, 2020).

Family: Pentatomidae

Subfamily: Pentatominae Leach, 1815

Genus: *Piezodorus* Fieber, 1860

5. *Piezodorus lituratus* (Fabricius, 1794)

Collection data

One specimen collected from Station 2, *Triticum aestivum* L, (Poaceae). Measurements: L (length) = 10 mm, 34°14'41" N, 5°42'14" E on 15th Mai, 2019.

Host plants

Vicia ervilia., *Medicago sativa.*, *Lens culinaris*, *Trifolium repens, Trifolium fragiferum, Trifolim pratense, Morus alba, Morus nigra, Prunus armeniaca* (Gözüaçık et al., 2011).

Distribution in Morocco

Widely distributed in almost all the country except the arid regions (Arahou, 2008).

Distribution outside Morocco

This is a Western Palaearctic species (Mutlu et al., 2020).

Ecological notes

This is a phytophagous species. *Piezodorus lituratus* can cause a serious problem and plant damage causes significant losses to productivity (Mutlu et al., 2018; Abdulla et al., 2019). Its rostrum allows it to pierce the epidermis and to take the substances necessary for its development. Growth delay, leaf wilting, fruit deformations are commonly observed damages.

Genus: *Dolycoris* Mulsant and Rey, 1866

6. *Dolycoris numidicus* (Horváth, 1908)

Collection data

One specimen collected from Station 2, *Triticum aestivum* L, (Poaceae). Measurements: L (length) = 9-12 mm, 34°14'41" N, 5°42'14" E on 25th Mai, 2019.

Host plants

This genus is found on *Triticum* sp., *Onopordon* sp., *Trifolium repens, Trifolium fragiferum., Trifolim pratense., Medicago sativa*, *Sesamum indicum*., *Helianthus annuus* (Fent and Aktaç, 1999), *Brassica napus*., *Sinapsis arvensis, Vicia ervilia.*, *Sisymbrium officinale.*, *Lens culinaris., Onopordum macracanthum.*, *Silene colorata* (Gözüaçık et al., 2011).

Distribution in Morocco

Common everywhere.

Distribution outside Morocco

Canary Islands (Heiss and Báez, 1990), Ibero-Maghrebian species, located in North Africa and Southern Spain (Dethier and Wahis, 1997).

Ecological notes

This polyphagous genus causes economic damage in wheat fields, in addition to infect about 50 species of plants, they are well-known for their ability to produce

strong smelling noxious secretions from the thoracic glands in the adults and the abdominal glands in the nymphs (Nakamura and Numata, 2006; Mohammed et al., 2017; Abdulla et al., 2019).

Genus: *Carpocoris* Kolaneti, 1846

7. *Carpocoris fuscispinus* (Boheman, 1850)

Collection data

One specimen collected from Station 3, *Medicago sativa* L. (Fabaceae), Measurements: L (length) = 10-14,5mm, 34°15'19" N, 5°44'01 on 15th July, 2020.

Host plants

This genus is found on *Capparis spinosa., Carduus* sp., *Centaurea* sp., *Cirsium* sp., *Triticum* sp*., Medicago sativa., Onopordum macracanthum*, *Lens culinaris* (Gözüaçık et al., 2011; Bolu, 2020).

Distribution in Morocco

Common in the northern provinces (Arahou, 2008).

Distribution outside Morocco

This is a Palaearctic species (Arahou, 2008).

Ecological notes

This genus is a phytophagous species; they are one of the most destructive wheat pests (Durak and Kalender, 2012). Their piercing-sucking mouthparts allow these insects to empty the maturing seeds (Zollinger et al., 2021).

Genus: *Aelia* Fabricius, 1803

8. *Aelia acuminata* (Linnaeus, 1758)

Collection data

One specimen collected from Station 2, *Triticum aestivum* L, (Poaceae), Measurements: L (length) = 7 mm, 34°14'41" N, 5°42'14" E on 20th Mai, 2019. Two specimens collected from Station 1, *Vicia faba* L. beans (Fabaceae), Measurements: L (length) = 7- 8.5mm, 34°12'35" N, 5°42'31" E on 10th July, 2019.

