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Jordan Journal of Natural History

Editorial Preface

It is a pleasure to present issue 8 of Jordan Journal of Natural History (JJNH), a journal published by the Conservation Monitoring Centre, The Royal Society for the Conservation of Nature (RSCN). The Jordan Journal of Natural History (JJNH) is an open access international scientific journal publishing original research and reviews in nature history in its broadest sense. This is taken to include conservation biology, botany, geology, paleontology, zoology, and ecology, including a broad range of systematics papers encompassing traditional taxonomic revisions and descriptions, cladistics analyses and molecular phylogenetic. The editorial policy of JJNH will follow the lines of most international journals. All manuscripts received by the editor will be examined by referees, who will be instructed to judge the papers by the significance and novelty of the results reported and to favour briefness of presentation.

The editorial board will make every effort to ensure prompt processing of the manuscripts received and to widen the circulation of the journal as far as possible. A group of distinguished scholars have agreed to serve on the editorial board. Without the service and dedication of these eminent scholars, JJNH would have never existed. Now, the editorial board is encouraged by the continuous growth of the journal and its formation into a true multidisciplinary publication. We are also honored to have the privilege of working with all members of the international advisory board served by a team of highly reputable researchers from different countries across the globe. We are also delighted with our team of national and international reviewers who are actively involved in research in different natural history fields and who provide authors with high quality reviews and helpful comments to improve their manuscripts.

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At the end of this preface, would like to thank our readers and authors for their continuing interest in JJNH, and each member of our editorial and review boards for their continued hard work, support and dedication, which made it possible to bring another new issue of JJNH to the multidisciplinary international audience. We very much appreciate your support as we strive to make JJNH one of the most leading and authoritative journals in the field of Natural History Sciences.

December, 2024

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The Jordan Journal of Natural History (JJNH) is an open access international scientific journal publishing original research and reviews in nature history in its broadest sense. This is taken to include conservation biology, botany, geology, paleontology, zoology, and ecology, including a broad range of systematics papers encompassing traditional taxonomic revisions and descriptions, cladistics analyses and molecular phylogenetic. The Jordan Journal of Natural History is published by the Conservation Monitoring Centre at the Royal Society for the Conservation of Nature, Jordan.

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Hamidan, NA, Geiger, MF and Freyhof, J. 2014. *Garra jordanica*, a new species from the Dead Sea basin with remarks on the relationship of *G. ghorensis, G. tibanica* and *G. rufa* (Teleostei: Cyprinidae). *Ichthyological Exploration of Freshwaters*, 25(3): 223-236.

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Key words	word; another word; lower case except names. Position aligned with abstract
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Scale Insects on Ornamental Plants in Tunisia

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Received: January 10, 2024; Revised: March 19, 2024; Accepted: April 4, 2024

Abstract: A survey was conducted from 2008 to 2022 in eight Tunisian coastal governorates to identify the scale insects of ornamental plants, as well as their host plants and to document their geographical distribution. Eighteen species from four families were identified: *Aonidia lauri* Bouché, *Aonidiella aurantii* Maskell, *Aulacaspis rosae* Bouché, *Chrysomphalus aonidum* L., *Leucaspis pusilla* Löw, *Parlatoria ziziphii* Lucas (Diaspididae), *Ceroplastes floridensis* Comstock, *Ceroplates rusci L., Saissetia olea* Olivier, *Coccus hesperidum* L. (Coccidae), *Maconellicoccus hirsutus* Green, *Phenacoccus peruvianus* Granara de Willink, *Phenacoccus madeirensis* Green, *Planococcus vovae* Nassonov, *Planococcus citri* Risso, *Ferrisia virgata* Cockerell and *Pseudococcus longispinus* Targioni-Tozzetti (Pseudococcidae) and *Icerya purchasi* Maskell (Margarodidae). In this study, the authors reported, for the first time, *L. pusilla* on *Pinus halepensis* (Pinaceae), *Coccus hesperidum* on *Musa sp*. and the secondary host *Dracenea marginata* (Asparagaceae) of *C. aonidum* for the first time in Tunisia. Faunistic studies are important for documenting new distributional data and notifying researchers of potential exotic pests.

Keywords: Scale insects, Ornamental plants, Invasive species, Geographical distribution, Tunisia.

Introduction

Scale insects are successful invaders of new territories, frequently introduced and acclimatized in all terrestrial zoogeographical regions. Several scales are established in Europe, representing hence one of the major insect groups alien to Europe (Pellizzari and Germain, 2010). Most of them (Diaspididae and Pseudococcidae) originate from tropical regions and essentially from Asia. The scale insect family Diaspididae (Hemiptera: Coccoidea), includes a number of important pests of wild and greenhouse plants (Alford, 2002). Based on literature, several scale insect species can be found on various host plants grown in Tunisia. Garcia Morales *et al.*, (2016) have reported sixteen scale insect species to occur in Tunisia. In addition, other species have also been recorded in Tunisia (Mansour et *al.* 2017). Studies on Scale Insects fauna were conducted in Tunisia and the Mediterranean Basin (Mansour et *al.,* 2012) on crops with high economic value including olive groves (Mansour et *al.,* 2011), vineyards and *Citrus* plantations (Mansour et *al.,* 2009 and 2010). Moreover, Mdellel et *al*., (2019) conducted a survey to identify mealybugs on ornamental plants and the host plants. Faunistic studies are important for documenting new distributional data and notifying researchers of potential exotic pests (Jendoubi, 2018). This work explores the fauna of scale insects on ornamental plant hosts, and their distribution across Tunisia.

Material and methods

Study sites

The study was conducted over the period from 2008 to 2022 in eight Tunisian coastal governorates. A total of twenty-six sites were surveyed irregularly (Figure 1). The study sites (Table 1) were chosen on the basis of the presence of many species of ornamental plants and various climate zones.

Infested leaves, inflorescences, and fruits with scale insects were collected, kept in alcohol 70°, and were sent to ANSES (French Agency for Food, Environmental,

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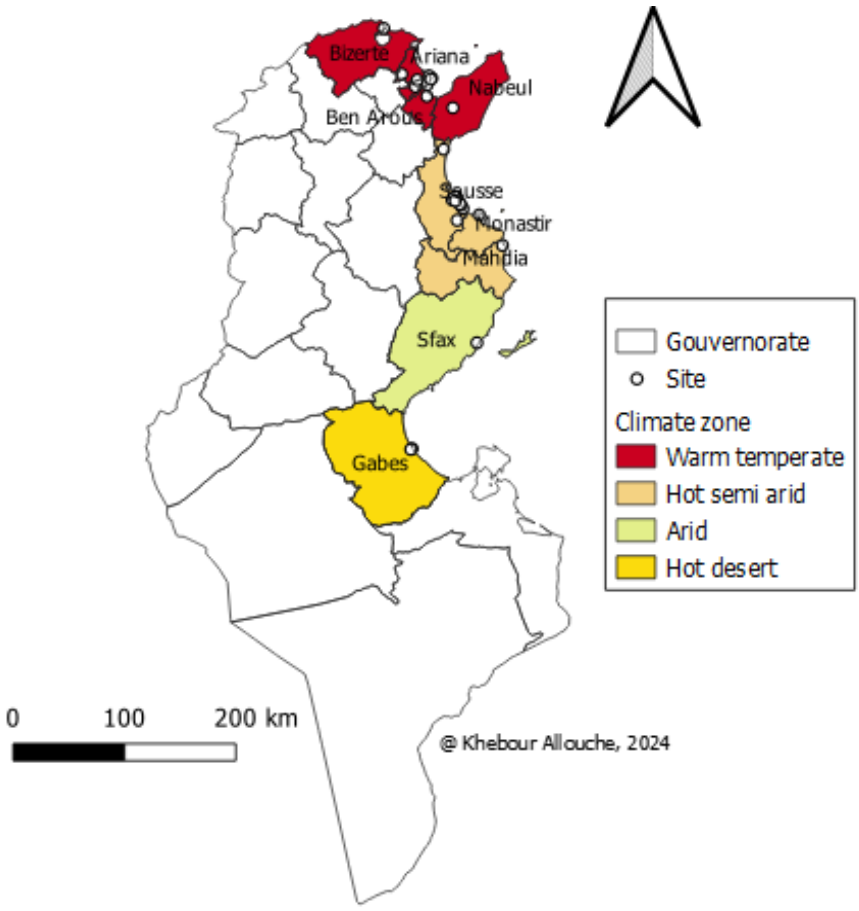

Figure 1. Climate zones in Tunisia and the collecting sites.
* Climate: According to Koppen Geiger (2016) classification (Rubel et *al.* (2017).

Table 1. The study's sites and period of the survey

Governorate	Bizerte	Ariana	Tunis	Ben Arous	Nabeul	Sousse	Monastir	Sfax	Gabes
Survey period	2016	2016-2017	2015-2017	2016	2015	2008 - 2022	2016	2016	2015-2016

and Occupational Health & Safety/France) for identification and confirmation. Identification and confirmation were done by Germain JF until 2019; after that Ouvrad D. and Balmés V. helped in the confirmation process.

After the mounting, the identification of mealy bugs was done by the first authors and was confirmed by Anses (Cox (1989), Kaydan and Gullan (2012), and Danzig and Gavrilov-Zimin (2015)). Samples of Coccidae were stored in 75% ethanol and slide mounted according to the methodology described by Kosztrab and Kozar (1988). The Coccidae were identified mainly using the characteristics given by Gill (1988). Voucher specimens were deposited in ANSES/France.

Results

The following is a list of scale insects collected from ornamental plants in different areas in Tunisia during a survey which lasted from 2008 to 2022 (Table 1). Members of four families were found on ornamental plants: Diaspididae (Table 2), Coccidae (Table 3), Pseudococcidae (Table 4) and Margarodidae (Table 5) with eighteen species of scale insects found on eighteen plant families in four climate zones.

Six species of Diaspididae were collected from different sites. *Aonidia lauri* and *Leucaspis pusilla* were observed in a hot semi-arid area. *L. pusilla* is recorded for first time in Tunisia in a hot semi-arid area on the needles of *Pinus halipensis*.

Aulacaspis rosae has been recorded on *Cycas* plant in different areas in Tunisia (Table 2) with heavy infestations near the crown of the host which can weaken or kill the plant. The species *Chrysomphalus aonidum* was observed on *Dracenea marginata* as a secondary host for the first time in a hot semi-arid zone. On this secondary host, an infestation appears as dark purple to reddish-brown or black spots with paler margins on both surfaces of the shaded leaves of the host plant.

As for the Pseudococcidae family, seven species were identified. Most of them are newly introduced in Tunisia (Mdellel et *al.,* 2019). *Ferrisia virgata, Planococcus vovae,* and *Phenacoccus madeirensis* were reported mainly from *Lantana camara, Cupressus macrocarpa* and *Cestrum nocturnum* and *Lantana camara* were found in hot semi-arid areas across Tunisia (Table 3) respectively. However, *Maconellicoccus hirsutus* colonies were recorded on leaves, shoots, the trunk and collar of the plant and induced desiccation of *Hibiscus rosasinensis* L. (Malvaceae*)* in warm temperatures, and hot semi-arid and desert areas. Concerning *Phenacoccus peruvianus*, it was observed on different ornamental plants in areas with warm temperatures and a hot semi-arid climate (Table 3).

Table 2. Diaspididae species, host plants, and collection areas in Tunisia.

Species	Host plant	Area	Climate
Aonidia lauri Bouché (1833)	*Laurus nobilis* (Lauraceae)	Akouda	Hot semi-arid
Aonidiella aurantii Maskell (1879)	*Citrus aurantium* (Rutaceae)	Nabeul city, Akouda, Ariana city	Warm temperate, Hot semi-arid
Aulacaspis rosae Bouché (1833)	*Cycas revoluta* (Cycadaceae)	Ariana city, Tunis city, Chott Mariem	Warm temperate, Hot semi-arid
Chrysomphalus aonidum L**.** (1758)	*Citrus aurantium* (Rutaceae)	Ariana city	Warm temperate
	Dracaena marginata (Asparagaceae)	Akouda, Tantana	Hot semi-arid
Leucaspis pusilla Löw (1833)	*Pinus halepensis* (Pinaceae)	Tantana, Chott Mariem	Hot semi-arid
Parlatoria ziziphii Lucas (1853)	*Citrus aurantium* (Rutaceae)	All governorates prospected	Warm temperate, Hot semi-arid, Arid, Desert

Table 3. Species of the Pseudococcidae family, host plants and collection areas in Tunisia.

Species	Host plant	Area	Climate
Ferrisia virgata Cockerell (1893)	*Lantana camara* (Verbenaceae)	Khezama	Hot semi-arid
Planococcus citri Risso (1813)	*Tradescantia flumunensis* (Commelinaceae)	Sidi Thabet	Warm temperate
	Thecoma smithi (Bignoniaceae)	Chott Mariem	Hot semi-arid
Planococcus vovae Nasonov (1908)	*Cupressus macrocarpa* (Cupressaceae)	Hammem Sousse	Hot semi-arid
Phenacoccus peruvianus Granara de Willink (2007)	*Myoporum sp* (Scrophulariaceae)	Sousse City, Hammem Sousse, Akouda, Kalaa Kebira Monastir City, Tunis City	Hot semi-arid Warm temperate
	Citharexylum quadrangularis (Verbenaceae)	Akouda	Hot semi-arid
	Bougainvillea glabra (Nyctaginaceae)	Sousse City, Akouda, Hammem Sousse, Msaken, Port Kantaoui, Ariana City, El Aouina, Tunis City, El-Marsa, Monastir city	Hot semi-arid, Warm temperate
Phenacoccus madeirensis Green (1923)	*Brugmansia arborea, Solandra maxima* (Solanaceae)	Akouda	Hot semi-arid
	Cestrum parquii (Solanaceae)	Akouda	Hot semi-arid
	Lantana camara (Verbenaceae)	Hammem Sousse	Hot semi-arid
Pseudococcus longispinus Targioni-Tozzeti (1867)	*Jasminum grandiflorum* (Oleaceae)	Port Kantaoui	Hot semi-arid
Maconellicoccus hirsutus Green (1908)	*Hibiscus rosasinensis* (Malvaceae)	Tunis City, El-Marsa, Goulette, Sidi-Bou Saïd, Carthage, Port Kantaoui, Akouda, Chott Mariem, Hammem Sousse, Msaken, Ariana City, El-Aouina, Bizerte City, Monastir City, Boumhel, Sfax city, Gabes city, Merth	Warm temperate, Hot semi-arid,, Arid, Desert
	Hibiscus mutabilis (Malvaceae)	Chott Mariem	Hot semi-arid

All species of the Coccidae family were recorded in areas with a hot semi-arid climate. C*eroplastes floridensis* was detected during this survey on three plants (Table 4) in areas with a hot semi-arid climate. *Coccus hesperidum* was observed for the first time on banana trees. This plant is a new host of *C. hesperidum* in Tunisia. *Saissetia oleae* is recorded on *Alcea rosea* for the first time in Tunisia. As for the Margarodidae family, *I. purchasi* was colleted on five plant families (Table 5) in warm temperate areas.

Table 4. Species of the Coccidae family, host plants, and the collection areas in Tunisia.

Species	Host plant	Area	Climate
Coccus hesperidum L. (1758)	*Sheflera arboricola* (Araliaceae) *Musa* sp. *(Musaceae)*	Chott Mariem Akouda	Hot semi-arid
Ceroplastes floridensis Comstock (1881)	*Pittosporum tobira* (Pittosporaceae)	Sousse city	Hot semi-arid
	Laurus nobilis (Lauraceae) *Hedera helix* (Araliaceae)	Akouda	Hot semi-arid
Ceroplates rusci L. (1758)	*Ficus nitida, Ficus benjamina* (Moraceae)	Sousse city, Akouda, Chott Mariem	Hot semi-arid
Saissetia olea Olivier (1791)	*Alcea rosea* (Malvaceae)	Port Kantaoui	Hot semi-arid

Table 5. Species of Margarodidae family, host plants and the collection areas in Tunisia.

Species	Host plant	Area	Climate
Icerya purchasi Maskell (1879)	*Laurus nobilis* (Lauraceae)	Akouda	Hot semi-arid
	Ocium basilicum (Lamiaceae)		
	Citrus aurantium (Rutaceae)	Akouda, Chott Mariem Beni Khaled	Hot semi-arid, Warm temperate
	Ficus nitida (Moraceae)	Akouda, Chott Mariem	Hot semi-arid
	Hedera helix (Araliaceae)	Akouda, Chott Mariem	

Discussion

The survey, which was carried out in twenty-three sites distributed across eight Tunisian coastal governorates, allowed the discovery of eighteen species belonging to four families on eighteen plant families in four climate zones. These include *A. lauri*, *A. aurantii*, *A. rosae*, *C. aonidum*, *L. pusilla*, *P. ziziphii*, *C. floridensis*, *C. rusci, S. olea*, *C. hesperidum*, *M. hirsutus*, *P. peruvianus*, *P. madeirensis*, *P. vovae*, *P. citri*, *F. virgata*, and *P. longispinus* and *I. purchasi*. In this study *A. lauri* was observed infesting the leaves and bark of laurel during 2008 in a hot semi-arid area. The laurel scale is widely distributed in the Mediterranean basin, almost exclusively on *Laurus nobilis* and other species of *Laurus. A. aurantia*. The red scale was observed on bitter-orange trees in urban areas and represents a real menace for citrus groves and fruit cultivations

(Jendoubi, 2018). *C. aonidum* was reported as a potential problem for ornamental plants in Hungary (Reiderné and Kozár, 1994). In this study, the authors report, for the first time, the presence of *L. pusilla.* This species was studied in a pine forest in Tuscany (Italy) and was found to cause damage to some of the pine forests in which the trees had already been weakened by abiotic and biotic factors (Raspi and Antonelli, 1987). *L. pusilla* was listed in Turkey (Ülgentürk *et al.,* 2012) and Egypt (Badr, 2014). The climate as an extrinsic integrative factor plays a crucial role in determining the abundance and distribution of insect pest population. This can explain the presence of *P. ziziphii* in four climate zones. It is a major pest of citrus in all Tunisian citrus regions (Jendoubi, 2018). *F. virgata and P. madeirensis* were newly introduced in Tunisia (Mdellel *et al.,* 2019). The genus *Ferrisia* is apparently of a New World origin, and it is by far the most widespread species in the genus (Kaydan and Gullan, 2012). The Madeira mealybug is a pest of ornamental plants both outdoors and in greenhouses (Pellizzari & Germain, 2010). *P. longispinus* was a less prevalent species recorded on *Jasminum grandiflorum* during July in one site in the Sousse governorate. The citrus mealybug, *P. citri,* is a common polyphagous species known from all zoogeographical regions and *P. vovae* is widespread throughout the Mediterranean region as well as the Palaearctic region (Mdellel *et al*., 2019). The fig wax scale was observed frequently on *Ficus microcarpa* and *Ficus benjamina* especially in a nursery of ornamental plants with a hot semi-arid climate. It is interesting to mention that *S. oleae* is an economic pest on both olive and citrus trees in Tunisia, and it is considered the key scale insect species (Jarraya, 2003).

In this study, it was noted that the trade of ornamental trees appears to be the main pathway of the transfer of scale insects. In Tunisia, despite the economic implications of scale insects, very few studies have so far been carried out to provide a checklist of the species injuring many strategic crops (Mansour *et al.*, 2017). This basic study demonstrates the role of ornamental plants to be an alternative host of several scale insects.

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Four New Records of Beetles (Coleoptera) from the Palestinian Territories – West Bank

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Abstract: In this study, *Phoracantha recurva* (Family Cerambycidae), *Myrrha octodecimguttata* and *Hyperaspis trifurcata* (Family Coccinelidae) and *Sitaris solieri* (Family Meloidae) are reported for the first time from the Bethlehem district in the Palestinian territories (West Bank).

Keywords: Invasive, introduced species, first record, West Bank, Palestine, Cerambycidae, Coccinelidae, Meloidae.

Introduction

Most of the available information on the entomofauna of the West Bank is based on Bodenheimer, (1935 and 1937). After the establishment of the Palestine Museum of Natural History (PMNH) in Bethlehem, few publications addressed different groups of insects; Lepidoptera (Abusarhan, *et al.,* 2016; Handal, 2022), Orthoptera (Abusarhan, *et al.,* 2017), Coleoptera (Handal and Amr, 2017; Najajrah, *et al.,* 2019), Heteroptera (Handal, 2017; Handal and Qumsiyeh, 2019), Odonata (Adawi, *et al.,* 2017; Adawi, *et al.,* 2023), Diptera (Adawi, 2012; Sawalha, *et al.,* 2017; Adawi and Qasem, 2018, Adawi, *et al.,* 2023), and Mantodea (Handal, *et al.,* 2018), among others (Qumsiyeh, *et al.,* 2017). Much work and effort are still needed to investigate the diversity of insects in the West Bank. This short communication reports additional records of beetles from the Palestinian territories (West Bank).

Most of the members of the family Coccinelidae are predators on aphids and other small insects and they are known to be the best example of biological control (Hodek et al. 2015; Najajrah, *et al.,* 2019). More than 6000 species were described from the world (Hodek et al. 2015), and over seventy-five of them were recorded from Historic Palestine (Halperin et al., 1995; Mendel, *et al.,* 2020; Rittner and Nir, 2013). The family Cerambycidae contain borers recognized by their long antenna (Evans et al., 2004). Over 35000 species were described from across the world, and 104 species were found in Historic Palestine (Sama et al., 2010). Species of the family Meloidae, known as blister beetles, are plant feeders; some are predators and feed on other insects including bees (Lückmann and Assmann, 2006). About 7500 species were described from across the world, and 115 species were recorded from Historic Palestine (Ptashkovsky, 2013).

This report records four beetle species new to the insect fauna of Palestine: *Phoracantha recurva* (Family Cerambycidae), *Myrrha octodecimguttata* and *Hyperaspis trifurcata* (Family Coccinelidae), and *Sitaris solieri* (Family Meloidae)

Materials and Methods

Several field trips covering the Bethlehem district in the occupied Palestinian territories (West Bank) were conducted between April 2022 to October 2023. The Bethlehem district is located within four phytogeographical ecozones: The Mediterranean, Irano–Truranian, Saharo-Arabian, and the Sudanian penetration ecozones). All specimens were identified and deposited at the first author's personal zoological lab.

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Results

Four species of the order Coleoptera bleonging to three families (Coccinelidae, Cerambycidae and Meloidae) were recorded for the first time from the West Bank The insects were collected either by hand or using light traps and butterfly nets.

Coleoptera Coccinellidae

Myrrha octodecimguttata (Linnaeus, 1758) (Figure 1-A)

Materials: Three specimens were collected from Bethlehem city (31°42'48.7"N 35°12'13.9"E) on the 8th of July 2022; 26th of August 2022; and the 25th of October 2023. The specimens were collected from urban areas surrounded by conifers trees using light traps.

Remarks: The eighteen-spotted ladybird, *Myrrha octodecimguttata,* is a species introduced and documented in Historic Palestine in 2007 without any knowledge about its way of entrance. It was found to feed on the conifer aphid (*Cinara marittimae*) and was reported for the first time form the Palestinian territories in the West Bank area (Rittner and Nir, 2013). Although Najajrah, *et al.* (2019) listed thirty-five species of coccinellid from the Palestinian territories, he did not find this species. The eighteen-spotted ladybird was reported from Europe (Nedved and Djuric, 2022), Northwest Africa, Turkey, and Syria (Kovar 2007). It is known as a predator on pine tree aphids (Adriaens, *et al.,* 2008). This species was recorded from Historic Palestine in Jerusalem particularly areas in northern Jerusalem (Rittner and Nir, 2013).

Hyperaspis trifurcata Schaeffer, 1905 (Figure 1-B)

Materials: Nine specimens were collected from Bethlehem city (31°42'48.7"N 35°12'13.9"E) on the 20th of August 2023. All specimens were collected by hand from a home garden in the city and were found to be feeding on *Dactylopius opuntiae*.

Remarks: The trident lady beetle is a species recorded for the first time from the

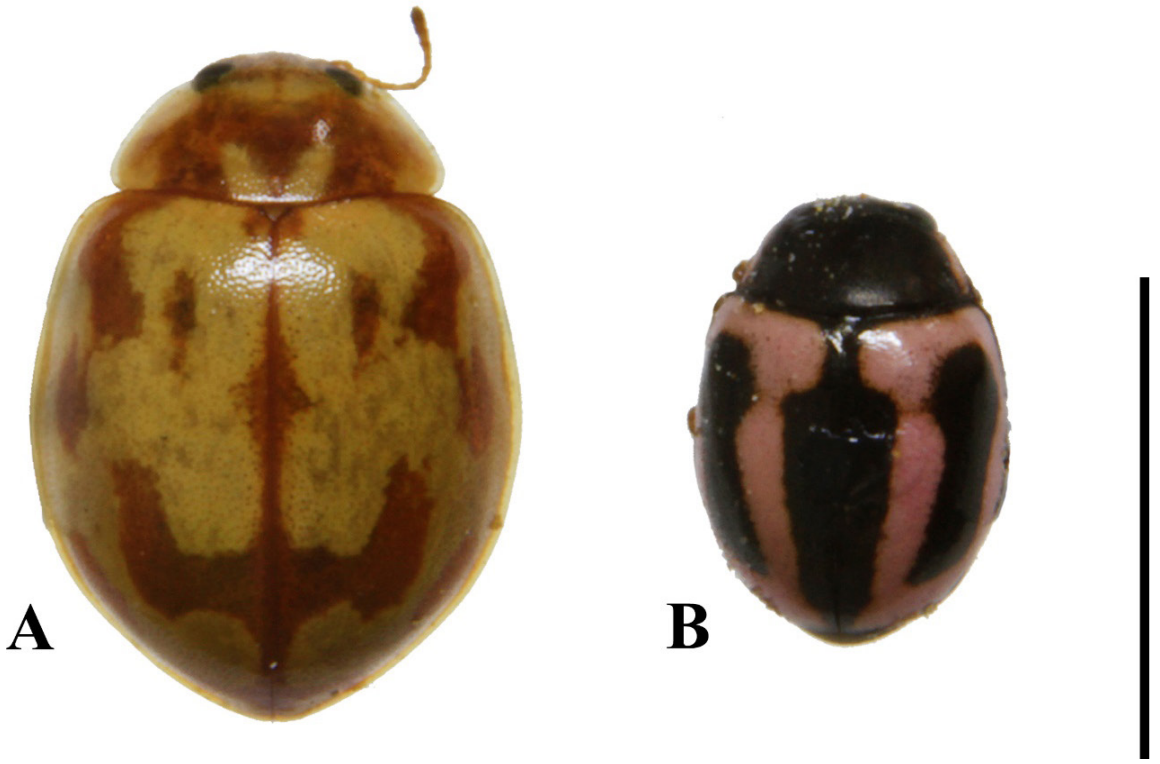

Figure 1. **A:** *Myrrha octodecimguttata*, **B:** *Hyperaspis trifurcata*, dorsal view. Scale Bar = 3.5mm.

Palestinian territories (Najajrah, *et al.,* 2019). This species was introduced in summer 2017 from Mexico, as a natural predator against the prickly pear cochineal, *Dactylopius opuntiae* (Cockerell, 1929) (Hemiptera: Dactylopiidae) which feeds on the Indian-fig prickly pear (*Opuntia ficus-indica*) and was first recorded on *Dactylopius opuntiae* in the north of Historic Palestine in 2013 (Mendel, *et al.,* 2020).

Family: Cerambycidae

***Phoracantha recurva* Newman, 1840 (Figure 2)**

Materials: Two specimens were collected from Bethlehem city (31°42'48.7"N 35°12'13.9"E) on the 16th of August 2022 and the 24th of September 2023. The specimens were collected from an empty land near houses using a butterfly net.

Remarks: The eucalyptus long-horned borer is a species native to Australia. Over the last thirty years, it has become an invasive species in south African, south American, and some Mediterranean countries (Ozdikmen and Caglar, 2005). This species was recorded from the north near Galilee in Historic Palestine in 2005 (Sama, *et al.,* 2010). It feeds on *Eucalyptus* spp. This is the first record of this species from the Palestinian territories in the West Bank.

The *Phoracantha semipunctata* is another species recorded from Historic Palestine. It somehow looks like *Phoracantha recurve* (Sama *et al.,* 2010). It is distinguished by its forewing color and patterns. *P. semipunctata* has wings covered mostly with dark brown and a zigzag line pattern and exhibits a cream-colored area in the middle. On the other hand, *P. recurva* is mostly creamy to yellowish in color with some dark brown areas primarily limited to the posterior end of the wing (Ptashkovsky, 2013).

Figure 2. *Phoracantha recurva,* dorsal view. Scale Bar = 10 mm.

Family Meloidae

***Sitaris solieri* Pecchioli, 1839 (Figure 3)**

Materials: One specimen was collected from Bethlehem City (31°42'48.7"N 35°12'13.9"E) on the 19th of October 2023. The specimen was found in botanical gardens and was collected by hand.

Remarks: This is the first documented record of this species from Palestine (West Bank). A photographed record from Jerusalem was made in 2010 by Oz Rittner and was posted on his personal website (http://israel-nature-site.com/?page_id=374). This species was collected and observed on Rosemary shrubs, *Rosmarinus* sp. in house gardens and was also observed at the Palestine Museum of Natural History botanical garden. According to Löbl and Smetana (2008), this species is distributed in the Palaearctic region (Europe: Croatia, France, Greece, Italy, Portugal, and Spain; North Africa: Algeria, Canary Islands, Marocco, and Tunisia; Asia: Turkey).

Figure 3. *Sitaris solieri,* dorsal view. Scale Bar = 10mm.

Discussion

Many efforts exerted by several researchers in the Palestinian territories, supported by several NGOs, universities, and the Environmental Quality Authority, are currently directed at studying the entomofauna of the Palestinian territories. The spread of many invasive insects around the world impose threats to countries that rely on agriculture as a source of economy. For instance, the palm weevil caused economic losses for the palm plantations in many countries (Kehat, 1999).

Other species of lady beetles, *Cryptolaemous montrouzieri*, were brought to control the infestation of *Dactylopius opuntiae* have been recorded by Najajrah, *et al.* (2019). The infestation of the *Dactylopius opuntiae* on the Indian-fig prickly pear was recorded by the Ministry of Agriculture in Palestine few years ago. It was reported from Jenin District and spread to several areas in the West Bank. *H. trifurcata* was recorded from Jordan for the first time in summer 2021 (Tawayah, *et al.,* 2023).

Several invasive species of the family Cerambycidae were reported from Historic Palestine, but have not yet been documented from the West Bank area (Sama, *et al.,* 2010, Friedman, *et al.,* 2008, Danilevsky, 2012, Rittner, 2016). This report increases the lady beetle fauna documented in the West Bank from thirty-five species to thirty-seven species (Najajrah, *et al.,* 2019). As for both the Cerambycidae and Meloidae families, they were not studied extensively in the West Bank area, so there is no updated list of the species that exist in this area. The researchers' knowledge depend on the literature that covers Historic Palestine such as Bodenheimer, (1935 and 1937) but lacks data on the West Bank and Gaza regions. Further studies on the insects of the West Bank should be encouraged and supported to reveal this region's biodiversity and to identify the invasive species that may pose a threat to the natural ecosystems.

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The State of Terrestrial and Freshwater Biodiversity in Jordan: Invertebrates (Annelida and Mollusca)

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Abstract: Comprehensive lists of recorded species of both phyla Annelida and Mollusca from Jordan are provided. Phylum Annelida includes three classes with a total of twenty-four species, with two new species described from Jordan. Phylum Mollusca contains forty-three species of terrestrial land snails and twenty-five species of freshwater snails.

Introduction

The geographical location of Jordan as the last frontier for Palearctic region allowed for the introduction of species originating from Eurasia and Europe, and those of Arabian affinities that penetrated northwards. Besides, the Levant as a zoogeographical entity enjoys a rich endemic fauna that is restricted either to the Levant or sometimes localized to its southern limit. This is exemplified by several species of earthworms of which two species and a subspecies were described from Jordan (Csuzdi and Pavliček, 2005, Szederjesi *et al*., 2013). Land snails on the other hand, include several species that are confined to Jordan and Palestine (e.g. *Truncatellina haasi*, *Calaxis hierosolymarum, Buliminus marsabensis, Euchondrus saulcyi*).

The purpose of this work is to summarize the current knowledge of the invertebrate fauna of Jordan, covering two major phyla: Annelida and Mollusca. All the known species reported in published papers or books are listed and their scientific names are updated. The intention of listing all the known species is to familiarize and provide field biologists and researchers with up-to-date information.

Phylum Annelida

Class Hirudinea

Leeches are of medical and veterinary importance. Four species of leeches have been recorded from Jordan (Table 1). A list published by Bromley (1994) included records from the Jordan River as well as previous records made by Dia (1983), Kinzelbach and Ruckert (1984), and Ruckert (1985). Damati and Abo-Shehada (1990) reported on six cases of human infestation by leeches in different parts of the country.

Class Oligochaeta

Twenty species and subspecies of earthworms have been recorded from Jordan (Rosa, 1893; Csuzdi and Pavliček, 2005, Pavliček and Csuzdi, 2006; Szederjesi *et al.*, 2013;). Eight species are thought to be introduced. The family Lumbricidae is represented by twelve species, while the families Acanthodrilidae and Ocnerodrilidae are represented by one species for each. *Dendrobaena orientalis karak* (Csuzdi and Pavliček, 2005), *Dendrobaena alexandrii* and *Dendrobaena transjordanica* (Szederjesi *et al.*, 2013) were described from Jordan (Table 2).

Phylum Mollusca

Class Gastropoda

Land snails

The land snails of Jordan have been studied on numerus occasions. Schütt (1983) based his study on a collection made by Dr. Bandel, a geologist who was stationed in Jordan. It includes records for twenty-one species. Petney and Huset (1992) presented the results of a master's thesis prepared by Huset on the land snails of Jordan. Their list includes a total of thirty-one species, mostly from northern Jordan. Recently, Ben-Ami and Sivan (2000) have conducted a survey on the land snails of southern Jordan and included

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Table 1. Hirudinea species recorded from Jordan.

Family	Species	Reference
Hirudinidae	*Limnatis nilotica* (Savigny, 1822)	Ruckert (1985)
	Limnatis paluda (Tennent, 1859)	Kinzelbach and Ruckert (1984), Ruckert (1985)
Erpobdellidae	*Dina lineata concolor* (Annandale, 1913)	Ruckert (1985)
	Trocheta bykowskii Gedroye, 1913	Ruckert (1985)

Table 2. Oligochaeta species recorded from Jordan.

Family	Species	Reference
Lumbricidae	*Aporrectodea caliginosa* (Savigny, 1826)	Rosa (1893), Csuzdi and Pavliček (2005); Pavliček and Csuzdi (2006), Szederjesi *et al.* (2013)
	Aporrectodea jassyensis (Michaelsen, 1891)	Rosa (1893), Csuzdi and Pavliček (2005)
	Aporrectodea rosea (Savigny, 1826)	Csuzdi and Pavliček (2005), Pavliček and Csuzdi (2006), Szederjesi *et al.* (2013)
	Bimastos parvus (Eisen, 1874)	Pavliček and Csuzdi (2006)
	Dendrobaena alexandrii Szederjesi *et al.* 2013	Szederjesi *et al.* (2013)
	Dendrobaena byblica (Rosa, 1893)	Csuzdi and Pavliček (2005), Szederjesi *et al.* (2013)
	Dendrobaena negevis Csuzdi & Pavlíček, 1999	Pavliček and Csuzdi (2006), Szederjesi *et al.* (2013)
	Dendrobaena orientalis karak Csuzdi & Pavliček, 2005	Csuzdi and Pavliček (2005)
	Dendrobaena semitica (Rosa, 1893)	Rosa (1893), Csuzdi and Pavliček (2005), Pavliček and Csuzdi (2006), Szederjesi *et al.* (2013)
	Dendrobaena transjordanica Szederjesi *et al.* 2013	Szederjesi *et al.* (2013)
	Dendrobaena veneta veneta (Rosa, 1886)	Csuzdi and Pavliček (2005), Pavliček and Csuzdi (2006), Szederjesi *et al.* (2013)
	Eisenia ftida (Savigny, 1826)	Csuzdi and Pavliček (2005)
	Eiseniella neapolitana (Örley, 1885)	Rosa (1893), Csuzdi and Pavliček (2005), Szederjesi *et al.* (2013)
	Eiseniella tetraedra (Savigny, 1826)	Csuzdi and Pavliček (2005), Szederjesi *et al.* (2013
	Healyella syriaca (Rosa, 1893)	Szederjesi *et al.* (2013)
	Helodrilus patriarchalis (Rosa, 1893)	Rosa (1893), Csuzdi and Pavliček (2005), Szederjesi *et al.* (2013)
	Metaphire californica (Kinberg, 1867)	Pavliček and Csuzdi (2006)
	Octodrilus transpadanus (Rosa 1884)	Csuzdi and Pavliček (2005), Szederjesi *et al.* (2013)
Acanthodrilidae	*Microscolex dubius* (Fletcher, 1887)	Csuzdi and Pavliček (2005), Pavliček and Csuzdi (2006)
Ocnerodrilidae	*Ocnerodrilus occidentalis* Eisen, 1878	Csuzdi and Pavliček (2005)

records of ten species from southwestern Jordan. Waitzbauer and Petutschnig (2004) presented a zoogeographical analysis of the so far known species from Jordan. They indicated that most of the snail fauna of Jordan is Mediterranean, with few species adapted to arid environments. A brief note on a collection of land snails deposited at the Hebrew University was published by Mienis (1978). The most comprehensive study was undertaken by Neubert *et al*. (2015) with a total of forty-three terrestrial land snails (Table 3) belonging to fifteen genera in seventeen families (Chondrinidae, Cochlicellidae, Enidae, Ferussaciidae, Helicidae, Hygromiidae, Limacidae, Oxychilidae, Pristilomatidae, Punctidae, Pupilidae, Pyramiduliae, Spincterochilidae, Subulinidae, Succineidae, Trissexodontidae, and Vertiginidae). Figures (1 and 2) show some land snail species collected from Jordan.

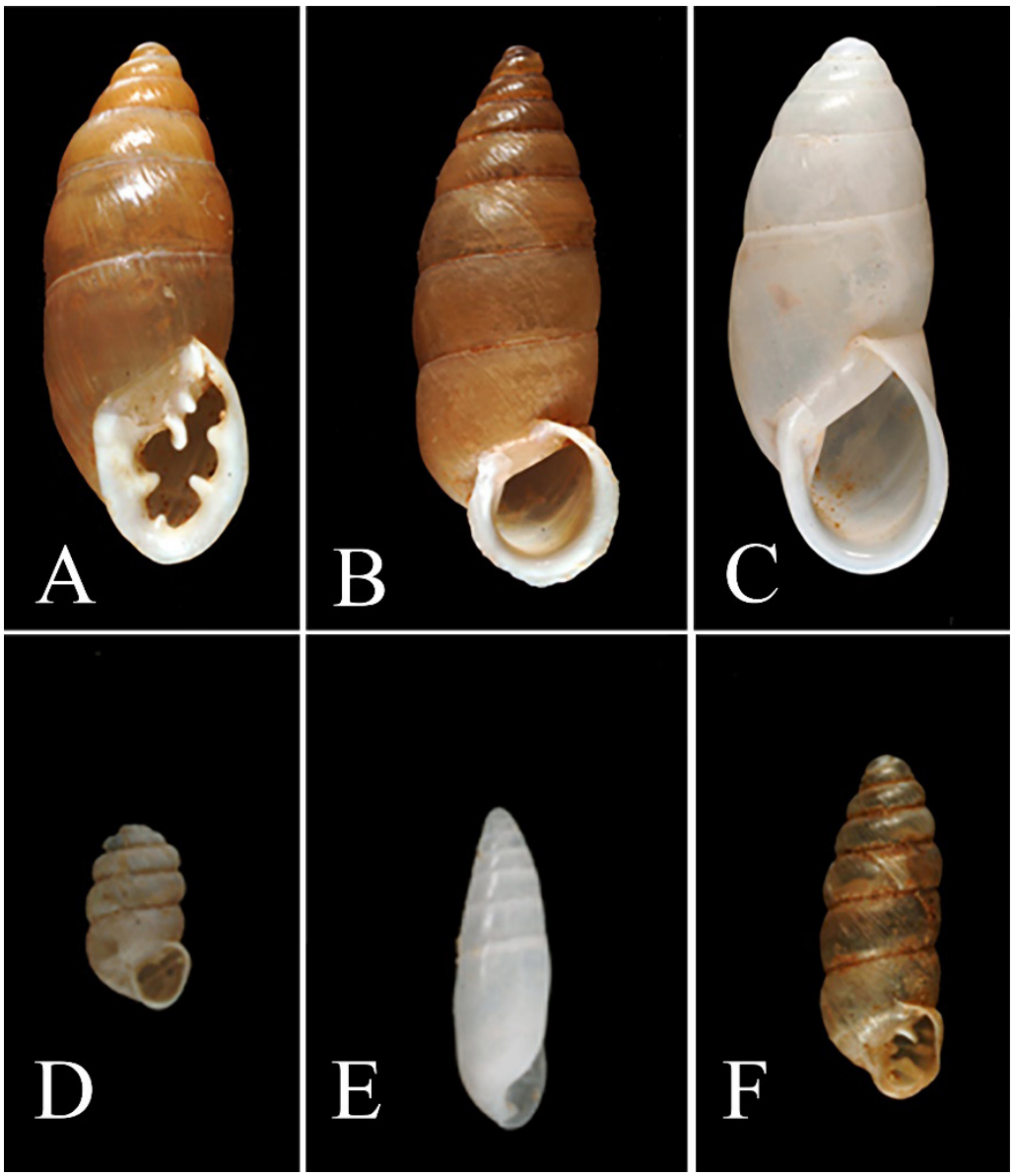

Figure 1. Land snails of Jordan. A. *Euchondrus septemdentatus*. B. *Paramastus episomus*. C. *Buliminus jordani.* D. *Truncatellina haasi*. E. *Calaxis hierosolymarum.* F. *Granopupa granum.*

Freshwater snails (Caenogastropoda and Pulmonata)

Due to their medical importance in disease transmission, the freshwater snails of Jordan have received much attention (Abdel-Azim and Gismann, 1956; Saliba *et al*., 1976, Burch *et al*., 1989; Arbaji *et a*l., 1998; Amr *et al*., 2004 and 2014; Nasarat *et al*., 2014). The freshwater snail fauna of Jordan consists of twenty-five species (Table 4) belonging to two subclasses of the class Gastropoda **(**Prosobranchia and Pulmonata). Prosobranchians includes seven families (Bithyniidae, Cochliopidae, Hydrobiidae, Neritidae, Melanopsidae, Thiaridae and Valvatidae) with eleven genera (*Bithynia, Heleobia, Falsipyrgula, Melanoides, Melanopsis, Ovatella, Plotia, Pseudamnicola, Pyrgophorus, Theodoxus,* and *Valvata*) representing nineteen species. Pulmonates are represented by three families (Lymnaeidae, Physidae and Planorbidae) within six genera and six species. Figures (3 and 4) show some freshwater snail species from Jordan.