Host plants

Triticum sp., *Hordeum vulgare.*, *Aegilops* sp., *Alopecurus* sp., *Avena sterilis*., *Bromus* sp., *Lolium rigidum*, *Oryza sativa.*, *Phalaris* sp., *Poa annua* L (Gözüaçık et al., 2011; Matocq et al., 2014).

Distribution in Morocco

Reported from north-east of Morocco (Oujda, Taforalt, Berkane) and from Kénitra by Vidal (1937), from the region of Tiflet, Itzer, Timahdit, Oulmes, Fès and the plain of Meknes by Voegelé (1969).

Distribution outside Morocco

This is a Euro-Siberian species (Ghahari et al., 2014; Medetov et al., 2021).

Ecological notes

Oligophagous pests of cereals. *Aelia acuminata* is a plague for agriculture by causing considerable damage to wheat at vegetative growth stage and grain (Mohaghegh Neyshaboori, 2013).

Family: Scutelleridae Leach, 1815

Subfamily: Eurygastrinae Amyot and Serville 1843

Genus: *Eurygaster* Laporte de Castelnau, 1833

9. *Eurygaster austriaca* (Schrank, 1776)

Collection data

Five specimens collected in station 2, *Triticum aestivum* L, (Poaceae), Measures: L (length) = 8-11 mm, 34°14'41" N, 5°42'14" E; Three specimens on May 25, 2019 and two specimens on May 12, 2020.

Host plants

Triticum turgidum subsp. *Durum*, *Triticum aestivum.*, *Hordeum vulgare., Avena sativa.*, *Verbascum longirostris* (Gözüaçık and Fent, 2012; Bolu, 2020).

Distribution in Morocco

The species is very common in the Northern provinces. It has been mentioned, in particular, from eastern Morocco (Vidal, 1937) and found in cereal fields or in the foliage of *Quercus ilex.*, in Azrou and Jaâba (Arahou, 2008).

Distribution outside Morocco

This is a Palaearctic species (Rieger, 2011).

Ecological notes

This is a phytophagous species. Nymphs and adults of this species have been linked to plant damage, as they feed on leaves, stems, and grains of cereals (Tarla et al., 2015).

Suborder: Cicadomorpha Evans, 1946

Family: Cercopidae Leach, 1815

Subfamily: Cercopinae Leach, 1815

Genus: *Cercopis* Fabricius, 1775

10. *Cercopis intermedia* (Kirschbaum, 1868)

Collection data

Four specimens collected from Station 2, *Triticum aestivum* L, (Poaceae), Measurements: L (length) = 8-11mm, 34°14'41" N, 5°42'14" E on 20th Jun, 2019 and 30th Jun, 2020. Two specimens collected from Station 1, *Vicia faba* L. beans (Fabaceae), Measurements: L (length) = 8.5-10.5mm, 34°12'35" N, 5°42'31" E on 25th July, 2019 and 12th Mai, 2020.

Host plants

Frequent in plants of the families Compositae, Dipsacaeae and Leguminosae and specifically in the species: *Crepis vesicaria*., *Salvia taraxacifolia., Sixalix atropurpurea* subsp., *Medicago* sp. (Navarro-Campos et

al., 2018).

Distribution in Morocco

Its distribution must be completed. Mentioned from around (High Atlas), Tiflet, the region of Oulmès, El Ksiba (Middle Atlas) and Aït Melloul by Lindberg (1964) and from surroundings of Azilal (High Atlas) by Nast (1972).

Distribution outside Morocco

This is a Palaearctic species (Demirel and Dinç, 2021).

Ecological notes

This is a plant-sap sucking species feed on leaves or stems of a wide variety of plants including open fields in forests, grasses and fruit tree. They can cause economic damage in fields because they cause plant dwarf and reducing stalk productivity (Hamad et al., 2020).