Noteworthy records include *Falsipyrgula barroisi* that was reported from the north of King Abdullah Canal (Alhejoj *et al.,* 2017), and *Ovatella myosotis* that was reported

Table 3. Land snail species recorded from Jordan.

Family	Species	Reference
Succineidae	*Oxyloma elegans* (Risso, 1826)	Neubert *et al*. (2015)
Pupillidae	*Pupoides coenopticus* (Hutton, 1834)	Hart (1891), Neubert *et al*. (2015)
Pyramiduliae	*Pyramidula rupestris* (Draparnaud, 1801)	Petney and Huset (1992), Neubert *et al*. (2015)
Chondrinidae	*Granopupa granum* (Draparnaud, 1801)	Petney and Huset (1992), Neubert *et al*. (2015)
	Rupestrella rhodia (Roth, 1839)	Neubert *et al*. (2015)
Vertiginidae	*Truncatellina haasi* Venmans, 1957	Petney and Huset (1992), Neubert *et al*. (2015)
Enidae	*Buliminus jordani* (Charpentier, 1847)	Petney and Huset (1992), Ben-Ami and Sivan (2000), Neubert *et al*. (2015)
	Buliminus diminutus (Mousson, 1861)	Heller (1975), Neubert *et al*. (2015)
	Buliminus marsabensis Westerlund, 1887	Schütt (1983), Petney and Huset (1992), Ben-Ami and Sivan (2000), Neubert *et al*. (2015)
	Buliminus negevensis Heller, 1970	Neubert *et al*. (2015)
	Buliminus sinaiensis Heller, 1970	Neubert *et al*. (2015)
	Pene bulimoides (L. Pfeiffer, 1842)	Petney and Huset (1992)
	Paramastus episomus (Bourguignat, 1857)	Petney and Huset (1992)
	Euchondrus septemdentatus (Roth, 1839)	Petney and Huset (1992), Neubert *et al*. (2015)
	Euchondrus saulcyi (Bourguignat, 1852)	Haas (1955), Neubert *et al*. (2015)
	Euchondrus michonii (Bourguignat, 1853)	Petney and Huset (1992), Ben-Ami and Sivan (2000), Neubert *et al*. (2015)
	Euchondrus chondriformis (Mousson, 1861)	Petney and Huset (1992)
Ferussaciidae	*Calaxis hierosolymarum* (Roth, 1855)	Petney and Huset (1992), Neubert *et al*. (2015)
	Cecilioides genezarethensis Forcart, 1981	Neubert *et al*. (2015)
	Cecilioides acicula (O. F. Müller, 1774)	Neubert *et al*. (2015)
	Cecilioides judaica (Mousson, 1861)	Neubert *et al*. (2015)
Subulinidae	*Rumina decollata* (Linnaeus, 1758)	Neubert *et al*. (2015)
Punctidae	*Paralaoma servilis* (Shuttleworth, 1852)	Neubert *et al*. (2015)
Pristilomatidae	*Vitrea contracta* (Westerlund, 1871)	Petney and Huset (1992)
Oxychilidae	*Eopolita protensa jebusitica* (Roth, 1855)	Petney and Huset (1992), Neubert *et al*. (2015)
	Oxychilus (*Hiramia*) *renanianus* (Pallary, 1939)	Neubert *et al*. (2015)
	Oxychilus (*Hiramia*) *sanctus* (Bourguignat, 1852)	Neubert *et al*. (2015)
Limacidae	*Limax flavus* Linnaeus, 1758	Neubert *et al*. (2015)
	Limax cecconii Simroth, 1906	Neubert *et al*. (2015)
Sphincterochilidae	*Sphincterochila prophetarum* (Bourguignat, 1852)	(Mienis, 1978), Petney and Huset (1992), Neubert *et al*. (2015)
	Sphincterochila fimbriata (Bourguignat, 1852)	Neubert *et al*. (2015)
	Sphincterochila zonata zonata (Bourguignat, 1853)	(Petney and Huset (1992), Ben-Ami and Sivan (2000), Mienis, 1978), Neubert *et al*. (2015)
	Sphincterochila zonata filia (Mousson, 1861)	Bar (1975), Neubert *et al*. (2015)
	Sphincterochila cariosa (Olivier, 1804)	Neubert *et al*. (2015)
Cochlicellidae	*Cochlicella acuta* (O. F. Müller, 1774)	Neubert *et al*. (2015)
Trissexodontidae	*Caracollina lenticula* (Michaud, 1831)	Neubert *et al*. (2015)
Hygromiidae	*Monacha obstructa* (L. Pfeiffer, 1842)	Petney and Huset (1992), Neubert *et al*. (2015)
	Monacha crispulata (Mousson, 1861)	Petney and Huset (1992), Neubert *et al*. (2015)
	Xerocrassa seetzenii (L. Pfeiffer, 1847)	Mienis (1978), Petney and Huset (1992), Neubert *et al*. (2015)
	Xerocrassa simulata (Ehrenberg, 1831)	Petney and Huset (1992), Ben-Ami and Sivan (2000), Neubert *et al*. (2015)
	Xerocrassa langloisiana (Bourguignat, 1853)	Petney and Huset (1992), Neubert *et al*. (2015)

	Xerocrassa tuberculosa (Conrad, 1852)	Petney and Huset (1992), Neubert *et al*. (2015)
	Xeropicta krynickii (Krynicki, 1833)	Petney and Huset (1992), Neubert *et al*. (2015)
Helicidae	*Levantina caesareana* (Mousson, 1854)	Petney and Huset (1992), Neubert *et al*. (2015)
	Levantina lithophaga (Conrad, 1852)	Petney and Huset (1992), Neubert *et al*. (2015)
	Helix (*Pelasga*) *engaddensis* Bourguignat, 1852	Petney and Huset (1992), Neubert *et al*. (2015)
	Massylaea vermiculata (O. F. Müller, 1774)	Petney and Huset (1992), Neubert *et al*. (2015)

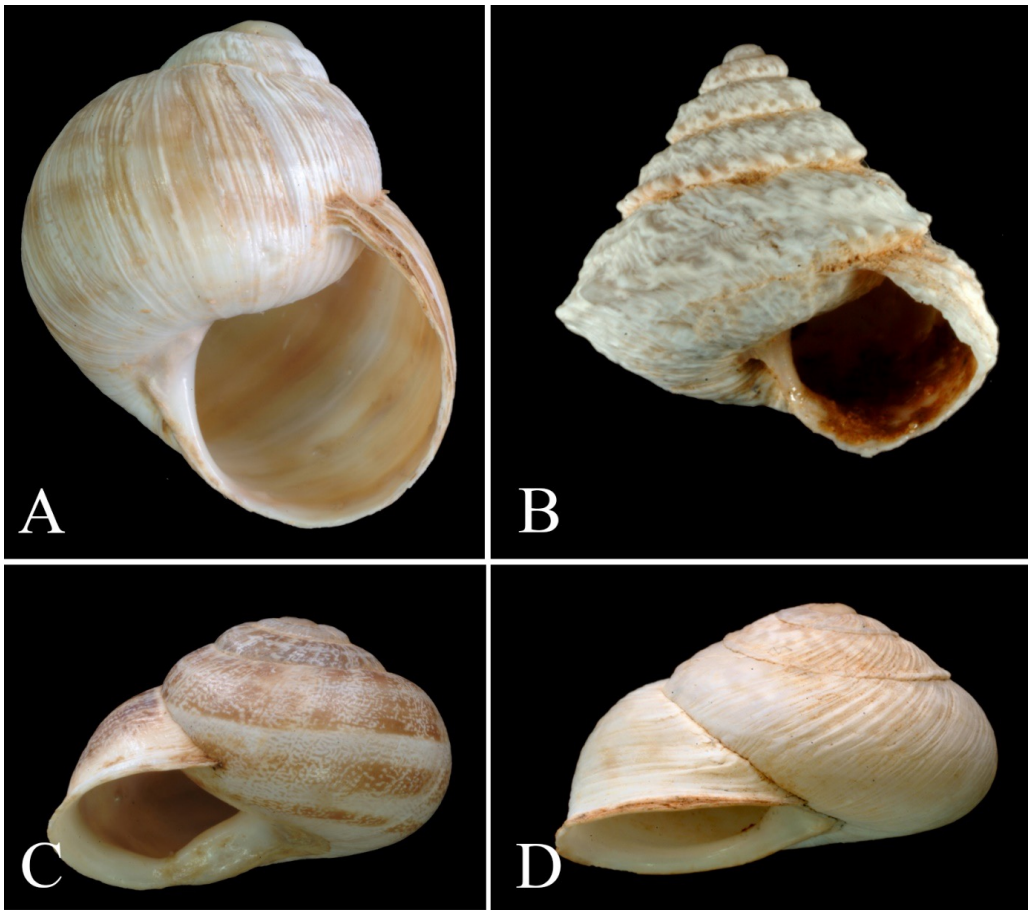

Figure 2. Land snails of Jordan. A. *Helix (Pelasga) engaddensis*. **B**. *Xerocrassa tuberculosa* **C**. *Massylaea vermiculata.* **D**. *Levantina caesareana*.

from brackish water spring near Madaba, and from around springs near the Dead Sea (Schütt, 1983).

Class Bivalvia

This class is represented by the Unionidae family in Jordan. So far, four species have been recorded from Jordan (Table 5). Alhejoj *et al.* (2017) studied the freshwater mollusca of the Jordan Valley. (Schütt, 1983) listed few records from Jordan in his comprehensive study on the freshwater mollusca of the Levant. *Unio terminalis* (Bourguignat, 1852) was collected from King Abdullah Canal in the Jordan Valley as well as from the sediments of the Jordan River (Alhejoj *et al*., 2017). *Unio semirugatus* (Lamarck, 1819) is a Circum-Mediterranean species. *Corbicula fluminalis* (Müller, 1774) is very common in King Abdullah Canal. It is confined to the Jordan Vally and was not encountered elsewhere in the country. It is believed that *Corbicula,* a south-east Asian species, has been introduced to Jordan only recently (Alhejoj *et al*., 2017). *Pisidium casertanum* (Poli, 1795) was recorded from Wadi Hisban spring and near the Zarqa River (Schütt, 1983). Nelson (1973) described *Pisidium* sp. from the Azraq Oasis. It seems to be very common in King Abdullah Canal near Abu Habil Mosque and SharHabili (Alhejoj *et al.*, 2017).

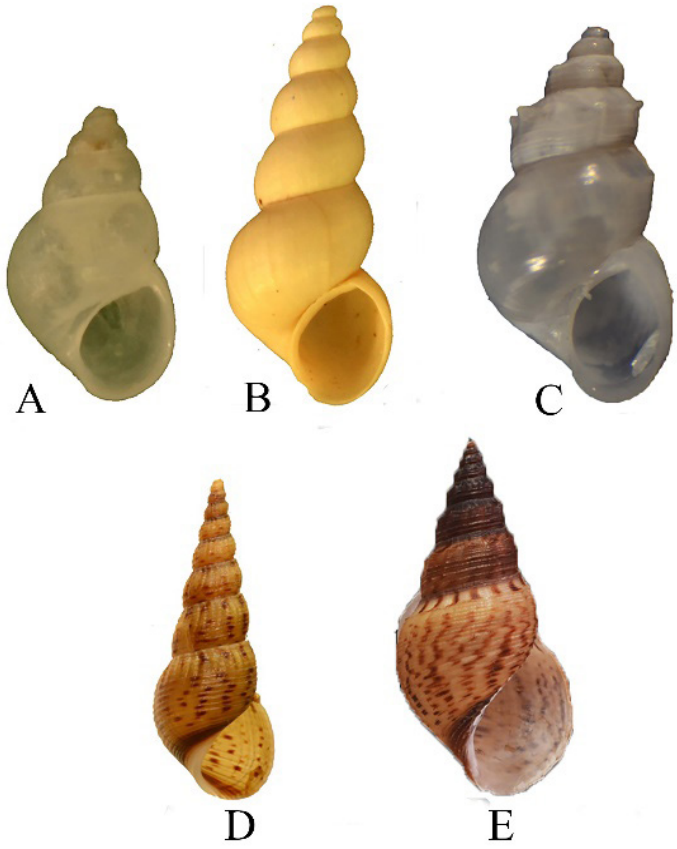

Figure 3. Freshwater snails of Jordan. A. *Heleobia contempta.* B. *Heleobia longiscata*. C. *Pyrgophorus coronatus.* D. *Melanoides tuberculata.* E. *Plotia scabra.*

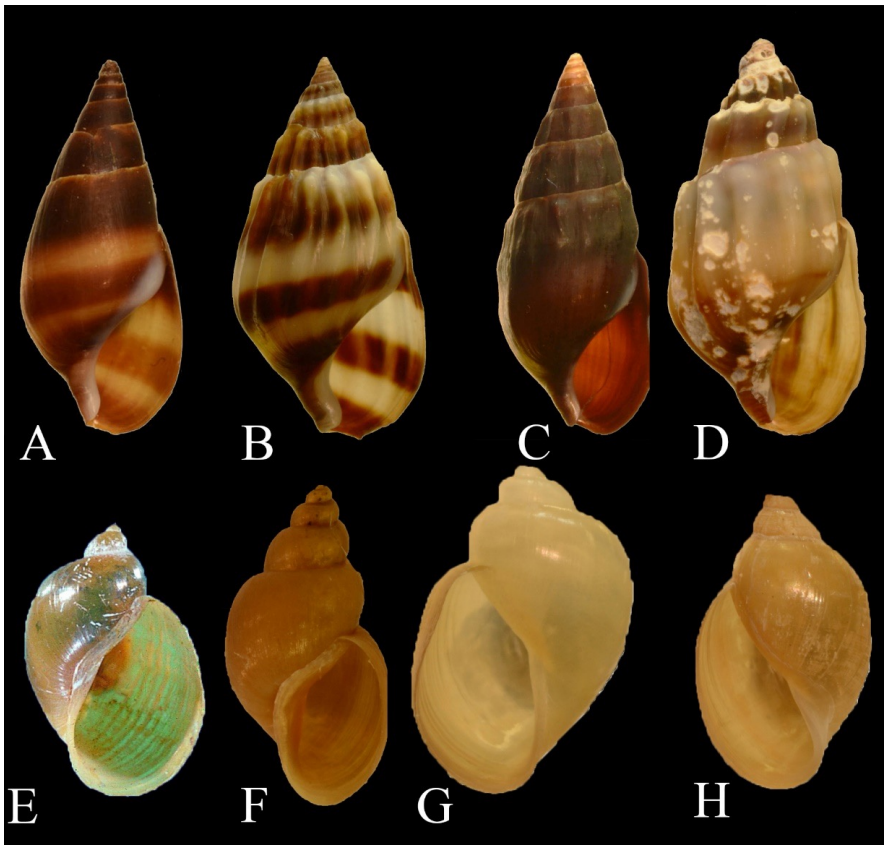

Figure 4. Freshwater snails of Jordan. A. *Melanopsis ammonis.* B. *Melanopsis costata jordanica*. C. *Melanopsis saulcyi.* D. *Melanopsis costata obliqua.* E. *Lymnaea natalensis.* F. *Galba truncatula.* G. *Bulinus truncatus.* H. *Haitia acuta.*

Table 4. Freshwater snail species recorded from Jordan.

Family	Species	Reference(s)
Neritidae	*Theodoxus jordani* (Sowerby 1844)	Burch *et al*. (1989), Amr *et al.* (2014)
	Theodoxus macrii (Sowerby 1844)	Burch *et al*. (1989), Amr *et al.* (2014)
Valvatidae	*Valvata saulcyi* Bourguignat 1853	Burch *et al*. (1989), Amr *et al.* (2014)
Bithyniidae	*Bithynia philalensis* (Conrad 1852)	Burch *et al*. (1989), Amr *et al.* (2014)
Hydrobiidae	*Falsipyrgula barroisi* (Dantzeuberg, 1894)	Alhejoj *et al.* (2017)
	Globuliana gaillardotii (Bourguignat, 1856)	Burch *et al*. (1989)
	Pseudamnicola solitaria Tchernov 1971	Burch *et al*. (1989), Amr *et al.* (2014)
Cochliopidae	*Heleobia contempta* (Dautzenberg 1894)	Burch *et al*. (1989)
	Heleobia longiscata (Bourguignat, 1856)	Burch *et al*. (1989), Amr *et al.* (2014)
	Pyrgophorus cf. *coronatus* (L. Pfeiffer, 1840)	Nasarat *et al*. (2014)
Thiaridae	*Melanoides tuberculata* (Müller, 1774)	Burch *et al*. (1989), Amr *et al.* (2014)
	Plotia scabra (Müller, 1774)	Nasarat *et al*. (2014)
Ellobiidae	*Phytia myosotis* (Draparnaud, 1801)	Schütt (1983), Alhejoj et al. (2017)
Melanopsidae	*Melanopsis ammonis* Tristram, 1865	Burch *et al*. (1989), Amr *et al.* (2014)
	Melanopsis buccinoidea (Olivier, 1801)	Burch *et al*. (1989), Amr *et al.* (2014)
	Melanopsis saulcyi (Bourguignat, 1853)	Burch *et al*. (1989), Amr *et al.* (2014)
	Melanopsis costata jordanica (Roth, 1839)	Burch *et al*. (1989), Amr *et al.* (2014)
	Melanopsis costata obliqua (Bourguignat, 1884)	Burch *et al*. (1989), Amr *et al.* (2014)
	Melanopsis costata lampra Bourguignat, 1884	Burch *et al*. (1989), Amr *et al.* (2014)
Lymnaeidae	*Galba truncatula* (O.F. Müller, 1774)	Burch *et al*. (1989), Amr *et al.* (2014)
	Lymnaea natalensis Krauss, 1848	Burch *et al*. (1989), Amr *et al.* (2014)
Physidae	*Haitia acuta* (Draparnaud, 1805)	Burch *et al*. (1989), Amr *et al.* (2014)
Planorbidae	*Bulinus truncatus* (Audouin, 1827)	Saliba *et al*. (1976), Burch *et al*. (1989), Arbaji *et al.* (1998), Amr *et al.* (2014)
	Gyraulus piscinarium (Bourguignat, 1852)	Burch *et al*. (1989), Amr *et al.* (2014)
	Planorbis planorbis (L. 1758)	Burch *et al*. (1989), Amr *et al.* (2014)

Table 5. Freshwater bivalves recorded from Jordan.

Family	Species	Reference(s)
Unionidae	*Unio terminalis* Bourguignat, 1852	Alhejoj *et al.* (2017)
	Unio semirugatus Lamarck, 1819	Alhejoj *et al.* (2017)
	Corbicula fluminalis (Müller, 1774)	Alhejoj *et al.* (2017)
	Pisidium casertanum (Poli, 1795)	Nelson (1973), Schütt (1983), Alhejoj *et al.* (2017)

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Combating Illegal Bird Trading: The First Project for the Conservation of Alexandrine Parakeets *Psittacula eupatria* (Linnaeus, 1766) in Odisha, India

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Abstract: Illegal wildlife trade critically threatens biodiversity and ecosystem balance, with species like the Alexandrine Parakeet (*Psittacula eupatria*) being particularly at risk. This paper analyzes the global and Indian illegal bird trade, focusing on the Alexandrine Parakeet in Odisha, India. It examines the trade's drivers and ecological impacts on wild populations using a multidisciplinary approach. The study investigates the modus operandi of illegal traders, trafficking routes, and market demand.

Highlighting the conservation status of Alexandrine Parakeets, this work underscores the urgent need for robust conservation efforts. The paper outlines the first comprehensive conservation project designed specifically for this species, which included integrating community engagement, education, habitat protection, and law enforcement to safeguard habitats and curb illegal trade. Through extensive fieldwork, capacity-building programs, and social-awareness campaigns for the youth and local communities, it provides actionable insights and recommendations for policymakers, conservationists, and law enforcement. The study ultimately aims to enhance the understanding of the challenges posed by illegal wildlife trade and propose effective conservation strategies for protecting the Alexandrine Parakeet and its ecosystem, mainly through fostering awareness among the local communities.

Keywords: Illegal wildlife trade, Avian species, social awareness campaigns, law enforcement, Youth involvement, Stakeholder engagement, Ecosystem balance, Conservation Initiatives

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Introduction

Wildlife has been essential for human survival, especially in biodiversity-rich countries (Ojasti and Dallmeier, 2000). The exploitation of wild species has driven the trade in animal products (Broad, 2001). Despite strong regulatory laws, illegal wildlife trade is the third-largest global trade, following drugs and arms trafficking (Barber-Meyer, 2010). Variations in trade drivers, resource use, governance, and enforcement affect management effectiveness (Chan *et al*., 2015). This trade impacts one-third of all bird species and many reptiles, amphibians, mammals, and fish (Rosen *et al*., 2010). In India, the Wildlife Protection Act 1972 and CITES regulate this trade. India has 1330 bird species, with one-hundred species being globally threatened (IUCN Red List, 2019). Overexploitation affects a third of these species (BirdLife International 2008).

Odisha, in eastern India, is rich in biodiversity but is severely impacted by illegal wildlife trade, especially in songbirds. The Utkaliya tradition in Puri's Chariot festival, featuring parakeet figures, highlights the cultural significance of these birds. Pet trade is a major driver, influenced by socio-ecological factors (Auliya *et al*., 2016). Consumers from higher socio-economic backgrounds sustain this trade (Ribeiro *et al*., 2019). Human population growth predicts future illegal trade, and enforcement remains critical. Expanding trade networks incorporate new regions (Ribeiro *et al*., 2019).

Alexandrine Parakeets are popular in India for their mimicking ability and low cost compared to exotic species. Odisha hosts three parakeet species and the Vernal Hanging parrot. Parrots are considered sacred and are valued for their voice-mimicking ability. Illegal poaching and trade, driven by demand from young buyers, threaten these species. Alexandrine Parakeets, which are listed as "Near Threatened" on the IUCN Red List and protected under CITES and Indian law, face rapid decline due to habitat loss and poaching. They inhabit forests, woodlands, and urban areas (Juniper and Parr, 1998; Khera *et al*., 2009).

Illegal trade disrupts ecosystems, causes habitat loss, and undermines conservation efforts. Community engagement and awareness are vital for conservation. Odisha's project, supported by the World Parrot Trust & NECF, is aimed at training forest staff, curbing trade, and protecting habitats. Alexandrine Parakeets are popular cage birds, with significant trade in Asia, Europe, and the US. Their rapid population growth in Europe has raised concerns about their impact on agriculture and native species (Weiserbs, 2009; van Kleunen *et al*., 2010; Roy *et al*., 2015).

Study Area

The study was conducted in Orissa state (20.940 N 84.803 E), Odisha is situated in the eastern coastal belt of India within Southeast Asia. Odisha has thirty unique districts that have been divided into three distinct revenue divisions to streamline governance. By area, Mayurbhanj is the largest district, while Jagatsinghpur is the smallest. The Central, Northern, and Southern Divisions have headquarters at Cuttack (Central Division), Sambalpur (Northern Division), and Berhampur (Southern Division), respectively. The study was carried out across four circles viz., Rourkela, Angul, Sambalpur, Baripada, respectively and six divisions.

Methodology

This project started in January 2023 after receiving funding from the World Parrot Trust for the entire duration of one year. During the Project tenure, the researchers conducted several frontline forest staff-training sessions covering biodiversity conservation, habitat protection, wildlife management, and law enforcement against the illegal trading of Alexandrine Parakeets and other bird species. Hands-on workshops, simulations, and skill-building collaborative exercises have been created to enhance the attendees' ability of handling diverse situations in the field effectively.

The researchers have organized capacity-building programs by holding workshops focused on sustainable resource management, alternative livelihoods, and conservation techniques. The capacity-building programs also entailed holding leadership-development sessions, providing tools for effective community engagement and fostering a sense of ownership among participants. To break the chain of demand and supply, youths and communities were involved in different village-level programs as well as classroom-oriented programs to address the protection associated with the alexandrine parakeet and other native birds. The researchers have also highlighted the role of birds in the ecosystem and the severity of population declination and extinction to reduce the demand. Organizing the first "World Parrot Day" in Odisha, has also been a major achievement, during which the researchers addressed over seventy students from nineteen universities and sensitized them to this issue through quiz competitions, awards, movies and field trip.

Socio-awareness campaigns in various community centers were designed and executed using multimedia presentations, interactive sessions, and informative workshops. The study has engaged local communities in discussions on the importance of bird diversity, wildlife conservation, and the impact of illegal capture and trade on avian diversity while also emphasizing the

significance of the Alexandrine Parakeet species.

Also, environmental education sessions and talks have been held in schools to raise the awareness of students and sensitize them to the status of Alexandrine Parakeets and the issue of illegal trade of the species for various purposes. These talks were focused on elaborating the high impact of the demand and supply chain in the market and the implications associated with it for the conservation of the species. Educating young minds about the detrimental effects of confining species like Alexandrine parakeets in cages at home is crucial for nurturing a sense of empathy and responsibility toward wildlife. By explaining the profound implications of keeping these birds captive, the researchers aimed to instill a deeper understanding of their natural needs and the larger conservation context. They have emphasized the disruption caused to their natural habitats, the adverse impacts on their physical and psychological health due to confinement, and the ethical considerations of restricting their freedom. Encouraging children to explore alternative ways of appreciating and supporting wildlife conservation empowers them to become advocates for these species' well-being in their natural environments. This can foster a generation with a profound respect for the importance of preserving the natural world and its inhabitants. Furthermore, eco-club activities and competitions were organized to help instill a sense of responsibility and to encourage students to stand against all forms of illegal trade in their area. This project facilitated community meetings, participatory planning exercises, and collaborative conservation initiatives involving local stakeholders and the frontline forest staff. These actions have been an integral part of the study's comprehensive strategy, contributing significantly to the researchers' overarching goal of fostering a culture of conservation and enforcement to curb the rapidly rising chain of trade in specific species viz. Alexandrine Parakeet.

Results

The Alexandrine parakeet is revered for its mimicking capability, vibrant green hue, and its perceived association with prosperity, and this increases the demand for it as pets and ornaments. This escalating demand fuels the illegal trade, posing a grave threat to the survival of parakeet populations, risking their imminent local extinction if unchecked. The parakeet trade typically starts from late November and continues until mid-March, as depicted in Figure 1. Poachers identify trees with tall canopies where parakeet nests are located. Once the eggs hatch, and the fledglings reach four to five days old, poachers climb the trees and steal the entire nests of parakeets. Subsequently, poachers nourish these fledglings with "Horse-gram Dal" to ensure their survival until they are ready for smuggling. Afterwards, illegal traders distribute the parakeets in quantities of ten, totaling 100 parakeets, to multiple buyers (ten fledglings each to ten buyers).

1. Sensitization and Capacity-building Programs for Frontline Forest Staff

The researchers conducted capacity-building and sensitization programs for the frontline forest staff and tried to gather information through semi-structed questionnaire interviews about the local ground situation within different divisions for the sake of identifying the potential hotspots of nest raiding and illegal trade centers. This helped assess the reserve forest areas accommodating the nests of parakeets and secure them against parakeet nest robbing by poachers (Table 1). Such engagement highlights the challenges encountered by frontline forest personnel in their daily responsibilities. These issues have been forwarded to the State Wildlife Headquarters for necessary steps to support and aid frontline forest staff in their duties.

2. Training of Frontline Forest Staff

The Odisha Forest department, operating through eight Forest Circles overseen by the

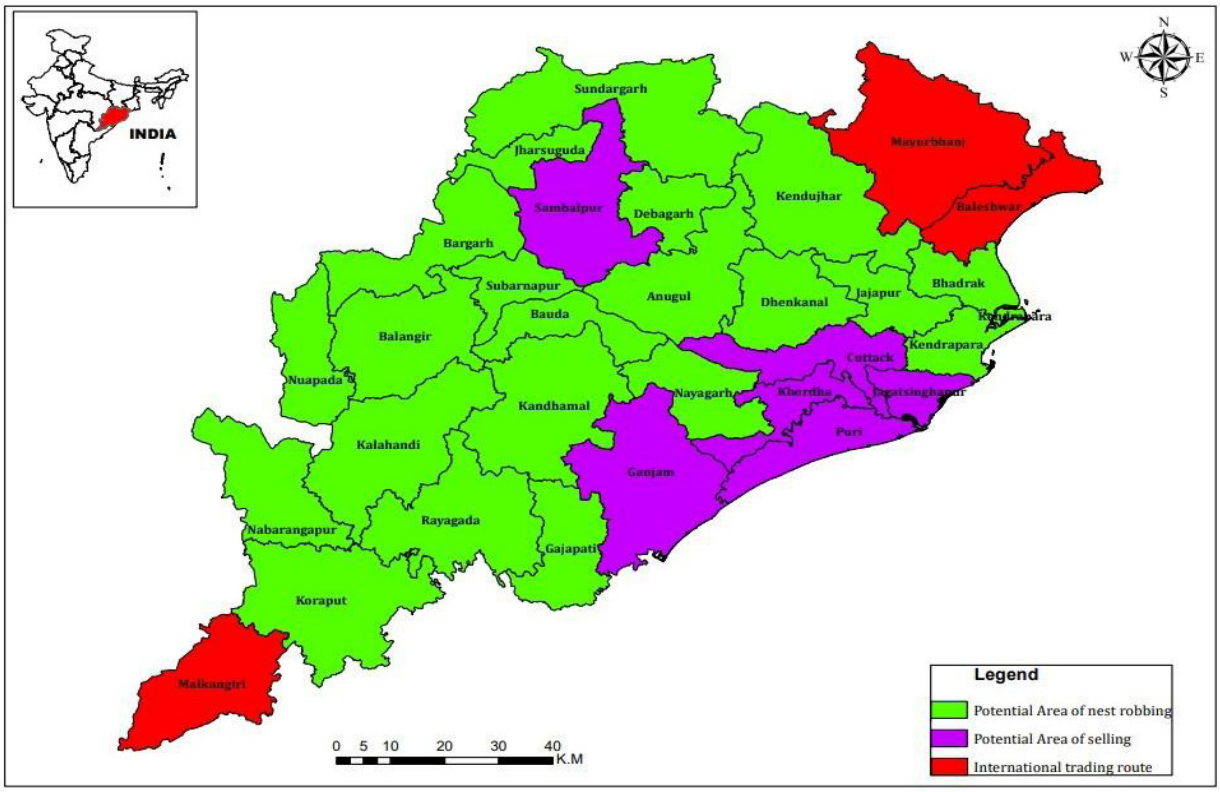

Figure 1. Trading Routes of Parakeets in Odisha

Table 1. Potential areas of Parakeet nests and Population.

Rourkela Circle	
Division Name	**Locations**
Bonai Wildlife Division	Sole Forest Range, Bonai Forest Division, Ulsura RF, Jarda Range,Ramhinala Section, Lunga RF, Siripada RF, Budhapahar RF, Tamara, Koira
Sundargarh Division (T)	Panchore RF, Hemgir Range, Kanika Section, Ujalpur Range,Rupabahal DPF, Gajpan Range
Keonjhar (T)	Kalapat RF, Borabanka RF, Atei RF
Rourkela	Matkujharan, Saranda, Jharkeda RF, Panposh
Angul Circle	
Division Name	**Locations**
Athamallik Division	Northern RF
Athagarh Division	Athagarh RF
Dhenkanal Division	Kapilas Range
Satkosia WL Division	Raiguda Range, Pampasar Range, Tikarpada, Purunakote
Angul (T) Division	Angul, Bantala
Cuttack Division	Nuapada Bazar, Jagatsinghpur, Dartary DPF
Mahanadi (WL) Division	Padamtola RF, Arakhapada RF, Mahanadi RF, Baisipalli RF
Sambalpur Circle	
Division Name	**Locations**
Bamra WL Division	Bandhabar RF, Resalbahal, Jarabaga, Badrama RF
Jharsuguda (T) Division	Raipur, Belpahar, Bagdihi
Hirakud WL Division	Mahultalu, Rengadahala (Jhugdabehera Section)
Sambalpur (T) Division	Dhama Range, Town range, Adar range
Bargarh Division	Gandhamardan PRF, Dechuen RF

Rairakhol (T) Division	Landimal RF, Landakote RF, Kholegarh RF, Sagmalia RF, Raher RF
Baripada Circle	
Division Name	**Locations**
Similipal (South)Division	Jenabil, UBK
Similipal (North) Division	Barheipani (N), Nawana Range, Kendumundi
Rairangpur (T) Division	Bisoi Range, Bankamundi RF, Babalda, Jari RF
Baripada (T) Division	Podadiha, Balidiha, Nedam, Similipal RF
Balasore WL Division	Kuldiha Sanctuary
Keonjhar (WL) Division	Rebana RF, adampahar RF, Budhipet DPF
Karanjia Division	Karanjia range, Boring RF, Satkosia RF

Principal Chief Conservator of Forest, spans thirty districts. Targeting areas most susceptible to parakeet trafficking, the training sessions were conducted in five circles: Rourkela, Angul, Bhawanipatna, Sambalpur, and Baripada. Each session, attended by thirty frontline staff members from respective divisions (Figure 2), included illustration-based education about parakeet trade issues and the distribution of informative materials. Upon completion, participants also received certificates. Following each successful training program, acknowledgment letters were issued by the Circle RCCFs to recognize the organization of such initiatives. The RCCFs have implemented significant measures within their circular divisions to combat the illegal trade effectively.

3. Enforcement and Seizure

Effective seizures were carried out (Figure 3) (Table 2) following a field survey and information has been gathered from local sources, with the assistance of the Odisha Forest Department. Precautionary measures were meticulously observed throughout the planning and execution stages to ensure that the raids were conducted optimally. Following the seizure of caged Parakeets that are still alive, the researchers closely monitored their health by assessing various factors including the wings, diet, feeding habits, and any injuries. Based on their observed conditions, the Parakeets were gradually released in groups to enhance their chances of survival in the wild, considering their natural habitat as high canopy birds with social behavioral patterns.

4. Provision for Bird Rescue Cages

As part of the efforts to tackle the issue of illegal bird trade, the researchers adopted the 4E Strategy, which stands for Educate, Empower, Equip, and Enforce. Through the frontline forest perception studies, the researchers have identified a significant deficiency in the basic rescue cages among the staff, which are particularly crucial for post-rescue care until they can be transferred to aviary enclosures. Presently, every interior division requires rescue cages, especially as most parakeet seizures occur during the fledgling stage. Therefore, to address the critical need for a proper care and management of the rescued birds, ten cages (Figure 4) were made available for distribution among the divisions where ongoing seizures are prevalent,

5. Parakeet rescue from agricultural by-catch

Odisha, primarily an agrarian state, relies heavily on farming for livelihood. The Odisha University of Agriculture and Technology focuses on agricultural development and innovation in the region. During the investigation, the researchers have found that parakeets were often accidentally caught in nets set up to protect corn crops from crows, a key income source for Odisha farmers (Tables 3 and 4).

Figure 2. Training of Frontline Forest Staff from a) Rourkela circle b) Angul circle c) Bhawanipatna circle d) Sambalpur circle e) Baripada circle in Odisha, India

Figure 3. Seizure and Rescue of Alexandrine Parakeets and Rose-ringed Parakeet in Odisha, India

Table 2. Parakeets raid post training programs.

Sl No.	Circle	Division	Date	Species	Numbers
1.	Rourkela	Rourkela	12.02.23	Alexandrine Parakeet	12
2.	Angul	Jagatsinghpur	04.03.23	Alexandrine Parakeet and Ring neck Parakeet	1A: 1R
3.	Angul	Cuttack	14.02.23	Ring-neck Parakeet	10
4.	Sambalpur	Bamra	27.02.23	Alexandrine Parakeet	30
5.	Baripada	Karanjia	30.03.23	Alexandrine Parakeet	23
6.	Rourkela	Rourkela	23.01.24	Alexandrine Parakeet	82
7.	Rourkela	Rourkela	01.02.24	Alexandrine Parakeet	40

Figure 4. Provision for Bird Rescue cages.

Table 3. Corn Farming schedules in Odisha (Occurring throughout the year in Odisha)

Month ofPlantation	Season	Flowering(In days)	Netting (In days)	Harvest(In days)	Total Days(In days)
June to July	Zaid (Monsoon)	50 to 60	60th day onwards	Post 40	100
November to December	Rabi (Winter)	70 to 75	75th day onwards	Post 50	125
February toMarch	Zaid (Summer)	40 to 45	45th day onwards	Post 20	65

Table 4: Parakeets and other birds rescued from by-catch.

Sl. No.	Date	Species	Nos. of Rescue	Flight	Wings	Diet	Date of Relocation
1.	18.02.23	Ring Neck Parakeet F: Adult	1	OK	OK	OK	19.02.23
2.	17.03.23	Jungle Babbler Un: Adult	2	OK	OK	OK	17.03.23
3.	29.05.23	Red vented Bulbul M: Adult	1	OK	OK	OK	29.05.23
4.	17.09.23	Ring Neck Parakeet M: Adult	3	OK	OK	OK	18.09.23
5.	18.09.23	Ring Neck Parakeet F: Sub Adult	2	OK	OK	OK	07.10.23
6.	02.10.23	Ring Neck Parakeet F (2): Adult	3	OK	OK	OK	07.10.23
7.	04.10.23	Ring Neck Parakeet F (2): Adult	3	OK	OK	OK	07.10.23

These trapped parakeets frequently became prey for feral dogs or were sold to illegal traders by farmers seeking extra income. To help solve this issue, the researchers collaborated with the University and farmers, offering small compensation in exchange for each rescued parakeet. Farmers were encouraged to notify the researchers promptly about any trapped parakeets, enabling timely rescues and future monitoring. After a year, this strategy significantly reduced parakeet by-catch incidents, demonstrating the effectiveness of such collaborative approach. The table below shows the netting periods from the beginning of the season until harvest.

6. Building a Quick response team

A rapid response team has been created by the researchers for the rescue of parakeets, gaining the trust of farmer communities and securing permissions from universities and support from local forest divisions. To incentivize cooperation, farmers were compensated with small rewards, certificates, and T-shirts for any nets damaged during the rescue operations (Figure 5). Raising the community's awareness and enlisting the help of farmers and communities have facilitated the safe relocation of rescued birds back into the wild and promoted harmony between two coexisting species in the same landscape.

Figure 5. Action Plan team for the rescue and effective seizures and post-rescue monitoring of birds.

7. Motivating pet owners to Surrender

Parakeets, known for their intelligence, are often considered part of the family, especially when raised by their owners from a young age, even if obtained from illegal traders. This bond can hinder efforts to release them into the wild. Additionally, a diet provided by the owner can lead to dependency and a lack of natural instincts. However, with proper rehabilitation, some parakeets can successfully be reintroduced to the wild after convincing the owner of their potential for survival. The researchers have succeeded in raising awareness and motivating local pet owners in this aspect.

8. Institutional Sensitization Programs

During the surveys, data have been gathered from informants, revealing that unemployed youths are involved in both the consumption and the illegal trade of parakeets. Poachers initially sell these birds at low prices, but by the time they reach buyers, the cost increases drastically. To combat this, the researchers collaborated with universities to raise awareness among students aged between eighteen and twenty-three about Wildlife Protection Acts related to parakeets. Surprisingly, many students were found to be unaware of these laws. Through year-long campaigns, 533 students from twenty colleges were educated. Through the enforcement efforts, the researchers have found that most culprits were youths utilizing social media platforms, mostly YouTube, Facebook, and Instagram Reels for illegal bird sales. To meet the demand for Alexandrine Parakeets, illegal traders, and poachers trade

Ring-necked Parakeets, using the Catechu *Senegalia catechu* extracts to dye their wings to resemble Alexandrine Parakeets. This deception sustains the trade, as it is difficult for people to distinguish between the *P.eupatria* and *P.krameri* species.

9. Organizing the "World Parrot Day"

In 2023, Odisha marked the "Year of Parakeets" with the inaugural "World Parrot Day" at the Nandankanan Zoological Park. Attended by seventy students from nineteen universities across six states in India, the event featured field observations (Figure 6), quiz competitions, and film screenings which highlighted the parakeet conservation efforts in Odisha supported by the World Parrot Trust, UK, and the Natural Encounter Conservation Fund. Praise was received from the State Forest Department and Nandankanan Zoological Park, with the deputy director issuing a letter of support for the Earth Crusaders Organization and World Parrot Trust.

10 Engagement of Local community and Community Sensitization activities

Community engagement is crucial for parakeet conservation. In this work, community involvement was ensured through raising awareness, reducing the demand in the market, and collaborating with the forest department to combat wildlife trade. The sensitization program aimed to achieve four main goals: educating the community about the legal issues of keeping parakeets as pets, highlighting the threat to ecosystems due to the declining parakeet populations, breaking the demand chain in the market, and encouraging community participation in reporting wildlife crimes. The researchers conducted these programs which involved more than 300 community members across eight high-risk districts in Odisha, focusing primarily on tribal and marginalized communities living near parakeet habitats (Figure 7).

Figure 6. Trail walks Organized on World Parrot Day.

11. Building a network of volunteers and Intelligence

Networking has played a crucial role in this project's success, as the researchers established connections with individuals closely associated with pet shop owners to combat smuggling. For security reasons, the informers' data will not be disclosed. The researchers collaborated with local informers and volunteers to gather evidence from social media platforms including YouTube, Instagram, Facebook, and Reels, to create enforcement actions through the forest department. Additionally, the researchers have obtained sensitive information on native bird trading, including the discovery of Red-breasted Parakeets *Psittacula alexandri (*Linnaeus, 1758) a species not previously reported in Odisha. This finding suggests the presence of a population of Red-breasted Parakeets in Odisha, an area less studied by researchers but documented by birders through photography.

Figure 7. Group Photo from the Tribal Community sensitisation in Odisha.

Discussions

Addressing the illegal trade in Alexandrine parakeets demands comprehensive and concerted efforts. Strengthening law enforcement, enhancing international cooperation, and fortifying monitoring and patrolling of habitats are crucial steps. Disrupting smuggling networks and imposing stricter penalties on wildlife traffickers are imperative to curb this illicit trade. In conclusion, combating the illegal trade of Alexandrine parakeets requires a multifaceted approach that integrates law enforcement, international collaboration, habitat protection, and community engagement. Only through a concerted global effort can we hope to preserve these stunning birds and safeguard the delicate balance of their ecosystems.