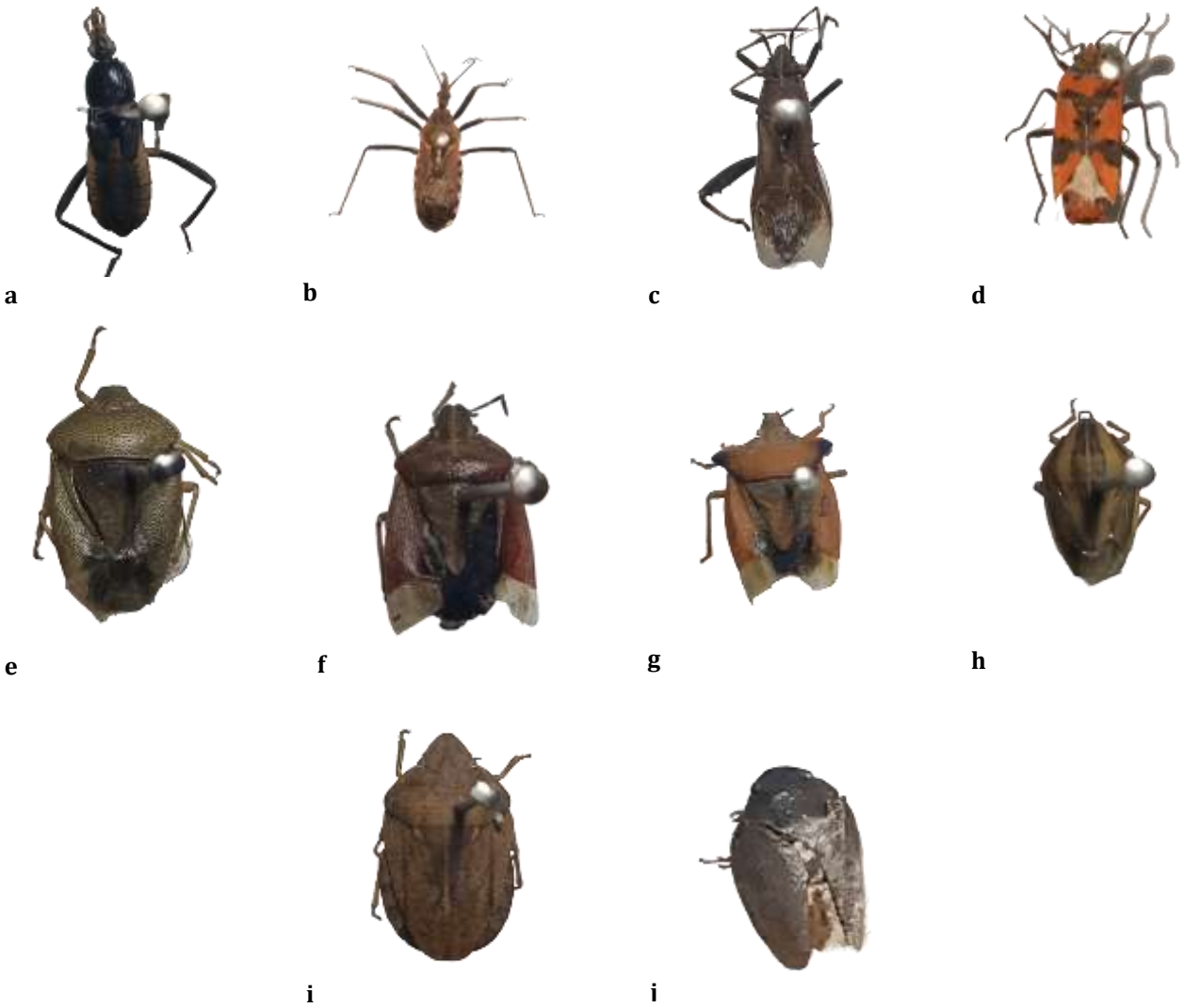

Figure 2: Bugs species, dorsal view. A) *Peirates stridulus*, B) *Rhynocoris erythropus*, C) *Camptopus lateralis*, D) *Lygaeus equestris*, E) *Piezodorus lituratus*, F) *Dolycoris numidicus*, G) *Carpocoris fuscispinus*, H) *Aelia acuminata*, I) *Eurygaster austriaca*, J) *Cercopis intermedia*.