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Screening Cactus Varieties Resistant to Cochineal Scale, *Dactylopius opuntiae* (Cockerell) (Hemiptera: Dactylopiidae) in Jordan

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Abstract: The cochineal scale, *Dactylopius opuntiae* (Cockerell) is a serious pest of cactus in many parts of the world. It was first recorded in the north of Jordan in 2018 and continued to spread in the country. To use environmentally safe control methods for this invasive pest, two experiments were conducted to find cactus accessions resistant to the cochineal scale. The first experiment was conducted on twenty-six accessions in a growth chamber at a temperature of 27°C ± 0.5°C and 70-80% of RH. The second experiment was conducted in the Jordan Valley and included ninety-nine accessions. All accessions were obtained from the International Center for Agricultural Research in the Dry Areas (ICARDA). Accessions from countries around the world were tested (Algeria, Argentina, Brazil, Italy, Jordan, Mexico, Morocco, South Africa, Syria, and Tunisia). All the first twenty-six accessions were found susceptible to the pest. The average duration of one generation of the insect ranged from thirty days to forty-one days with an average of 36.3 ± 2.59 days. On the other hand, out of the ninety-nine cactus accessions, four were found resistant and showed no infestation at all. These were Unknown 120 and Unknown 122 from Syria, *Opuntia robusta* 1280 from Argentina, and *Opuntia robusta* 200146 from Brazil. The most susceptible accessions were Zastron 4 and M3 Bianca di Macomer from Italy and 40-Tronzar and GS from Tunisia with an infestation rate of more than 90%.

Keywords: Cochineal, resistant varieties, prickly pear, Jordan.

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Introduction

In Jordan, *Opuntia ficus indica* is planted as a fence around farms, mainly for its fruits, which have a good market value in the country. It is sometimes used as animal feed. The cactus growing area in Jordan is estimated at 3,000,000 m², mainly in the Jordan Valley and Madaba, south of Amman, the capital city. However, the actual area is most likely larger than this. Some cactus farms have been established in Madaba, south of Amman, producing around 400 tons per year in this province. It is not easy to estimate the exact area, as cacti are sporadic in-home gardens and garden fences or are scattered in the wilderness and are not traditionally planted on large farms except occasionally. The cochineal scale, *Dactylopius opuntiae*, feeds on cacti causing serious damage to this crop in many parts of the world. Its current distribution includes thirty-one countries: Algeria, Australia, Brazil, Cape Verde, Chile, Cyprus, Egypt, France, Hawaiian Islands, India, Jamaica, Jordan, Kenya, Lebanon, Madagascar, Mauritius, Mexico, Morocco, New Caledonia, Pakistan, Palestine, Reunion, Saudi Arabia, South Africa, Spain, Sri Lanka, Syria, Tunisia, United Kingdom, United States, and Zimbabwe (García *et al*., 2016).

The cochineal scale, *D. opuntiae* attacks all parts of the cactus sucking the sap from cladodes causing yellowing at the beginning, and as the infestation proceeds it covers the entire cladodes and eventually kills the plant (Figure 1). Unfortunately, due to their short lifecycle and shortage of natural enemies in Jordan, farmers' initial control method

Figure 1. Destroyed cacti by *D. opuntiae* in Al-Rafeed in 2018, north of Jordan**.**

was to burn the infested plants. However, over the past decade, many integrated pest-management measures have been evaluated, whether mechanical (pruning), physical (fire), or biological through the multiplication and manipulation of predators and the usage of bio-degradable products and plant extracts such as Neem and Cassava (Borges *et al*., 2013). Vasconcelos *et al*. (2009) tested twenty forage cactus clones for resistance to the carmine cochineal in a greenhouse experiment in Brazil. Akroud *et al*. (2021) studied the mechanism of resistance of the Moroccan cactus ecotypes. Berhe *et al*. (2022) studied six *Opuntia* cultivars collected from different locations in Mexico. Then they studied the mechanism of resistance of the same six varieties (Berhe *et al*., 2023). Sabbahi and Hock (2022) discussed control measures against *D. opuntiae* (Cockerell) in Morocco which included natural extracts, biorational insecticides, natural enemies, pruning and uprooting heavy infestations, and planting resistant cactus varieties.

This research was conducted to screen diverse cactus varieties resistant to the cochineal scale, *D. opuntiae*, which will contribute to any integrated management program that adopts traditional pesticides-free control program for this pest.

Materials and Methods

A total of 125 cacti accessions were tested for resistance to *D. opuntiae.* The first group included twenty-six accessions and was conducted in a growth chamber at the Department of Plant Protection, School of Agriculture, the University of Jordan, while the second group included ninety-nine accessions and was conducted in the field in the Jordan Valley. All accessions were obtained from the International Center for Agricultural Research in the Dry Areas (ICARDA) located near Madaba city about twenty-five km south of the capital Amman. Accessions from various countries around the world were tested (Algeria, Argentina, Brazil, Italy, Jordan, Mexico, Morocco, South Africa, Syria, and Tunisia).

1. Assessment of twenty-six cactus accessions in a growth chamber

Three cladodes (two years old) from twenty-six cacti accessions from different countries worldwide (Table 1) were used. They were left to heal for two days before planting. Later, the three cladodes of each accession were planted in pots 20 cm in diameter and 18 cm in height, with a mixture of soil, sand, and manure (1:1:1 ratio) (Figure 2). The pots were placed in a controlled chamber at 27°C, 70 ± 10 % RH, and 12:12 (L:D). Baskets of medical cloth were hand-rolled, filled with fifteen gravid females, and then pinned on the top of each cladode (Figure 3). The movement of the first instar nymphs was observed daily as they crawled out of baskets and settled on cladodes. The life cycle was followed till the hatching and crawling of the first instar nymphs of the second generation. If one generation was completed on the cactus accession, it was considered susceptible.

Figure 2. Curing and planting of different cactus accessions in a growth chamber.

2. Assessment of ninety-nine cactus accessions in the field

This experiment was based on a research farm in the Deir Alla area in the Jordan Valley. It was conducted in an insect proof screen house (Figure 4). The temperature ranged from 35-45 °C, and relative humidity was 50-80% throughout the whole study period; both were recorded daily throughout the whole experiment via weather forecasts. Three cladodes of the ninety-nine accessions (Table 2) were planted in pots containing peat moss, sand, and clay soil mixed in a 1:1:1 ratio.

Figure 3. Hand-rolled infestation baskets containing gravid *D. opuntiae* females and crawlers.

Cladodes were infested as described in the first experiment. After infestation, observations on infestation occurrence and infestation percentage on each cladode were recorded throughout the weekly site visits, mainly focusing on the cacti accessions with the least *D. opuntiae* infestation. Thereafter, the accessions that showed no infestation were further assessed twice under the aforementioned growth-chamber conditions to make sure that no infestation occurred.

Figure 4. Cacti accessions planted in Deir Alla to assess their resistance to *D. opuntiae*.

Table 1. Names of cacti accessions used in the growth-chamber experiment and their source country.

No.	Accession name	Source country	No.	Accession name	Source country
1	9-FOZA9	Mexico	14.	46-Mornag B-74076	Tunisia
2	10-FOZA10	Mexico	15.	6-Ain Boudriess-96245	Tunisia
3	VN-Villanueva	Mexico	16.	48-Sefrou-74083	Morocco
4	2-25-15	Mexico	17.	32-Morocco-74001	Morocco
5	2-26-21	Mexico	18.	13-Bab Toza-74115	Morocco
6	Red san cono	Italy	19.	22-l Borouj-75018	Morocco
7	Trunzara yellow bronte	Italy	20.	32–Ain Jimaa-75019	Morocco
8	Trunzara yellow San Cono	Italy	21.	BAG-E.E. - Caruaru	Brazil
9	Mezzojuso	Italy	22.	IPA-90-73	Brazil
10	White Roccapalumba	Italy	23.	IPA-90-115	Brazil
11	33-Oueslatia-69246	Tunisia	24.	Additional-1258	Brazil
12	R	Tunisia	25.	Additional-1258	Brazil
13	20-Sbeitla-74071	Tunisia	26	Mucahqqer	Jordan

Table 2. Names of cactus accessions studied in field and their country of origin.

No.	Accession name	Source country	No.	Accession name	Source country
1	Mleeh	Jordan	**31**	M3 Bianca di Macomer	Italy
2	J-Jalpa	Mexico	**32**	M2 Rossa di macomer	Tunisia
3	V1-COPENA V1	Mexico	**33**	RSS Rossa San spate	Tunisia
4	VN-Villanueva	Mexico	**34**	RC Rossa di casttelsardo	Tunisia
5	F1-COPENA F1	Mexico	**35**	M1 Gialla di Macomer	Tunisia
6	Morado	Sicilia, Italy	**36**	GSH Gialla di sarroch	Italy
7	Zastron 4	Sicilia, Italy	**37**	8-Leavis	Tunisia
8	Trunzara Red San Cono	Sicilia, Italy	**38**	8-Algeria	Tunisia
9	Algerian 3/2	Sicilia, Italy	**39**	10-Bianca	Tunisia
10	Blue Motto	Sicilia, Italy	**40**	32-Matmata	Tunisia
11	Roly Poly	Sicilia, Italy	**41**	26-Montarnaud	Tunisia
12	Seedless Santa Margherita Belice	Sicilia, Italy	**42**	47-Mornag B	Tunisia
13	Red Santa Margherita Belice	Sicilia, Italy	**43**	34-Caref 58	Tunisia
14	Yellow Santa Margherita Belice	Sicilia, Italy	**44**	31-Burbank Azrou	Tunisia
15	White Santa Margherita Belice	Sicilia, Italy	**45**	15-Sicile Le folin	Tunisia
16	Yellow San Cono	Sicilia, Italy	**46**	1364	Tunisia
17	White San Cono	Sicilia, Italy	**47**	4-Mexico	Tunisia
18	Red Roccapalumba	Sicilia, Italy	**48**	N	Tunisia
19	Yellow Roccapalumba	Sicilia, Italy	**49**	2-17-25	Tunisia
20	Seedless Roccapalumba	Sicilia, Italy	**50**	2-11-85	Tunisia
21	Trunzara red Bronte	Sicilia, Italy	**51**	2-21-68	Tunisia
22	Yellow Belpasso	Sicilia, Italy	**52**	40-Tronzara	Tunisia
23	Tunzara Bianca bronte	Sicilia, Italy	**53**	17-Sanguinea	Tunisia
24	Trunzara yellow San Cono	Sicilia, Italy	**54**	22-El Borouj	Tunisia
25	Tunzara Bianca San Cono	Sicilia, Italy	**55**	Zelfeue	Tunisia
26	Red Roccapalumba/2	Sicilia, Italy	**56**	G	Tunisia
27	Seedless Margherita	Sicilia, Italy	**57**	GS	Tunisia
28	Spineless	Sicilia, Italy	**58**	2	Tunisia
29	Bari Gialla	Sicilia, Italy	**59**	10	Tunisia
30	BB Bianca de Bonacardo	Italy	**60**	24	Tunisia

61	26	Tunisia	**81**	100001	Brazil
62	29	Tunisia	**82**	200008	Brazil
63	38	Tunisia	**83**	*Opuntia robusta*	Brazil
64	37	Tunisia	**84**	200173	Brazil
65	41	Tunisia	**85**	100004	Brazil
66	42	Tunisia	**86**	100413	Brazil
67	B(6)1	Tunisia	**87**	100412	Brazil
68	43-Mexico	Tunisia	**88**	100408	Brazil
69	59-Unknown	Tunisia	**89**	100407	Brazil
70	60-Unknown	Tunisia	**90**	200002	Brazil
71	61-Unknown	Tunisia	**91**	200016	Brazil
72	20	Syria	**92**	100003	Brazil
73	21	Syria	**93**	20-Chico	South Africa
74	22	Syria	**94**	Unknown 120	Syria
75	25	Syria	**95**	Unknown 121	Syria
76	26	Syria	**96**	Unknown 122	Syria
77	27	Syria	**97**	*Opuntia robusta*-1020	Argentina
78	Mexican vegetable 1294	Brazil	**98**	ANV1-1.08	Argentina
79	100410	Brazil	**99**	*Opuntia robusta* 1280	Argentina
80	200001	Brazil			

Results

1. Assessment of twenty-six cactus accessions in a growth chamber

All the twenty-six cactus accessions obtained from ICARDA were susceptible to *D. opuntiae.* Figure (5) shows the development of the insect white colonies on some of the cactus accessions. The average duration of one generation (from 1st instar to 1st instar) ranged from thirty days to forty-one days with an average of 36.3 ± 2.59 days for all accessions at the temperature of 27°C ± 0.5°C and 70-80% of RH (Figure 6).

Figure 5. Some of the cacti accessions susceptible to *D. opuntiae* are covered with insects.

2. Assessment of ninety-nine cactus accessions in the field

The average infestation % ranged from 0% to 96.67% with an average of 34.7% for all the accessions tested (Figure 7). Four accessions were resistant (0% infestation) to *D. opuntiae*: Unknown 120 and Unknown 122 from Syria, *O. robusta 1280* from Argentina and *O. robusta 200146* from Brazil (Figure 8). Their cladodes showed no attack by nymphs or establishment of a colony formation from the beginning of infestation till the end of the experiment after six weeks. Another twenty-seven cactus accessions had an average infestation % of ten or less. These accessions may be considered more resistant to the scale than the rest of the accessions. These accessions were from countries in the five continents from which the accessions were originally collected. The most susceptible accessions were M3 Bianca di Macomer from Italy and Zastron from Sicilia, Italy. Both accessions had an average infestation% of 96.67. These two accessions were followed by Zelfeue, 40-Tronzara, and GS all from Tunisia with

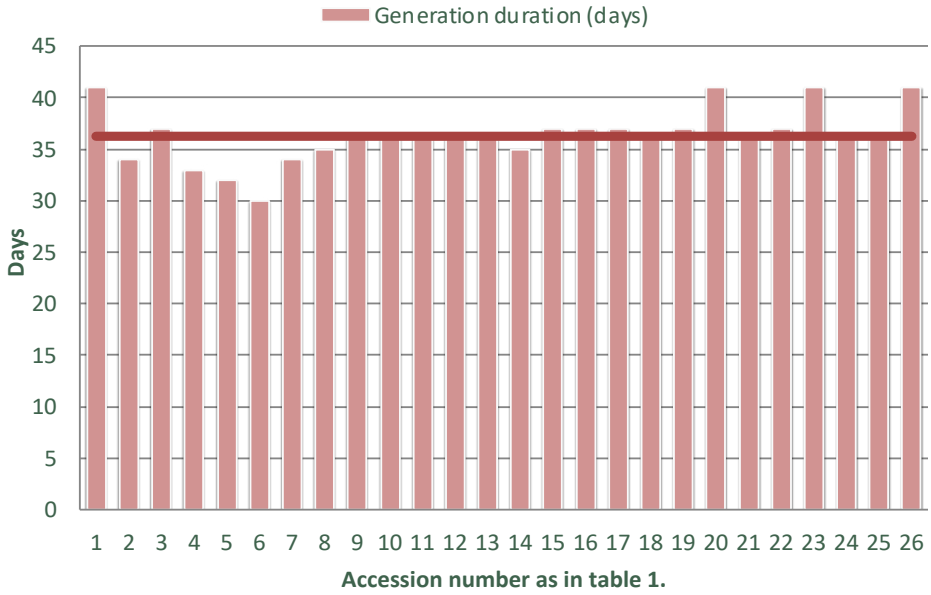

Figure 6. Generation duration per accession.

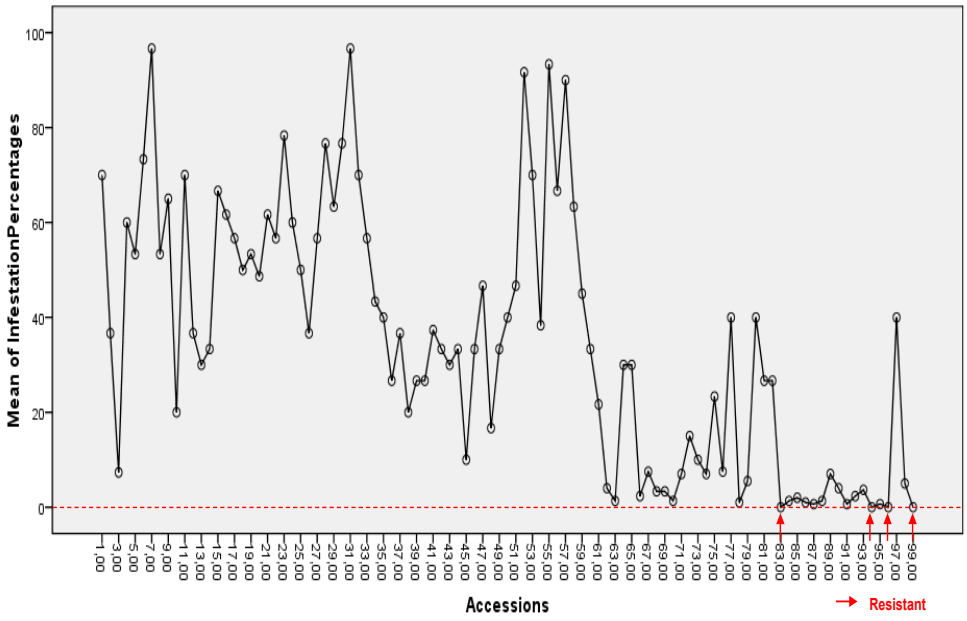

Figure 7. Mean percentage of infestation in the ninety-nine cactus accessions.

an average infestation% of 93.33, 91.67, and 90.00, respectively. These four accessions may be considered as highly susceptible (with 90% infestation or more). The re-infestation of the four resistant accessions under controlled conditions showed no infestation for a period of thirty days.

Discussion

Since the cochineal scale was able to develop for an entire generation on all tested cactus accessions in the first experiment, all twenty-

Figure 8. The four resistant accessions (A: *O. robusta* 1280, B: Unknown 122, C: Unknown 120, D: *O. robusta* 200146) at the end of the experiment, free of infestation.

six accessions were considered susceptible. The average duration of one generation of *D. opuntiae* on the first twenty-six cactus accessions ranged from thirty days to forty-one days with an average of 36.3 ± 2.59 days. According to Flores Hernandez *et al*. (2006), the ideal temperature and relative humidity for the development of *D. opuntiae* are 26 ° C and 60%, respectively. Palafox-Luna *et al*. (2018) found that females took 16.7 ± 2.69 days to complete development, while males took up to 24.48 ± 2.23 days under a temperature of 25 ± 1 °C and 40 ± 10% of RH. Whereas in this study, the insects took a longer period (an average of 36.3 ± 2.59 days for all accessions) at a temperature of 27°C ± 0.5°C and 70-80% of RH. This difference in the generation time could be attributed to the different cactus accessions used in both experiments or is due to the difference in external environmental factors such as RH, temperature, and light.

When a larger number of cactus accessions were studied (the second patch of ninety-nine accessions), four cactus accessions did not show any signs of infestation and were later proven to be resistant to *D. opuntiae* in growth-chamber conditions (Unknown 120 and Unknown 122 from Syria, *O. robusta* 1280 from Argentina and *O. robusta* 200146 from Brazil). No previous studies were found in the literature related to these specific accessions. However, Vasconcelos *et al*. (2009) tested twenty forage cactus clones for resistance to the carmine cochineal in a greenhouse experiment in Brazil from September 2001 to January 2002. The clones that showed greater resistance to the pest attack were Miúda and Orelha de Elefante, while the Redonda clone was highly susceptible. Berhe *et al*. (2022) studied six *Opuntia* cultivars collected from different locations in Mexico: three *O. ficus-indica* ('Rojo Pelón', 'Atlixco', and 'Chicomostoc'), two *O. cochenillifera* ('Nopalea'and 'Bioplástico') and one *O. robusta* ('Robusta'). Their results showed that the 'Rojo Pelón' variety was resistant to *D. coccus* among the *O. ficus-indica* cultivars because the insects could not develop and complete the life cycle but died at the nymph I stage. Berhe *et al*. (2023) studied six cultivars, those were three *O. ficus-indica* (resistant 'Rojo Pelón' and susceptible 'Atlixco' and 'Chicomostoc'), two *O. cochenillifera* (resistant 'Bioplástico' and susceptible 'Nopalea') and one *O. robusta* (resistant 'Robusta'). They found that cladode thickness, calcium oxalate number, and epidermis thickness had positive correlations with resistance. These results demonstrate that calcium oxalate number and epidermis thickness might have a positive role in *Dactylopius coccus* Costa resistance in *O. ficus-indica*. Akroud *et al*. (2021) showed that antibiosis and antixenosis (nonpreference), played a role in the resistance of the Moroccan cactus ecotypes. Eight cultivars resistant to *D. opuntiae* were identified, registered, multiplied, and planted on a large scale in Morocco (Sabbahi and Hock, 2022).

The authors believe that the four resistant cactus accession found in this study are potential tools in developing an integrated pest management program against the cochineal scale. Further research is needed to study the sources of resistance in these accessions whether they are chemical, physical or both. In addition, the suitability of these accessions for the farmers and consumers should be studied. It is important to emphasize the benefits of using resistant varieties by farmers and plant protection specialists as well. Using resistant varieties is considered an ideal pest control strategy since it reduces the insect population in the area and shows permanent effects. This strategy is also safe for humans and the environment and does not require advanced knowledge on the part of farmers when it comes to implementation.

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First Record of the Lime Butterfly *Papilio demoleus* (Linnaeus, 1758) (Lepidoptera: Papilionidae) from Jordan

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Abstract: The lime butterfly *Papilio demoleus* (Linnaeus, 1758) (Lepidoptera: Papilionidae) is recorded from Jordan for the first time based on the identification of three specimens collected from Al Kurayyimah in the Jordan Valley during May 2024. Its biology, ecology, and distribution are briefly discussed.

Key words: Papilionidae, *Papilio demoleus*, lime swallowtail, invasive species, Jordan, Citrus.

Introduction

Five species of Papilionidae are known to occur in Jordan: *Papilio machaon syriacus* (Verity, 1908), *Papilio alexanor maccabaeus* (Staudinger, 1892), *Allancastria deyrollei eisneri* (Bernardi, 1971) *Archon apollinus* (Herbst, 1789), and *Papilio saharae* (Oberthür, 1879). (Larsen and Nakamura, 1983; Katbeh-Bader *et al*., 1998; Katbeh Bader *et al*., 2004). However, the lime butterfly, *Papilio demoleus* (Linnaeus, 1758), has never been recorded in Jordan before. *Papilio demoleus* has many common names: citrus dog, lemon butterfly, lemon caterpillar, lime butterfly, lime swallowtail, and orange butterfly. This butterfly is distributed in tropical and subtropical regions of southern Asia, ranging from Turkey, Syria, Lebanon, Iraq, Saudi Arabia, Iran and the Middle East to India, Nepal, southern China, Taiwan, and Japan. It is also found in Malaysia, Indonesia, New Guinea, and Australia. Also, it has been recorded in the Dominican Republic, Cuba, Puerto Rico, and Jamaica (CABI Compendium, 2021; Başbay *et. al*. 2020, Guerrero *et al*., 2004; Homziak and Homziak, 2006; Larsen, 1977 and 1984; John *et al*., 2021; Morgun and Wiemers, 2012; Koçak *et al*., 2006; Peggie *et al.,* 2022).

Several subspecies are known of this species: *Papilio demoleus demoleus* (Linnaeus, 1758) is known in the Middle East, southern Asia and China, *P. d. malayanus* (Wallace, 1865), in South-East Asia, *P. d. novoguineensis* (Rothschild, 1908) in New Guinea, *P. d. libanius* (Fruhstorfer, 1908) in Taiwan, and *P. d. sthenelus* (Macleay, 1826) in Australia. A similar species, *Papilio demodocus* (Esper, 1798), is found in the Afrotropical region (including southern Oman, Yemen, and southwestern Saudi Arabia (Pittaway, l985).

Benyamini *et al.* (2007) confirmed the records of *Papilio demoleus* (Linnaeus, 1758) in Syria and discussed its appearance in Turkey and the Dominican Republic. After it was first recorded from Palmyra in 2003–2006, the lime butterfly was found in Aleppo in 2020. Its appearance maybe associated with abandoned agricultural areas due to the war or to climate change which may be considered as an indicator of climate change during last two decades in Syria (Zarikian, 2020).

Papilio demoleus attacks cultivated *Citrus* spp. in rural or urban areas but avoids dense, damp forests, and very wet areas. *P. demoleus* larvae feed on at least nineteen citrus species and varieties (Yunus and Munir, 1972). Feeding on the leguminous genus, *Psoralea* appears to be confined to the Australasian subspecies (Common and Waterhouse, 1981), but the Babchi, *Psoralea corylifolia* was found as a host in India (Pandey and Bogawat, 1969). Other hosts recorded from India were the Custard Apple, *Annona squamosa* and the Champak, *Michelia champaca* (Patil and Rajashekhargouda, 1985). Riaz *et al*. (2020) reviewed the morphology, life cycle and management of two invasive subspecies of *P. demoleus* including *P. d. demoleus*. Radke

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and Kandalkar (1988) found that the female laid fifteen to twenty-two eggs, but Farid (1987) recorded a maximum of 511 eggs per female. The natural lifespan of wild adults rarely exceeds six days (Singh and Gangwar, 1989). Badawi (1981) studied some aspects of its biology and ecology in Saudi Arabia.
The objective of this article is to record the presence of *P. demoleus* in Jordan for the first time and to alert citrus farmers in Jordan and plant protection specialists to the presence of this invasive pest.

Materials and Methods

Three specimens were collected by Dania Ashowbaky from a home garden with citrus trees in Al Kurayyimah, Jordan Valley (32°16'35.00" N 35°35'57.77" E), 153 m below sea level, in May 2024. Another specimen was seen on the 3rd of June 2024 under an orange tree at the same location. The specimens were deposited at the University of Jordan Insect Museum.

Results and Discussion

The three specimens were identified as *Papilio demoleus* (Linnaeus, 1758) (Figure 1). It appears to be as a natural range expansion of the Syrian populations of this species. The subspecies is most probably *P. d. demoleus* since the Syrian populations have been recently identified as *P. d. demoleus* based on a molecular study (John *et al*., 2021). It is probable that *P. demoleus* has been introduced accidentally to new areas with citrus stock as egg, larvae, or pupae. Its spread may be promoted by new citrus plantations in agricultural or urban areas. It is possible that this butterfly has been in Jordan for several years but was not detected by farmers or non-specialists because it was thought to be one of other known papilionids such as *Papilio machaon* Linnaeus. This species is expected to expand its range in Jordan southwards, following citrus plantations along the Jordan Valley and may reach at a certain time to Aqaba at the southern tip of Jordan. Furthermore, it may expand its range into Palestine and Egypt and even other citrus cultivation areas in the southern Mediterranean countries.
Peggie *et al.* (2022) showed that the average duration of eggs was 3.7 days on *Citrus* spp., the duration of larvae lasts from thirteen to nineteen days, prepupal duration for one day, pupal duration lasts from nine to fourteen days and the total duration of the immature stages was between twenty-six and thirty-eight days. Adults live up to nineteen days in captivity. Therefore, the butterfly is expected to develop several generations in a year in Jordan. Its development may be arrested in the months of extreme hot summer months in the Jordan Valley, but it is expected to breed continuously in other seasons of the year.
It may attack citrus trees in home gardens in

Figure 1. *Papilio demoleus* Linnaeus, 1758 dorsal (left) and ventral (right) views.

the high lands.

Synthetic pyrethroids such as deltamethrin are highly effective for the control of *P. demoleus* larvae, however, integrated pest management using as biocontrol agents, microbial pesticides and phytopesticides, with synthetic pesticides should also be implemented (Riaz *et al*., 2020). A survey should be carried out to determine the current distribution of this insect and to evaluate the damage caused by its larvae to citrus orchards. In addition, natural enemies, and alternative hosts other than citrus should be investigated. Citrus farmers and plant protectionists in Jordan should be alerted to the presence of this invasive butterfly in Jordan.

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Morphology and Sexual Dimorphic Traits in the Scales and Fins of the Old-World Cyprinodontiform fish *Aphaniops sirhani* (Actinopterygii: Aphaniidae)

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Abstract: Sexual differences between males and females have been of special interest in the study of systematics/taxonomy, phenotypic evolution, and the farming of different invertebrate and vertebrate taxa including fishes. Sexual differentiation may be a result of natural selection, sexual selection, or a combination of the two. This study aims to examine the microscopic characteristics of scales and rays in the toothcarp *Aphaniops sirhani* (Cyprinodontiformes: Aphaniidae) that is endemic to Azraq wetland in northeastern Jordan. The study discusses the taxonomic and evolutionary significance of these structures and determines whether they can be used as secondary sexual dimorphism traits. The findings here indicate that the Azraq killifish males of the toothcarp have contact organs that exhibit sexual dimorphism in the form of spicule-like structures in the anal-fin rays and ctenus-like structures in the posterior margin of the scales. The contact organ variations in size, number, and location may offer a taxonomic and evolutionary signal for a deeper comprehension of the aphaniid species.

Keywords: Killifishes, toothcarps, sexual differences, ctenus-like structure, spicule-like structure, systematics

Introduction

Sexual differences between males and females have been of special interest in studying systematics/taxonomy, phenotypic evolution (Beltrán *et al*., 2022), and the farming of different invertebrate and vertebrate taxa including fishes. Sexual differentiation can arise from natural selection, sexual selection, or the combination of the two and can most likely be attributed to either the female mate choice or to the male-male competition (Moore *et al*., 1990; Abrahão *et al*., 2019; Beltrán *et al*., 2022). Sexual selection/ secondary sexual dimorphism has triggered the evolution of remarkable morphological novelties among different groups of fishes: i) sexual size dimorphism (differences in the mean body size of adult male and female individuals). It includes female-biased sexual size dimorphism (females are larger than males e.g., *Gambusia holbrooki*, *Orestias gloriae*), and male-biased sexual size dimorphism (males are larger than females) e.g., *Iranocichla persa* and *I. hormuzensis*, ii) sexual colour dimorphism/ dichromatism (differences in male and female coloration as observed in the genera *Aphanius*, *Aphaniops* and *Paraphanius*, iii) sexual shape dimorphism (comparative analysis of shape variation in males and females using geometric morphometrics or GM), e.g., *Caquetaia kraussi*, a cichlid fish with cryptic morphological behavior (Hernandez *et al*., 2022), iv) sexual structural dimorphism (differences in the presence or absence of a macrostructure: clasper, gonopodium, breeding tubercles, urogenital papilla in males and ovipositor in females (Esmaeili *et al*., 2017; Garcia and Zuanon, 2019; Esmaeili *et al*., 2020a); teeth variation as seen in the ray *Urotrygon microphthalmum* (de Sousa Rangel *et al*., 2016), and differences in the dentition on the fifth ceratobranchial of males and females of *O. gloriae* (Vila *et al*., 2011); gill glands in the mature males of Cheirodontinae; contact organs on the scales and fins of male profundulids (Velázquez-Velázquez *et al*., 2022; Esmaeili *et al*., 2023; Sungur *et al*. 2023); bony hooks along unbranched and

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anteriormost branched rays of the pelvic and anal fins of male *Tyttobrycon shibattai* (Abrahão *et al*., 2019), and differences in the length, width, and density of the dermal denticles on the pectoral fin, area posterior to the pectoral fin, caudal fin, and pelvic girdle of mature females and males of the lesser-spotted catshark, *Scyliorhinus canicula* (Crooks *et al*., 2013), v), sexual olfactory dimorphism (larger olfactory organs of mature males of characid fish *Tyttobrycon shibattai* (Abrahão *et al*., 2019), and vi), sexual glandular dimorphism (hypertrophied tissues, caudal fin gland, and caudal fin organ (see Malabarba and Weitzman, 1999; de Oliveira *et al*., 2012; Fukakusa, 2020).

In the order Cyprinodontiformes, secondary sexual dimorphism is associated with i) the occurrence of contact organs on scales and fins (Esmaeili *et al*., 2023; Sungur *et al*., 2023), ii) size differences and sexual dichromatism/ colouration pattern (Esmaeili *et al*., 2020b; Velázquez-Velázquez *et al*., 2022), iii) specific structure e.g., gonopodium in males (Wiley and Collette 1970; Tripathi, 2018; Esmaeili *et al*., 2020b; Velázquez-Velázquez et al., 2022), and iv) otoliths of some aphaniid fishes (Motamedi *et al*., 2021; Teimori *et al*., 2021). However, comparatively, the contact organs have received less attention. These unique structures are found in some families currently classified in the order Cyprinodontiformes: Anablepidae, Cyprinodontidae, and Poeciliidae. Contact organs originate as bony dermal outgrowths of the scale margin or the ray (Wiley and Collette, 1970; Velázquez-Velázquez *et al*., 2022); they were first reported by Garman (1895) as "small spines appearing on the fins of males in several genera" of cyprinodontiform fishes during the breeding season (Wiley and Collette, 1970). The contact organs have been reported in some species of the family Aphaniidae classified in the genera *Aphanius*, *Aphaniops,* and *Paraphanius* based on Esmaeili *et al*., (2020b), or other genera (see Freyhof and Yoğurtçuoğlu, 2020) (Table 1).

Table 1. Taxonomic position of aphaniids mentioned in the present study based on Esmaeili et al. (2020), and Freyhof & Yoğurtcuoğlu (2020).

Esmaeili et al. (2020b)	**Freyhof & Yoğurtcuoğlu (2020)**
Aphanius anatoliae (Leidenfrost, 1912)	*Anatolichthys anatoliae* (Leidenfrost, 1912)
Aphanius chantrei (Gaillard, 1895)	*Anatolichthys chantrei* (Gaillard, 1895)
Aphanius darabensis Esmaeili, Teimori, Gholami & Reichenbacher, 2014	*Esmaeilius darabensis* (Esmaeili, Teimori, Gholami & Reichenbacher, 2014)
Aphanius iconii Akşiray, 1948	*Anatolichthys iconii* (Akşiray, 1948)
Aphanius marassantensis Pfleiderer, Geiger & Herder, 2014	*Anatolichthys marassantensis* (Pfleiderer, Geiger & Herder, 2014)
Aphanius meridionalis Akşiray, 1948	*Anatolichthys meridionalis* (Akşiray, 1948)
Aphanius shirini Gholami, Esmaeili, Erpenbeck & Reichenbacher, 2014	*Esmaeilius shirini* (Gholami, Esmaeili, Erpenbeck & Reichenbacher, 2014)
Aphanius sophiae (Heckel, 1847)	*Esmaeilius sophiae* (Heckel, 1847)
Aphanius villwocki Hrbek & Wildekamp, 2003	*Anatolichthys villwocki* (Hrbek & Wildekamp, 2003)
Aphaniops ginaonis (Holly, 1929)	*Aphaniops ginaonis* (Holly, 1929)
Aphaniops kruppi (Freyhof, Weissenbacher & Geiger, 2017)	*Aphaniops kruppi* (Freyhof, Weissenbacher & Geiger, 2017)
Aphaniops sirhani (Villwock, Scholl & Krupp, 1983)	*Aphaniops sirhani* (Villwock, Scholl & Krupp, 1983)
Aphaniops stoliczkanus (Day, 1872)	*Aphaniops stoliczkanus* (Day, 1872)
Paraphanius alexandri (Akşiray, 1948)	*Paraphanius alexandri* (Akşiray, 1948)
Paraphanius mento (Heckel, 1843)	*Paraphanius mento* (Heckel, 1843)
Paraphanius similis (Akşiray, 1948)	*Paraphanius similis* (Akşiray, 1948)

Materials and methods

Study Area

Azraq wetland is situated in northeastern Jordan (Figure 1), with an area of 74 km square featuring both seasonally flooded expanses and five permanently flooded and restored water bodies (Figure 2). It is the first Ramsar site in Jordan declared in 1977. It hosts the only endemic vertebrate in Jordan, namely the Azraq toothcarp *A. sirhani*. The whole area is protected and managed by the Royal Society for the Conservation of Nature as the Azraq Wetland Reserve where systematic monitoring and restoration programmes are carried out.

The climate in the Azraq region is harsh and arid, characterized by a hot and dry summer with temperatures reaching a height of 40 C°. Winters are somehow cool with temperatures reaching 0 C° sometimes. Water abstraction, habitat loss, and the existing of invasive species are the greatest threats facing the Azraq wetland and the ongoing restoration programmes.

Studied taxa

The scales and anal fin were removed from the alcohol fixed (70%) specimens collected from the Azraq Oasis, Jordan, 31°49’59.0”N, 36°49’19.1”E.

Scale preparation

Light microscopy

The scales were removed from six specific regions along the longitudinal axis of both

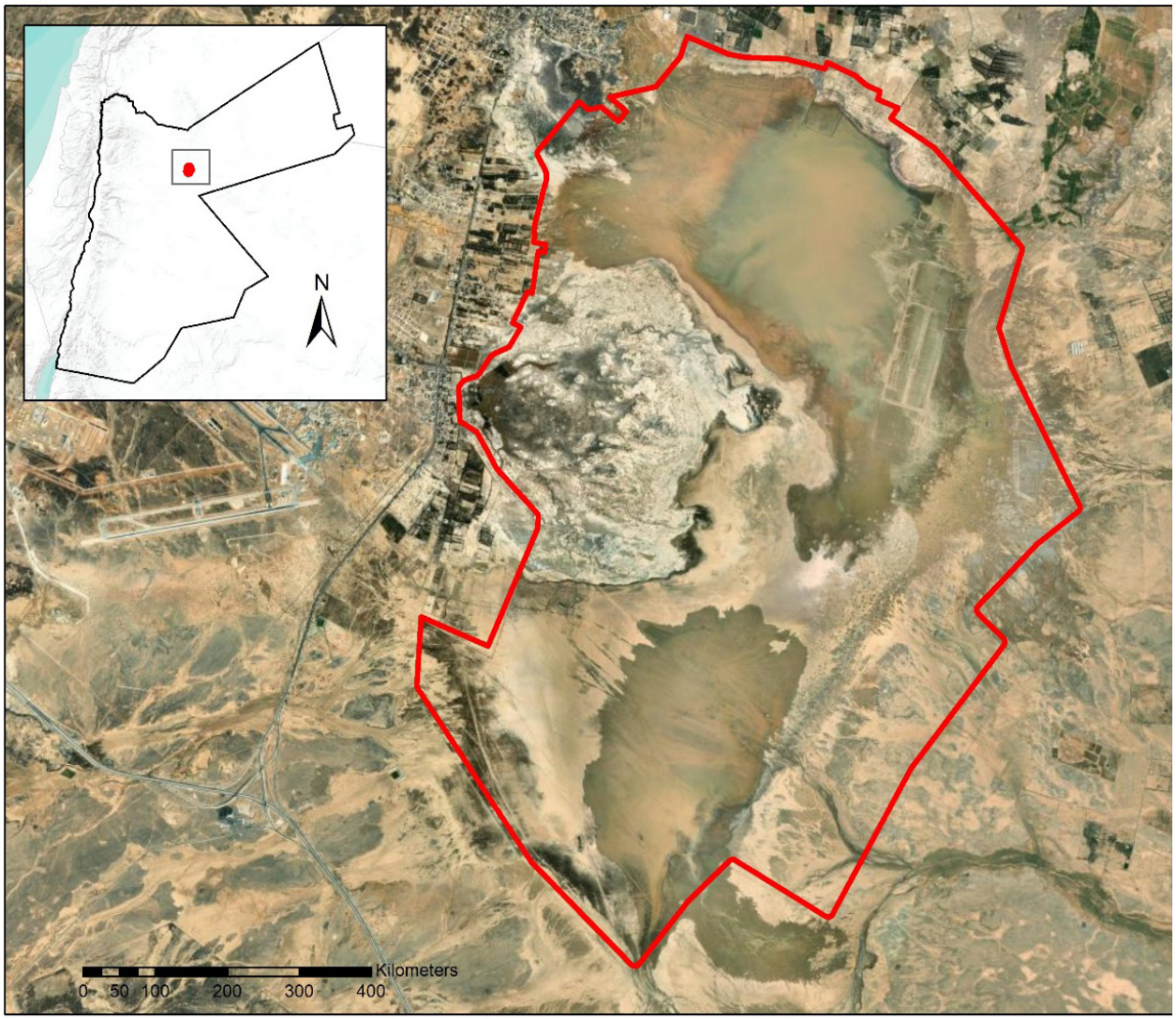

Figure 1. Location of the Azraq wetland in northeastern Jordan.

Figure 2. The permanent flooded type of habitats in the Azraq wetland.

male and female specimens. This extraction process was performed meticulously using tiny forceps, as seen in Figure (3). To prepare the scales used in this study, the researchers followed Lippitsch (1990), Esmaeili (2001), Gholami *et al*. (2013), Echreshavi *et al*. (2021), and Esmaeili *et al*. (2023). After removal, the scales were promptly rinsed with distilled water, subjected to a cleansing process, and were then immersed in a 1% potassium hydroxide (KOH) solution for forty minutes. This procedure aimed to eliminate the presence of soft and mucous tissues adhering to the scales' surface, using a suitable brush for this purpose. Subsequently, the scales underwent dehydration in a sequential series of ethanol solutions with concentrations of 30%, 50%, 70%, and 90% (with each step lasting thirty minutes), followed by thorough drying using filter paper. Finally, to mitigate the potential torsion of the scale edges, the scales were placed between two glass slides (Lippitsch, 1990; Figure. 3).

Scanning electron microscopy

As for the scanning electron microscopy, the scales were removed with fine forceps from the left side of the body, without damaging the scale (Lippitsch, 1990, 1995). Immediately after their removal under a dissecting microscope, the scales were rinsed in distilled water, and the adhering and irrelevant tissues were detached mechanically using a fine brush and were transferred into a 1% KOH solution for forty minutes to remove the soft tissues from the surface (Sadeghi *et al*., 2020; Echreshavi *et al*., 2021; Esmaeili *et al*., 2023, Sungur *et al*., 2023). After dehydration in 30, 50, 70, and 90% ethanol at thirty-minute intervals, the cleaned scales were dried on the Whatman filter papers, and to avoid curling the margins of the scales, they were immediately mounted on aluminium stubs using a double adhesive tape with the dorsal surface being upward. The stubs were coated with gold to a thickness of 100 Å in a gold coating unit.