DISCUSSION

This investigation significantly contributes to the understanding of the insect fauna in Morocco. Specifically, it sheds light on the bug families of Reduviidae, Lygaeidae, Pentatomidae, Cercopidae, Scutelleridae, and Alydidae, which have been the least studied in Morocco's agroecosystems. Within these families, a total of four species from Pentatomidae, two

species from Reduviidae, and one species each from Lygaeidae, Scutelleridae, Cercopidae, and Alydidae have been documented. It is worth noting that many insects belonging to the Pentatomidae and Scutelleridae families are considered agricultural pests due to their ability to rapidly reproduce and form large populations that feed on crops. This poses a significant threat to agricultural productivity. Furthermore, some of these pests have developed resistance to various insecticides, further complicating pest management efforts (Ghahari et al., 2014). By expanding our knowledge of these bug families and their association with agroecosystems, this study provides valuable insights for pest control strategies and agricultural management in Morocco. Understanding the behavior, distribution, and potential resistance of these insects is crucial for developing effective and sustainable pest management practices.

Among the species studied, *Dolycoris numidicus*, *Carpocoris fuscispinus, Aelia acuminata,* and *Eurygaster austriaca* emerge as significant pests of cereals, particularly wheat, during both the vegetative growth stage and grain development (Schaefer and Kotulski, 2000). Additionally, *Piezodorus lituratus, Lygaeus equestris, Cercopis intermedia*, and *Dolycoris numidicum* are recognized as major pests of alfalfa (*Medicago sativa*). On the other hand, *Rhynocoris erythropus* and *Peirates stridulus*, known for their predatory behavior towards various insects, prove highly beneficial due to their efficient control of insect pests. By conserving these natural enemies within agroecosystems, the effectiveness of the aforementioned species can be significantly enhanced.

The current inventory of insects offers an initial glimpse into the heteropteran fauna found in the north-west region of Morocco. This fauna is primarily composed of five distinct geographical divisions that can be identified for the hemipterans collected from the Sidi Kacem area (Figure 3). Palaearctic chorotype species, accounting for 50% of all recorded species, exhibit a slight dominance, followed by the western Mediterranean at 20%, and finally the ibero-Maghrebian, euro-Siberian, and western palaearctic regions (each at 10%). This investigation significantly contributes to expanding the known distribution of bug species.

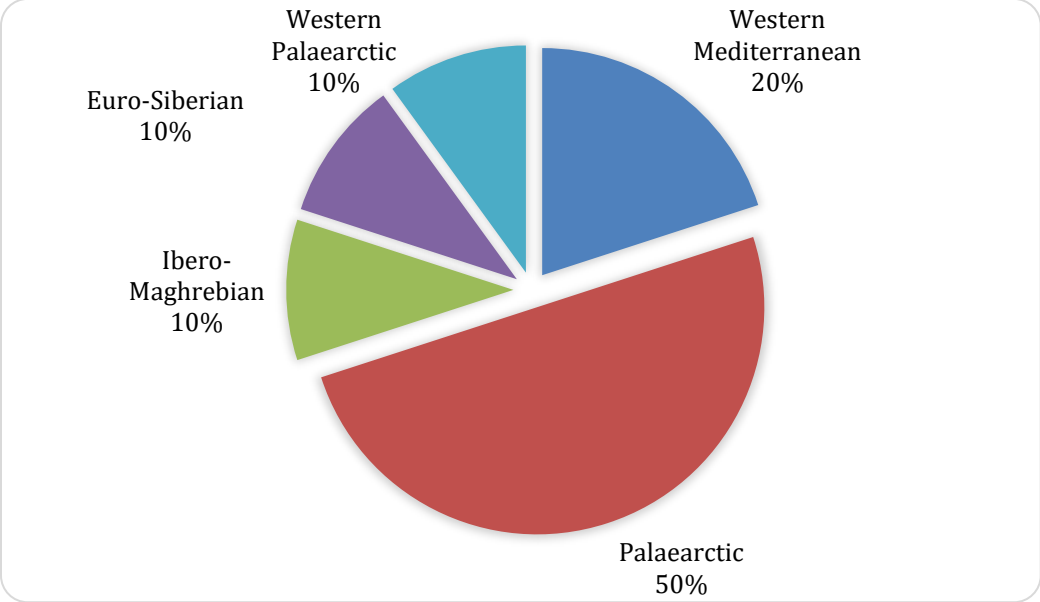

Figure 3: Main chorological categories of the studied species.