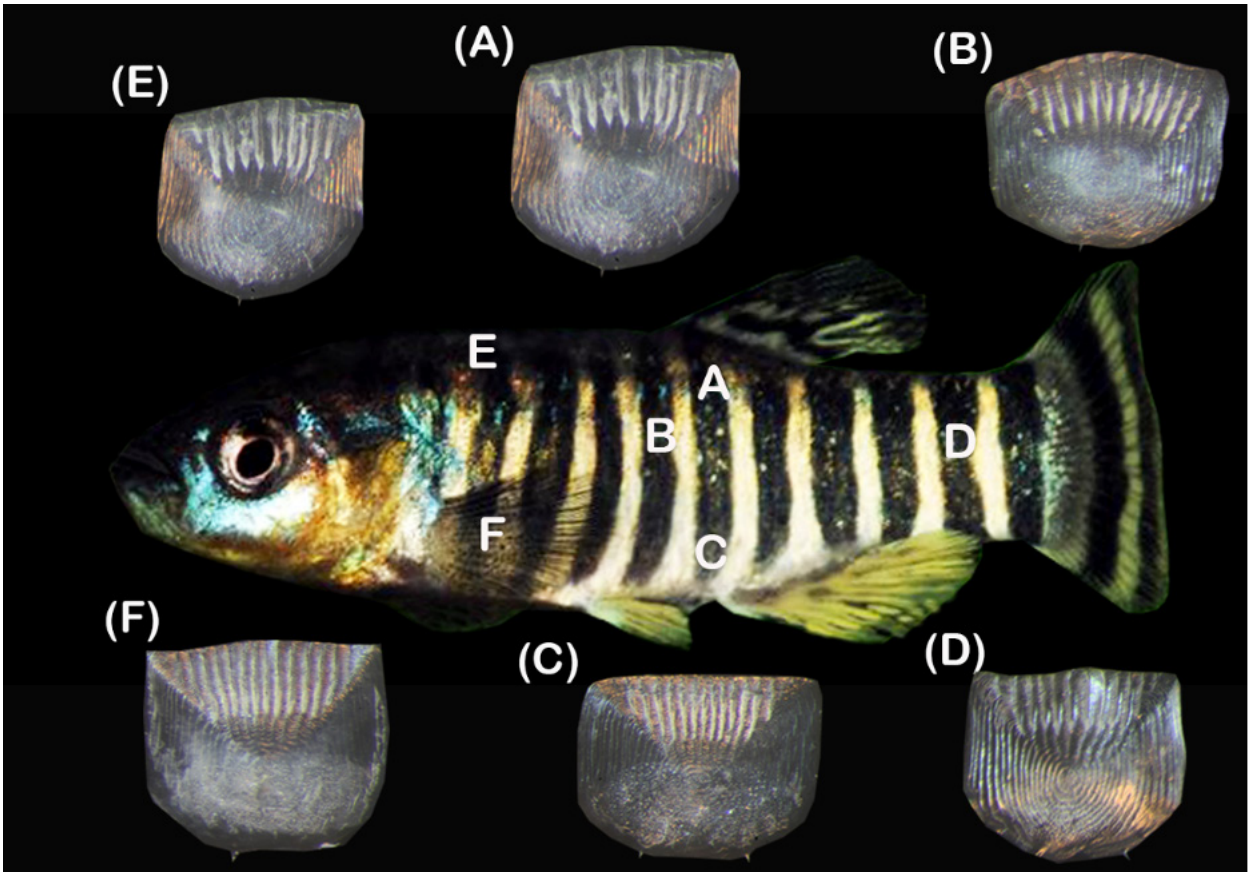

Figure 3: Image of male *Aphaniops sirhani* showing six different studied body regions where scales were removed from the left side of the fish. (A) Key scale below the dorsal fin; (B) middle of the body; (C) dorsal area of the pelvic fin; (D) caudal peduncle; (E) head region; (F) beneath the pectoral fin.

Digital imaging

The cleaned scales were then subjected to digital imaging using a Canon EOS 7D Camera connected to a computer for light microscopy. The gold coated scales were subjected to digital imaging using a TESCAN vega3 SEM instrument (Shiraz University, Iran) at 15 or 20 kV., and several images per scale were captured. The digital images were then used to do the morphological descriptions.

Fin preparation and digital imaging

The fins were removed, cleaned, and stained (bone alizarin and cartilage counter-stained with Alcian blue), following the technique recommended by Taylor and van Dyke (1985). The cleaned and stained fins were then subjected to digital imaging using a Canon EOS 7D Camera connected to the computer for light microscopy (Esmaeili *et al*., 2023).

Terminology of scales and fin rays

The terms used to describe the characteristics of scales and fins (Esmaeili *et al*., 2023) are as follows:

Contact organs: Dermal protrusions that are made of bone and are located on the posterior margin of the scales (ctenus-like structure on the posterior margin of the scales in males) or fin ray (spicule-like structure in the rays of the anal fin of males) (Figure. 4F).

Fields: The parts of the scale surface in the anterior, posterior, and two lateral parts (Figure. 4A).

Focus: The first area of the scale that appears. The geometrical position of the focus varies in different forms of scales and may be in the posterior, anterior, or posterior-central and central areas of the scale (Figure. 4A).

Circulus/circuli: Continuous concentric lines that approximately follow the outline of the scale and are commonly interrupted

by radii in the anterior part of the scale (Figure. 4C).*Radius/radii*: Groove/grooves that usually radiate from the focus to the edges (Figure. 4A).
Primary radii: Radii that extend from the focus to the edge of the scale (Figure. 4A).
Secondary radii: The radii that are formed with the distance from the center and toward the outer edge of the scale (Figure. 4A).
Tertiary radii: Radii that are positioned between the scale margin and the focus and are the shortest radii (Figure. 4A).
Ctenus/cteni: Tooth-like structure(s) that become ossified. The cteni appear in one or more rows on the margin of the posterior field (Figure. 4E).
Granules/tubercles: Protrusions of different shapes, sizes, and numbers are located on the posterior part of the scale (Figure. 4D).
Lepidonts: Small tooth-like structures that are located on the crown of circuli and have different shapes (Figure. 4B).
Sectioned scales: Scales with well-developed radii (Figure. 4).

Results

Light microscopy

The overall shapes of the scales in six body regions in *A. sirhani* are given in Figure (5). Scales were relatively large, of the cycloid type, with numerous radii (sectioned scale). These cycloid scales were further categorized into several subtypes being quadrilateral/square in all body regions of males, and quadrilateral/square in the A, B, and D regions, circular/true circular in the C region, and Intermediate/calyx in the E and F regions of the female specimens. The scales showed the general characteristics of the aphaniid scales. Each scale displayed a rostral field, two lateral fields, and a caudal field, with numerous circuli. The rostral field is embedded in the dermis, and only the caudal field is visible on the surface. The scales from all six regions demonstrated ctenus-like structures in males (Figure. 5), but these structures were not present in the scales of female individuals.

Scanning electron microscopy

The overall shapes of the scales in six body regions in *A. sirhani* are given in Figure 6. The scales were large, of the cycloid type, with numerous radii (sectioned scale), and presented general characteristics of aphaniid scales. Each scale displays a rostral field, two lateral fields, and a caudal field, with numerous circuli. Circuli in the rostral field were closely spaced and interrupted vertically by primary, secondary, and sometimes by tertiary radii, while they were widely spaced and continuous on the lateral and caudal fields. The change in the curvature of the circuli, the absence of radii and a lower number of circuli on the lateral fields determined the boundary between the rostral and lateral fields. Fusion of some of the circuli were mainly on the lateral fields. The caudal field contained tubercles which give colour to the fish body. The caudal field was recognizable due to the remains of the thin, soft tissue of the skin on its borders, the widening of the intercircular spaces and fewer circuli. The caudal field beard tubercles

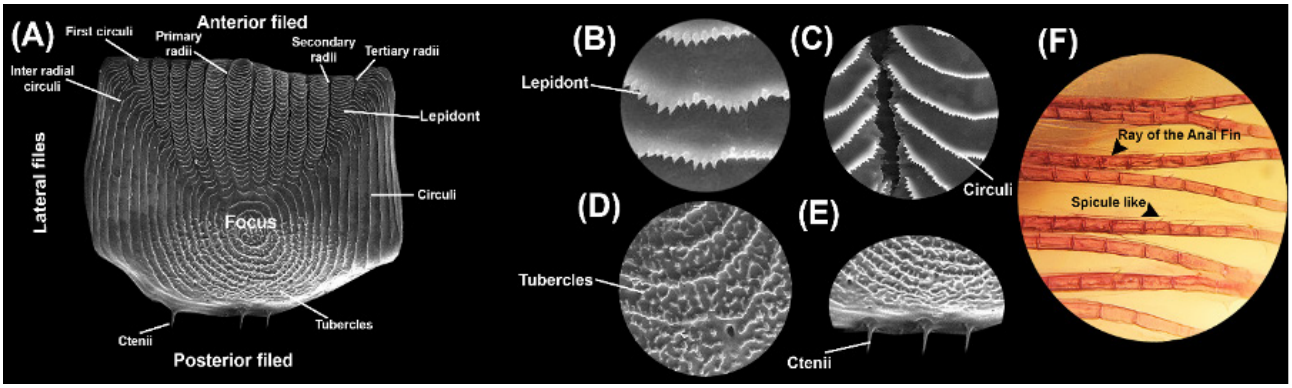

Figure 4: Morphological terminology of an aphaniid fish scale and ray of the anal fin. (A), general morphology; (B-E), microstructures on the scale. (F), Digital illustration of the anal fin and its rays.

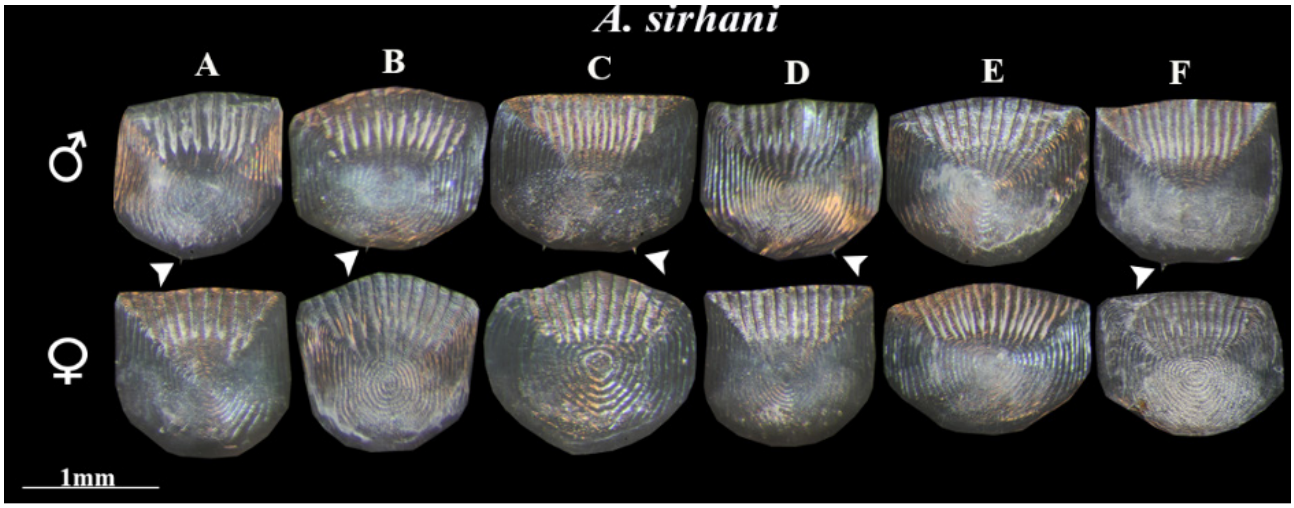

Figure 5: Light microscopic photographs of scales from different regions (A–F) in male and female individuals of *Aphaniops sirhani*. Arrows show ctenus-like structures (contact organs).

or was without tubercles. Focus was distinct and clear, with different sizes, almost with tubercles located in the central position or slightly toward the posterior.

Based on these SEM figures, none of the examined females had contact organs in the form of ctenus-like structures in the posterior part of their scales, while the male specimens displayed one to three ctenus-like structures in the posterior part of the scales (Figure. 6), revealing remarkable structural sexual dimorphism.

Fin ray

The examined males of *A. sirhani* presented contact organs in the form of spicule-like structures on the distal end of the anal-fin rays. These organs were in rows along the inner surface of the fin rays (Figure. 7), and spicules were numerous, thin, and small (almost no spicules on the proximal and middle parts). No spicule-like structures were seen on the caudal-fin rays. Female specimens had no contact organs on the anal-fin rays (Figure. 7).

Discussion

The study provides details of the macro and microstructure of scales, and the existence of novel characteristics related to sexual dimorphism in the scales and anal-fin rays of *Aphaniops sirhani*, and aphaniid species restricted to the Azraq Oasis in Jordan.

Scale morphology

The scales of *A. sirhani* show the general main characteristics of aphaniid scales, and this finding is consistent with the findings in previous studies on other aphaniids

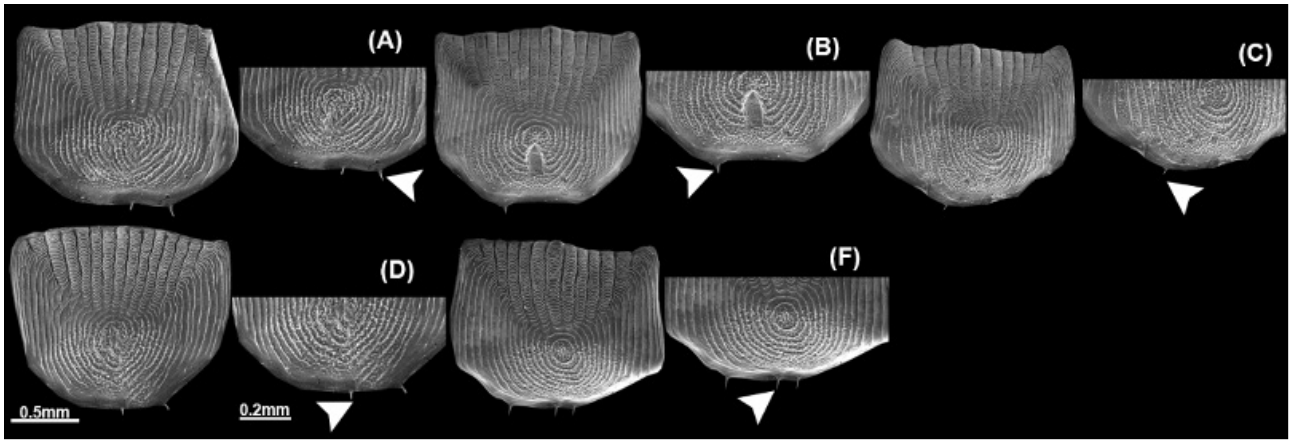

Figure 6: Scanning microphotographs of scales from several regions in male individuals of *Aphaniops sirhani*. Arrows show ctenus-like structures (contact organs).

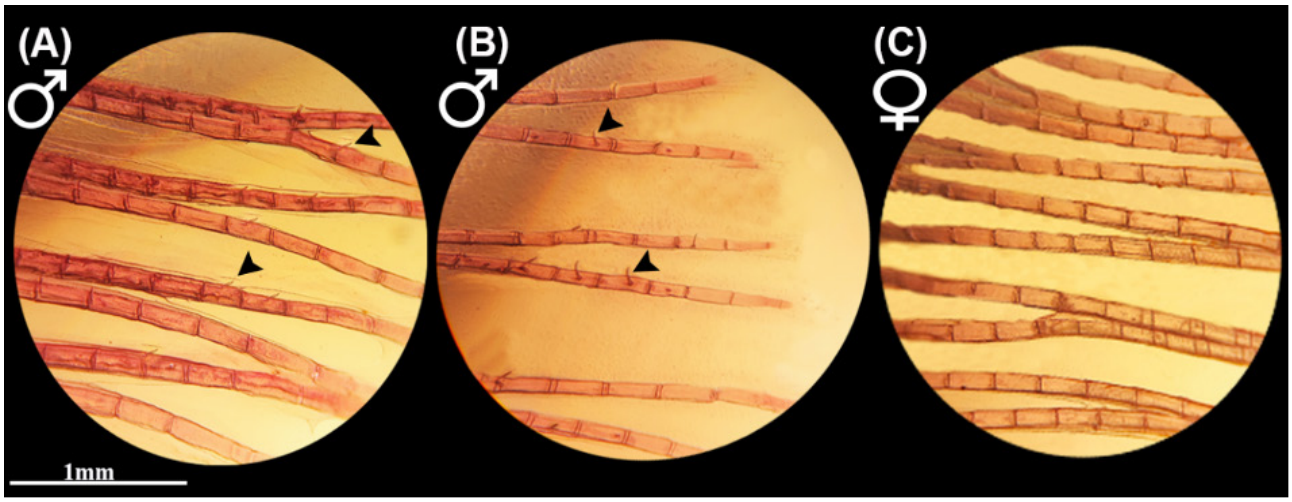

Figure 7: Light microscopic photographs of anal fin rays in male (A, B), and female (C) individuals of *Aphaniops sirhani*. Arrows show spicule-like structures (contact organs).

(e.g., Gholami *et al*., 2013; Teimori *et al*., 2017 a,b; Esmaeili *et al*., 2019, 2023; Esmaeili *et al*., 2023; Sunger *et al*., 2024). The scales exhibited a cycloid morphology, distinguishing them from the placoid, ganoid, or ctenoid scales of other bony fishes. These scales displayed typical features such as anterior, posterior, and lateral fields, as well as fin architectural structures including focus, radii, circuli, inter-circular space, and lepidonts. The cycloid scales were in the forms/subtypes of quadrilateral/square, circular/true, and intermediate/calyx depending on the sex and their locations on the fish body. Based on Sunger *et al*. (2024), the scales of the genera *Anatolichthys* and *Paraphanius* exhibit a notable level of diversity, including circular (true circular) 48%, circular (cordate) 24%, quadrilateral (square) 10%, intermediate (calyx) 8.2%, polygonal (pentagonal) 4.5%, oval (reversed ovoid) 2.6%, oval (ovoid) 1.8% and oval (oblong) 0.9%. Based on Esmaeili *et al*. (2023), the spinoid cycloid type scales are found in *Aphanius arakensis, Ap. darabensis, Ap. kavirensis, Ap. mesopotamicus, Ap. pluristriatus, Ap. shirini, Ap. sophiae*, and *Ap. vladykovi* species (placed in the genus *Esmaeilius* by Freyhof and Yoğurtçuoğlu, 2020) (Table 1). In *A. farsicus, Paraphanius mento, Aphaniops ginaonis, A. hormuzensis, A. kruppi,* and *A. stoliczkanus*, the overall shape is polygonal (pentagonal). *Aphanius baeticus* presents quadrilateral (square) scales, while *Ap. isfahanensis* demonstrates polygonal (pentagonal) or circular (discoidal) scales (Esmaeili et al., 2023). However, it should be noted that these subtypes exhibited no sexual dependency, a characteristic shared with other members of the Aphaniidae family, as shown by Esmaeili *et al*. (2023), and Sunger *et al.* (2024). Generally, the morphological variation observed in nature may be the result of phenotypic plasticity, ecological character displacement, local adaptation, genetic divergence, or the interaction of any of these main factors (Nicieza, 1995) in the species, subspecies, populations and even different body parts of the same individual. At the species level, morphological differences among the species are often considered genetic divergent as consequences of competition and ecological preferences so that different species exploit various resources (e.g. Ehlinger and Wilson, 1988; Dynes *et al*., 1999). However, the among-population differences are often considered to be the result of adaptation to local environmental conditions (e.g. Mittelbach *et al*., 1992). To sum up, variation in morphology has resulted either from environmental effects on phenotypic characters or by counteracting genetic differences between populations (Marcil *et al*., 2006).

The scales of many fish taxa show variable shapes and possess a high degree of morphological plasticity within species, specimens, and body parts, often making a clear identification at the species level

difficult for some taxa (Ganias, 2014; Braeger *et al*., 2017). Similarly, in other fish body parts, the scale phenotype is also affected by genetic, environmental and their covariate effects, during the lifespan of the fish (Garduno-Paz *et al*., 2010; Ibanez *et al*., 2012; Staszny *et al*., 2013, 2019). Scale morphology varies considerably at the level of species, population (e.g., age, size, sexual maturity and sex) and different body regions (e.g., Gholami *et al*., 2013; Teimori *et al*., 2017 a,b; Esmaeili *et al*., 2019, 2023; Motamedi *et al*., 2020; Sabbah *et al*., 2021; Al Jufaili *et al*., 2021; Sunger *et al*., 2024). Within the same population, the plasticity in scale morphology is likely to be in connection with the ontogenetic development of the fish body shape, which was described in detail in several studies (see Zelditch and Fink, 1995; Reis *et al*., 1998; Braeger *et al*., 2017; Staszny *et al*., 2019).

Some scale morphological characteristics can be used as diagnostic features at the genus level for aphaniids. Males of the genus *Anatolichthys* can be distinguished from the genus *Paraphanius* by having a higher number of ctenus-like structures and a wider distribution range (vs. a low number of ctenus-like structures and a narrow distribution range). Esmaeili *et al*. (2023) revealed variations in the position, quantity, and dimensions of contact organs across many typical species of the Aphaniidae family, such as *Aphanius* (=*Esmaeilius*), *Aphaniops,* and *Paraphanius*.

Sexual dimorphism

Sexual dimorphism refers to differences between males and females of a species in secondary sex-related features, including body size, colour pattern, morphological details of specific body parts, and behaviour (Esmaeili *et al*., 2023). Sexual colour dimorphism/dichromatism (SCD) is the main and primary sexual dimorphism recorded for the aphaniid species (see Esmaeili *et al*., 2020). As in all members of the family Aphaniidae, sexual colour dimorphism is pronounced in *Aphaniops sirhani* (Figure. 8). Males of *A. sirhani* exhibit a series of dark vertical bars on the flanks with usually two bars in the caudal fin. The fins are yellowish with some dark markings, especially in the dorsal and caudal fins. Females are larger and much plainer possessing only a series of irregular dark spots on the body and completely hyaline finnage. Male individuals of *Paraphanius* display a colour pattern consisting of various shades of grey, blue, or nearly black bodies, often accompanied by irregularly shaped and positioned iridescent blue-white to silvery spots (Freyhof and Yoğurtcuoğlu, 2020; Esmaeili *et al*., 2020, 2023; Sunger *et al.,* 2024). These spots may form narrow vertical rows along the flanks, particularly in juvenile specimens. Furthermore, males possess a caudal fin that features very narrow rows of blue–white or silvery spots, or small blotches, arranged in bands against a black or blue background (Freyhof and Yoğurtcuoğlu, 2020). Male *Anatolichthys* present black or dark-brown bars in the caudal fin, a series of black or brown patterns in the flanks, and black dorsal and anal-fin margins. Female *Anatolichthys* present a bold, black spot at the center of the caudal-fin base (Freyhof and Yoğurtcuoğlu, 2020).