Furthermore, this study serves as a valuable contribution to the understanding of bug ecology, faunistics, and distribution in Morocco. It highlights that despite the increasing number of studies on this insect group, there are still unrecorded genera and species in Morocco. Consequently, this research provides crucial information for future studies on Hemiptera associated with agroecosystems in northwest Morocco. It is imperative to encourage further research in order to explore potential control strategies and safeguard this sector. The findings of this study hold immense significance for pest control strategies in the region. By

identifying the various pests associated with agrosystems, we acquire valuable insights into the development of targeted and highly effective control measures. Understanding the behavioral patterns and preferences of these pests empowers us to design more efficient traps and attractants, thereby reducing pest populations and minimizing the need for broad-spectrum insecticides. Moreover, this research provides a comprehensive inventory of the diverse pests linked to agroecosystems, thereby opening up new avenues for sustainable pest management. Furthermore, by enhancing our understanding of local pest dynamics through this study, we can formulate region-specific plans that address the unique challenges faced by farmers and landowners in a cost-effective manner. These results pave the way for innovative pest management strategies that significantly enhance efficiency and productivity. In conclusion, the implications of this study are far-reaching, revolutionizing the field of pest control. The knowledge gained from identifying of pests associated with agrosystems enables the development of targeted and efficient control measures. This research not only provides a valuable inventory of pests but also opens up new possibilities for sustainable pest management. By utilizing these findings, we can adopt a more precise and environmentally-friendly approach to pest control, minimizing the negative impact on natural ecosystems while preserving agricultural yields.

AUTHORS' CONTRIBUTION

EH conducted the surveys, collected the specimens of different bugs species, identified the species and wrote the results and the manuscript; MD, KS helped in data collection; GC reviewed the manuscript. All the authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

REFERENCES

Abdulla, B.S., Moulod, N.A., Mohammed, A.M.A., 2019. Some biological aspects of *Carpocoris coreanus* Distant (Hemiptera, Pentatomidae) In Kurdistan Region-Iraq. Zanco Journal of Pure and Applied Sciences 31(2), 79-88. doi, 10.21271/zjpas.31.2.11.

Amokrane, A., 2020. Bioecological study of the entomological complex related to cereal crops cereal crops in the region of Oum El Bouaghi. PhD. University of Larbi Ben M'Hidi. Algeria.

Arahou, M., 2008. Catalogue de l'entomofaune du Chêne vert du Moyen Atlas (Maroc). Documents de l'Institut Scientifique. Rabat. n° 22.

Baena, M., 2011. Unusual Feeding Habits in Four Iberian Heteroptera (Hemiptera). Boletín de la Sociedad Entomológica Aragonesa 48, 399-401.

Benziane, M., Abbassi, M., Jahaj, A., 2001. Comparaison de deux méthodes de lutte intégrée contre les principaux ravageurs associés aux agrumes dans la région du Gharb. In, AMPP (ed.). Proceeding du Symposium sur « la Protection intégrée des cultures dans la région méditerranéenne ». Rabat. 29-31 Mai 2001: pp 257-269.

Bolu, H., 2020. Southeastern Anatolia region insect fauna 2 (order Hemiptera 1, suborder Heteroptera: Pentatomoidea) of Turkey. Journal of the Heteroptera of Turkey 2, 81-101.

Bouharroud, R., Amarraque, A., Qessaoui, R., 2016. First report of the *Opuntia* cochineal scale *Dactylopius opuntiae* (Hemiptera: Dactylopiidae) in Morocco. Bull OEPP 46, 308-310. https,//doi.org/10.1111/epp.12298.

Coutinot, D., Bon, M.C., Arahou, M., Taleb, A., Matocq, A. 2008. Explorations en Europe et en Afrique du Nord pour la recherche de nouvelles populations du genre *Peristenus* (Hymenoptera: Braconidae) pour la lutte biologique contre *Lygus Spp*. (Hemiptera: Miridae) en Amerique du Nord. Annals of the 8th International Conference on Pests in Agriculture. Montpellier. October 22-23.

Demirel, E., Dinç, H., 2021. *Cercopis sanguinolenta* (Scopoli, 1763) (Hemiptera, Auchenorrhyncha, Cercopidae) redescription of rare *Cercopis* Fabricius, 1775 species from Turkey. Turkiye Entomoloji Dergisi 45(1), 99-114.

Derreumaux, V., 2012. Les punaises Pentatomidae vertes de France. Clé photographique simplifiée. 22 pp.

Dethier, M., Wahis, R., 1997. Hétéroptères récoltés au Maroc (Mission Calypso 1994 et 1995). Lyon Bulletins mensuels Sommaires - Société linnéenne de Lyon 66(5), 135-140.

Durak, D., Kalender, Y., 2012. Structure and chemical analysis of the metathoracic scent glands of *Carpocoris fuscispinus* (Boheman, 1851) (Heteroptera: Pentatomidae) from Turkey.

Turkish Journal of Zoology 36 (4), 526-533. https,//doi.org/10.3906/zoo-1105-7

Dursun, A., Salur, A., 2013. Presence of *Sphedanolestes sanguineus* (Fabricius, 1794) in Turkey followed by an annotated checklist of Reduviidae (Hemiptera: Heteroptera). Turkiye Entomoloji Dergisi 37, 610-620. https,//doi.org/10.3906/zoo-1203-17.

Dursun, A., Kaçar, G., Ulusoy, M.R., 2010. The Alydidae (Hemiptera, Heteroptera, Coreoidea) of Turkey, a key to the genera. new records and a species checklist. Entomological News 121(5), 487-497.

El Aalaoui, M., Bouharroud, R., Sbaghi, M., El Bouhssini, M., Hilali, L., Dari, N., 2019. Ennemis naturels associés à *Dactylopius opuntiae* (Cockerell) (Hemiptera, Dactylopiidae) au Maroc et leurs fluctuations démographiques. Revue Marocaine des Sciences Agronomiques et Vétérinaires 7(3), 391-396.

Fent, M., Aktaç, N., 1999. Edirne Yöresi Pentatomidae (Heteroptera) Faunası Üzerine Taksonomik ve Faunistik Araştırmalar. Turkish Journal of Zoology 23(2), 377-395.

Gözüaçık, C., Fent, M., İnanç Ö., 2011. Güneydoğu Anadolu Bölgesi Pentatomidae (Hemiptera: Heteroptera) Faunasına Katkılar. Turkish Bulletin of Entomology 1(4), 235-252.

Gözüaçık, C., Fent, M., 2012. Güneydoğu Anadolu Bölgesi'nde Scutelleridae (Hemiptera) Faunası Üzerinde Araştırmalar. Bitki Koruma Bülteni 52(4), 313- 323.

Ghahari, H., Moulet, P., Rider, D.A., 2014. An annotated catalog of the Iranian Pentatomoidea (Hemiptera, Heteroptera, Pentatomomorpha). Zootaxa 3837(1), 1-95.

Hamad, M.I., Mawlood, N.A., Khidhir, A.Q.S., 2020. Redescription of Froghoppers. *Cercopis intermedia* Kirschbaum 1868 (Homoptera, Cercopidae) from Erbil Governorate Kurdistan Region–Iraq. Zanco Journal of Pure and Applied Sciences 32(6), 116-122. doi, 10.21271/ZJPAS.32.6.13.

Heiss, E., Báez, M., 1990. A preliminar catalog of the heteroptera of the Canary Islands. Vieraea 18, 281-315.

Joseph-Edouard, J.P., 2019. Arthropods of the daya of Dar Bouazza. Bilan 2018. Report of the ornithology group of Morocco GOMAC. 1-40 pp.

Kment, P., Hradil, K., Baňař, P., Balvín, O., Cunev, J., Ditrich, T., Jindra, Z., Roháčová, M., Straka, M. R., Sychra, J., 2013. New and interesting records of true bugs (Hemiptera, Heteroptera) from the Czech Republic and Slovakia V. Acta Musei Moraviae. Scientiae Biologicae 98(2), 495-541.

Laukkanen, L., Kalske, A., Muola, A., Leimu, R., Mutikainen, P., 2018. Genetic drift precluded adaptation of an insect seed predator to a novel host plant in a long-term selection experiment. PLoS ONE 13 (6), e0198869.

Lindberg, H., 1964. Zur Kenntnis der Zikanenfauna von Marokko II. Neotropical Entomology 44, 53-70.

Linnavuori, R.E., 2011. Studies on the Cimicomorpha and Pentatomomorpha (Hemiptera, Heteroptera) of Khuzestan and the adjacent provinces of Iran. Acta Entomologica Musei Nationalis Pragae 51(1), 21-48.

Malenovský, I., Baňař, P., Kment, O., 2011. A contribution to the faunistics of the Hemiptera (Cicadomorpha, Fulgoromorpha, Heteroptera and Psylloidea) associated with dry grassland sites in southern Moravia (Czech Republic). Acta Musei Moraviae Scientiae Biologicae 96(1), 41-187.

Matocq, A., Pluot-Sigwalt, D., Özgen, İ., 2014. Terrestrial Hemiptera (Heteroptera) collected in South-East Anatolia (Diyarbakır. Mardin and Elazığ Provinces) (Turkey). Munis Entomology and Zoology Journal 9(2), 884-930.

Medetov, M.J., Musaev, D.M., Abdullaeva, J.K., Reimov, K.D., 2021. Studies on True Bugs (Heteroptera, Cimicomorpha, Pentatomomorpha) on the Ustyurt Plateau in North Western Uzbekistan. Nat Volatiles Essent Oils 8(5), 11837-11868.

Mohammed, A.M.A., Abdulla, B.S., Abdurrahman, N.M., 2017. The Biological study on *Dolycoris baccarum* (Linnaeus) (Heteroptera, Pentatomidae) in Erbil-Kurdistan Region-Iraq. Iraqi Journal of Agricultural Sciences 48 (Special Issue), 144-149.

Mohaghegh Neyshaboori, J., 2013. Biological and reproductive characteristics of spring generation of *Aelia acuminata* L. (Hemiptera, Pentatomidae) in laboratory conditions. Plant Pests Research 3(2), 33-41.

Moulet, P., 1995. Hémiptères Coreoidea Pyrrhocoridae et Stenocephalidae Euro-Méditerranéens. Faune de France (France et Régions Limitrophes). Vol 81. Fédération Française des Sociétés des Science

Naturelles, Paris, 336 pp.

Mutlu, Ç., Buyuk, M., Eren, S., Karaca, V., Duman, M., Bayram, Y., 2018. Management of the Stink Bugs *Dolycoris baccarum* (L.) and *Piezodorus lituratus* (F.) (Hemiptera, Pentatomidae). and Chalky Spot Damage on Red Lentil in Southeast Anatolia Region. Journal of the Kansas Entomological Society 91(1), 40-50.

Mutlu, Ç., Çiftçi, V., Yeken, M.Z., Mamay, M., 2020. The influence of different intensities of chalky spot damage on seed germination, grain yield and economic returns of red lentil. Phytoparasitica 48, 191-202. https,//doi.org/10.1007/s12600-020-00785-9.

Nakamura, K., Numata, H., 2006. Effect of photoperiod and temperature on the induction of adult diapause in *Dolycoris baccarum* (L.) (Heteroptera, Pentatomidae) from Osaka and Hokkaido. Japanese Journal of Applied Entomology and Zoology 41(1),105- 109.

Navarro-Campos, C., Calabuig-Gomar, A., Garcia-Marí, F., Llopis-Raimundo, J.M., Rallo-Blay, E., Pacheco-Vinaroz, B., Dalmau, V., Cubillos-Pérez, D., Ferrer-Matoses, A., Roselló-Pérez, M., Soto, A., 2018. Aspectos de la biología y ecología de vectores potenciales de *Xylella fastidiosa* en almendros del sudeste de la península ibérica. Phytoma-España 304, 33-37

Nast, J., 1972. Palaearctic Auchenorrhyncha (Homoptera). An annotated check list. In, Warszawa. Polish Scientific Publishers, 550 pp.

Ouguas, Y., Chemseddine, M., 2011. Effect of pruning and chemical control on *Saissetia oleae* (Olivier) (Hemiptera. Coccidae) in olives. Fruits 66(3), 225-234. doi,10.1051/fruits/2011029.

Pericard, J., 1998. Euro-Mediterranean Hemiptera Lygaeidae. Faune de France. Vol 84 A. B. C. Fédération française des Sociétés de Sciences Naturelles, Paris, 487 pp.

Péricart, J., 2001. Family Lygaeidae Schilling. 1829 - Seed-bugs. pp. 35-211. In , Aukema B. Rieger C. (editors), Catalogue of the Heteroptera of the Palaearctic Region. Volume 4. Pentatomomorpha I. Published by the Netherland Entomological Society, Amsterdam, 346 pp.

Quirós, D.I., Remaudière, G., Nieto Nafría, J.M., 2009. Contribución al conocimiento de Aphididae y Phylloxeridae (Hemiptera: Sternorrhyncha) de Panamá [Contribution to the knowledge of the Aphididae and Phylloxeridae (Hemiptera: Sternorrhyncha) from Panama]. Neotropical Entomology 38(6), 791-800. Spanish. doi: 10.1590/s1519-566x2009000600013.

Rieger, C.H., 2011. What is *Eurygaster austriaca* seabrai China. 1938 (Hemiptera, Heteroptera, Scutelleridae). Heteropterus Revista de Entomologica 11(2), 339-343.

Saidi, A., Diouri, M., 2017. Food self-sufficiency under the Green-Morocco Plan. Journal of Experimental Biology and Agricultural Sciences 5, 33-40.

Schaefer, C.W., Kotulski, J., 2000. Scentless plant bugs (Rhopalidae). In, Schaefer CW. Panizzi AR (editors), Heteroptera of economic importance. CRC Press. Boca Raton (Florida), 828 pp.

Smaili, C. Afellah, M., Zrida, L. 2001. Contribution à la mise en place d'un système de lutte intégrée sur Clémentinier dans la région du Gharb. In Région Gharb/INRA Kénitra (editors). Proceeding du 1er colloque de l'Agriculture sur « le Développement agricole et recherche agronomique dans la région du Gharb. Bilan et perspective ». Kénitra. 23-24 juillet 2001.

Smaili, M.C., Blenzar, A., Boutaleb, A.J. 2009. Étude prospective de la fondation. de l'immigration et des facteurs de mortalité des colonies de pucerons noirs de l'oranger *Toxoptera aurantii* Boyer de Fonscolombe (Hemiptera, Aphididae) au nord du Gharb. Ecologia Mediterranea 35, 5-18.

Smaili, M., Boutaleb-Joutei, A., Blenzar, A., 2020. Beneficial insect community of Moroccan citrus groves, assessment of their potential to enhance biocontrol services. Egyptian Journal of Biological Pest Control 30(47), 1-15. https,//doi.org/10.1186/s41938-020-00241-0.

Tarla, G., Tarla, Ş., İslamoğlu, M., 2015. First report of Hexamermis sp. (Nematoda, Mermithidae) parasitizing *Eurygaster maura* (Heteroptera, Scutelleridae) in an overwintering Area. Florida Entomologist 98(3), 974-978.

Triplehorn, C.A., 2005. Borror and DeLong's Introduction to the Study of Insects. Belment, 7th edition. Thomson Brooks, Cole, 864 pp .

Vidal, J.P., 1937. Contribution à l'étude des Hémiptères-Hétéroptères du Maroc. Bulletin de la Société d'histoire naturelle de l'Afrique du nord 28(3), 185-208.

Voegelé, J., 1969. Les Aelia du Maroc. Al Awamia 30, 1-135.

Weirauch, C., Bérenger, J., Berniker, L., Forero, D., Forthman, M., Frankenberg, S., Freedman, A., Gordon, E., Hoey-chamberlain, R., Hwang, W., Marshall, S., Michael, A., Paiero, S., Udah, O., Watson, C., Yeo, M., Zhang, G., Zhang, J., 2014 . An Illustrated Identification Key to Assassin Bug Subfamilies and Tribes (Hemiptera, Reduviidae). Canadian Journal of Arthropod Identification 26, 115.

Yazici, G. Yildirim, E., Moulet, P. 2015. Contribution to the knowledge of the Lygaeoidea (Hemiptera. Heteroptera) fauna of Turkey. Linzer Biologische Beitraege 47(1), 969-990.

Zollinger, F., Chablais, R., Crovadore, J., Cochard, B., Haenzi, M., Bovigny, P.Y., Lefort, F. 2021. Microbiological control of *Carpocoris fuscispinus* (Hemiptera, Pentatomidae). A pest of onion and leek seed crops. AGROFOR International Journal 6(1), 65-72.