Besides the sexual colour dimorphism, in a recent study conducted by Esmaeili *et al.* (2023) on sixteen aphaniid species (classified under the three genera *Aphanius*, *Aphaniops,* and *Paraphanius*), the presence of a new morphological characteristic (contact organs/ctenus-like structures) on the scales of male individuals were observed and documented. In another work by Sunger *et al*. (2024) on nine species and two genera of aphaniids including *Anatolichthys anatoliae*, *An. chantrei*, *An. iconii*, *An. marassantensis*, *An*. cf. *meridionalis*, *Anatolichthys* sp., *An. villwocki*, *Paraphanius alexandri*, and *P. similis*, the researchers documented the presence of contact organs in the forms of ctenus-like structures in the posterior margin of the scales, and spicule-like structures in the anal-fin rays of males in all examined species. The present study revealed that these contact organs are present in the

Figure 8: Sexual colour dimorphism in *Aphaniops sirhani*. male (upper) and female (lower).

posterior margin of the scales and anal-fin rays of males in another aphaniid species (*A. sirhani*). The contact organs are not present in the scales of female specimens of *A. sirhani* (present study) and all other studied aphaniids except *Aphaniops ginaonis* though females had fewer contact organs (Esmaeili *et al*., 2023; Sunger *et al*., 2024).

Aphaniops sirhani presents ctenus-like structures in the scales of all the six examined regions. This also applies to some other congeneric species including *A. kruppi* and *A. stoliczkanus* (Esmaeili *et al*., 2023).

The variation is observed in the scales of other male aphaniids being in one or more areas of the fish body in the male specimens: being in one region (*An. Anatoliae*, *Aphanius darabensis*), two regions (*An. marassantensis*), three regions (*An. iconii* and *An*. cf. *meridionalis*), four regions (*Aphaniops ginaonis*), five regions (*An. chantrei*, *An. villwocki*, *Paraphanius alexandri*¸ and *P. similis*, *Aphanius vladykovi*), and six regions (*Anatolichthys* sp.), (Esmaeili *et al*., 2023; Sunger *et al*., 2024).

In addition, the location, number, and extent of contact organ development varied intra- and interspecifically in the aphaniid species.

The number of contact organs on the scales of the genus *Aphaniops* are more than those in the genera *Aphanius* and *Paraphanius*, and they were short, pointed, and wide covering almost the entire posterior area of the scales (Esmaeili *et al*., 2023). Most of the species of the genus *Anatolichthys* are also characterized by a higher number of ctenus-like structures and a wider distribution range and were variously short, pointed and wide in shape (Sunger *et al*., 2024). However, the species of the genus *Paraphanius* are characterized by a low number of long and pointed ctenus-like structures limited to a region in the posterior part of the scales (Sunger *et al*., 2024). Hence, these characteristics might provide a taxonomic and evolutionary signal. Variations are also found in the position of contact organs in the fin rays of aphaniids as presented in Figure (9) (Esmaeili *et al*., 2023; Sunger *et al*., 2024, and the present study).

Contact organs have long been known in fish-related publications under a confusing variety of terms (Kang *et al*., 2013; Tripathi, 2018; Velázquez-Velázquez *et al*., 2022). Esmaeili *et al*. (2023) have shown that contact organs in male aphaniid fishes mostly manifest in mature individuals and during periods of active reproduction. During the spawning season, several species of aphaniids, including *Aphanius fasciatus*, show courtship displays. In this habit, both male and female individuals exhibit a strong affinity for one another, maintaining close physical proximity by adhering to each other's posterior regions. Notably, the male fish envelops the whole of the female fish body with its own. The conduct serves as evidence for the presence and importance of contact organs in reproductive processes (Grech and Schembri, 1993; Cavraro *et al*., 2013).

Conclusion

The findings of this study demonstrate that *Aphaniops sirhani* (i) exhibit sexual colour dimorphism, (ii) their cycloid scales display phenotypic flexibility across several body regions, (iii) sexual dimorphism in their contact organs is seen in the forms of ctenus-like structure (in the posterior margin of the scales), and in the form of spicule-like structures on the distal end of the anal-fin rays in male individuals; such structures are

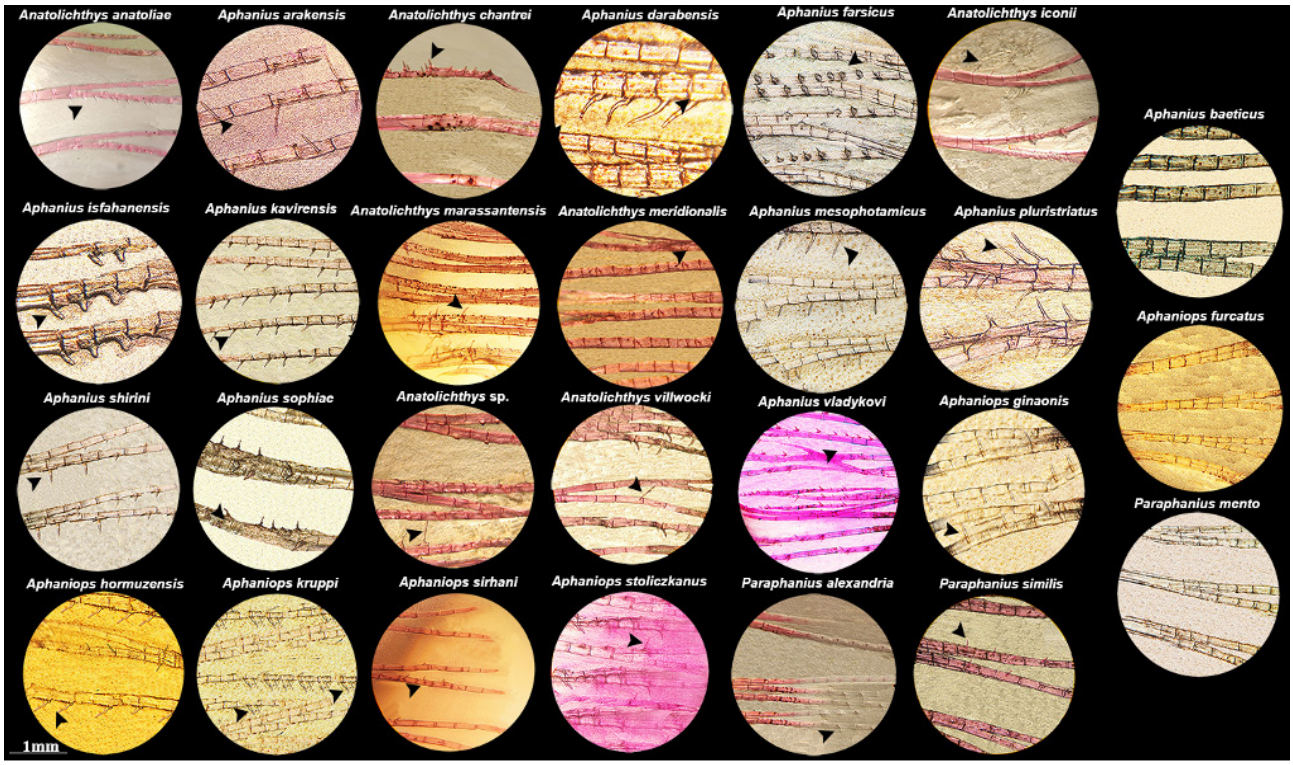

Figure 9: Light microscopic photographs of anal fin rays in male individuals of 27 aphaniid species. Arrows show spicule-like structures (contact organs), based on Esmaeili et al. (2023), Sunger et al. (2024), and the present study.

mostly functional and facilitate the physical contact between male and female individuals during the active phase of reproduction, (iv) females do not exhibit contact organs, and (v) variations in size, number, and position of contact organs in aphaniids might provide a taxonomic and evolutionary signal.

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Short Communication

A New Record of the Sand Cat, *Felis margarita*, from Al-Dahek Reserve in the Eastern Desert, Jordan

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The Sand Cat (*Felis margarita*) is a small-sized desert felid weighing two to three kg. Sand Cats have a broad head with large eyes, low-set ears, and short limbs. The tail, which can account for about half of the head-body length or 28-38cm (Ghadirian *et al.*, 2016), features two or three rings and a black tip. Sand Cats have dense hair and pads on the soles of their feet that protect against the intense heat and coldness of their habitat, as well as aiding in movement across the Sand. (Smithsonian's National Zoo and Biology Institute, 2020). It is found in Sand deserts and gravel deserts ranging from the north of Africa to Asia, with the Arabian Peninsula as its central distribution area (Sausman, 1997). It is well adapted to living in arid areas and where temperature changes are extreme ranging from 0C° to 58C° (Sausman, 1997). The Sand Cat is a nocturnal, spending the days in shallow burrows or under vegetation (Ahmad *et al*., 2016). Its preferred prey consists of small rodents, reptiles and insects. (Abbadi, 1991; Bunnian *et al.,* 1998; Cunningham, 2002).

The Sand Cat was recorded for the first time in Jordan by Mountfort (1965) in Wadi Rum during the second Jordan international expedition. It was reported again in Wadi Rum after finding a skull (Hemmer, 1978) which confirmed its first record in Wadi Rum. Bunaian *et al.,* (1998; 2001) have recorded the Sand Cat in the Eastern Desert three times, two of which occurred by observation and the third was conducted using a trap near Mansheyat Al-Ghiath. Later, the Sand Cat was recorded near Al Safa Dam (Hamidan and Al-Gheyyath, 2017).

Throughout the survey in Al-Dahek Protected area in the Eastern Desert (31.6767 N 34.98483 E), the Sand Cat was photographed on the 28th of February 2024 at 9:48 p.m. using a camera trap in an area dominant with *Soda rosmarinous* and *Anabasis articulata* (Figure 1). This record was confirmed after three months on the 16th of May 2024 in the same loCation providing evidence of the presence of the Sand Cat in this region. The first record of the Sand Cat in Al-Dahek Reserve expands the distribution map of this species in Jordan.

The Sand Cat is one of the common types of carnivores in the Eastern Desert in Jordan; many carnivores have been recorded in the Al-Dahek PA, such as the Wolf, *Canis lupus*, the Sand Fox, *Vulpes rueppelli,* the Red Fox, *Vulpes vulpes*, the Striped Hyaena, *Hyaena hyaena* and Caracal, *Caracal caracal.* (Amr, 2012).

According to the classifiCations of the IUCN red list, the Sand Cat is considered a least concern species in the world and is listed as a critically endangered species in Jordan according to the National Red data book of mammals in Jordan (Eid *et al.,* 2020). Also, the Sand Cat is listed in Appendix II of the CITES. The Sand Cat can be considered as a key species for Al-Dahek PA, which gives the reserve greater importance and increases the need for more programs to monitor this species and others as well in the region.

The assumption made by Eid *et al*. in their published article in 2022 that the Sand Cat is inevitably facing extinction has not fully considered the recent positive developments in conservation efforts. The establishment of new protected areas in Burqu' and Al Dahek has demonstrated promising outcomes, as evidenced by the recording of new Sand Cat populations within these PAs. These findings suggest that the creation and effective management of protected habitats can

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significantly bolster the survival prospects of the Sand Cat by providing safe habitats that minimize human disturbances and habitat encroachment. These PAs can counteract some of the adverse effects predicted by climate change scenarios. This progress highlights the critical role of proactive conservation measures and indiCates that the populations of the Sand Cat can be improved which creates a renewed era for its continued existence. Therefore, the assumption of the Sand Cat's inevitable extinction should be reconsidered in light of these conservation successes and the high level of uncertainty provided by climate change scenarios in the arid areas. Finally, satellite tracking research will be of a high advantage to understand and determine the population size of the Sand Cat in Al Dahek PA, its home range, breeding, and behavior. More importantly, it can help draft a science-based conservation plan to save this species.

The Dahek PA is considered an extension of the Hammadah vegetation patterns in the Eastern Desert, and according to the records in Dahek PA and Burqu PA, the Sand Cat might be found between the two PAs. This requires further studies in the Eastern Desert region and necessitates the installation of tracking devices using satellites to identify the expected places to record this species. Including this record, the distribution of the Sand Cat in Jordan expands to three PA as shown in the figure below (Figure 2).

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Figure 1. Sand Cat photographed in Al-Dahek by a camera trap.

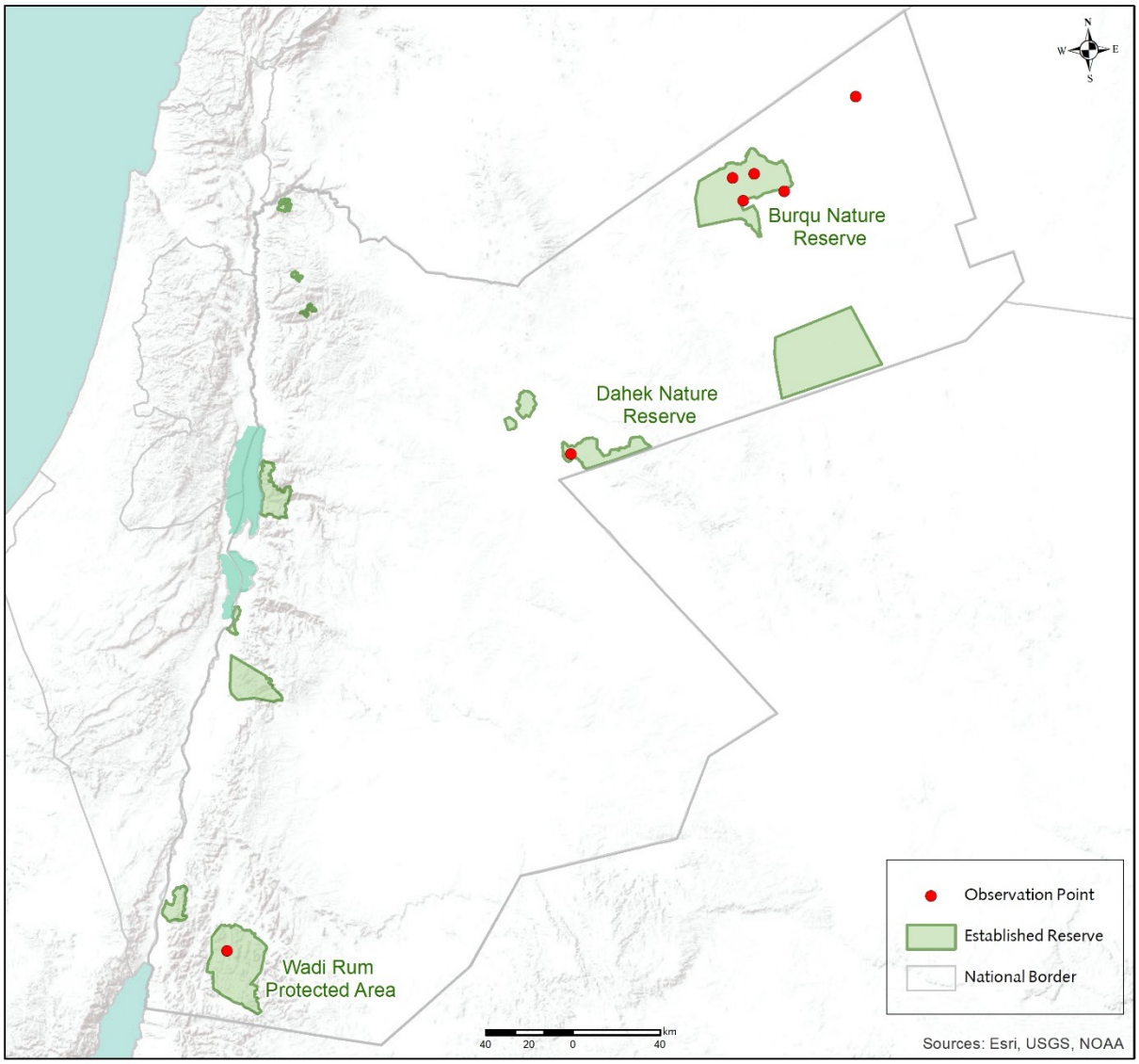

Figure 2. A new distribution of the Sand Cat in Jordan.

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Short Communication

The First Occurrence of Entomopathogenic Fungi *Ophiocordyceps nutans* in Tamil Nadu, India

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Abstract: The novel observation of *Ophiocordyceps nutans* infecting *Erthesina fullo* in Kargudi, Tamil Nadu, emphasizes the potential of entomopathogenic fungi (EPF) as natural agents for controlling pests. *O. nutans* is known for its host spectrum (primarily ants), which now includes a significant pest, the stink bug. This discovery highlights the complex connections in ecosystems and indicates the possibility of utilizing EPF for environmentally friendly pest control. This work suggests more research on the ecological and agricultural impacts of EPF to investigate sustainable pest management techniques and support biodiversity conservation.

Keywords*:* Insect-fungi interactions, Sustainable pest management, Ecosystem dynamics, Fungal ecology

Entomopathogenic fungi (EPF) majorly fall under the taxonomic divisions of Zygomycota and Ascomycota. EPF use the mechanism of direct penetration of the host species by using several entry mechanisms, such as the usage of spores via which they adhere to the epicuticle, germinate, and then grow through the procuticle (which poses a significant physical and chemical barrier to infection). This is accomplished through a combination of mechanical pressure from hyphal tips and the secretion of proteolytic enzymes (Samson, *et al.,* 1988; Chandler, 2017). There have been multiple occurrences of EPF parasitizing insects, which were observed in *Beauveria bassiana* on *Cephalcia tannourinensis*, and in *Beauveria lii* sp. on *Henosepilachna vigintioctopunctata,* as well as in *Cordyceps javanica* on sweet potato whiteflies (Abdo, *et al.,* 2008; Zhang, *et al*., 2013; Wu, *et al.,* 2021).

Ophiocordyceps nutans (Figure 1) belongs to the Phylum Ascomycota, the genus *Cordyceps*, and the family of Ophiocordycipitaceae which includes organisms that can feed on fungi, plants, or animals (Chandler, 2017). They are known to infect arthropods and turn them into fruit bodies. They are also known to follow host-specific pathogenicity which makes them ideal control agents (Ito and Hirano 1997; Evans, *et al.,* 1999). Previous studies showed that the *Ophiocordyceps* species were observed in ants where they had a unique method for altering infected individual's behaviour as a means of transmission. In these infections, the host behaviour serves as an extended phenotype of the fungus. The infected individuals migrate from nests in the forest canopy to the understory vegetation, where conditions are ideal for the formation of stromata and ascospore generation on corpses. Repeated convulsions by behaviourally compromised ants cause them to fall from plants and prevent them from climbing back up into the canopy (Hughes, *et al.,* 2011; Boomsma, *et al.,* 2014).

Similar to this phenomenon, on 14 July 2023 in Kargudi, Tamil Nadu, India (Figure 2), *Ophiocordyceps nutans* was observed to have infected *Erthesina fullo* (Thunberg,

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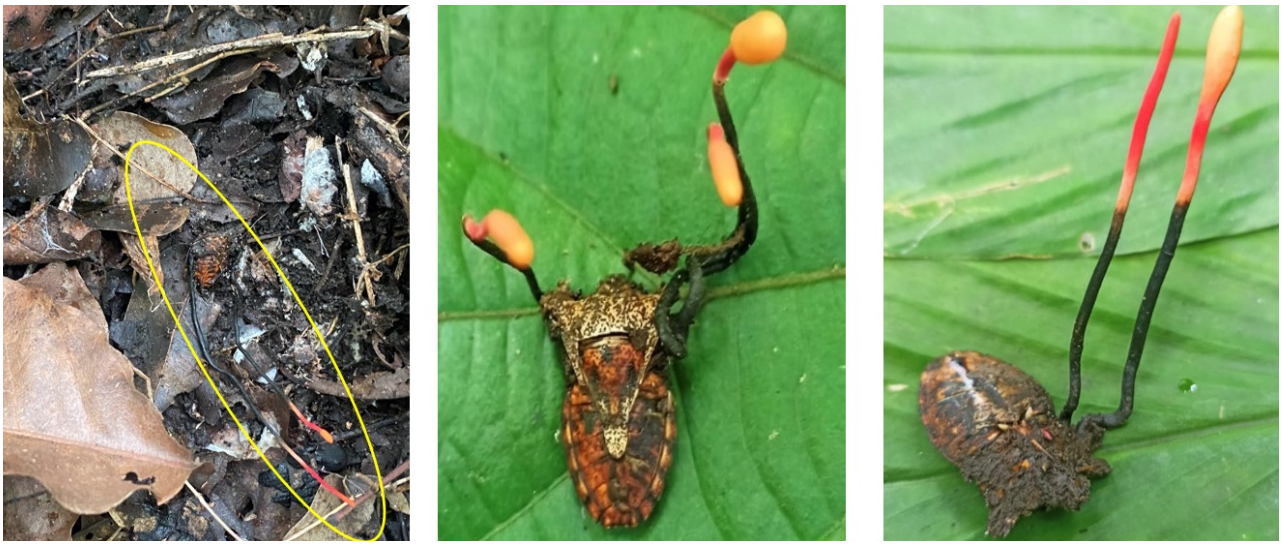


Figure 1. Observation of *Ophiocordyceps nutans.*

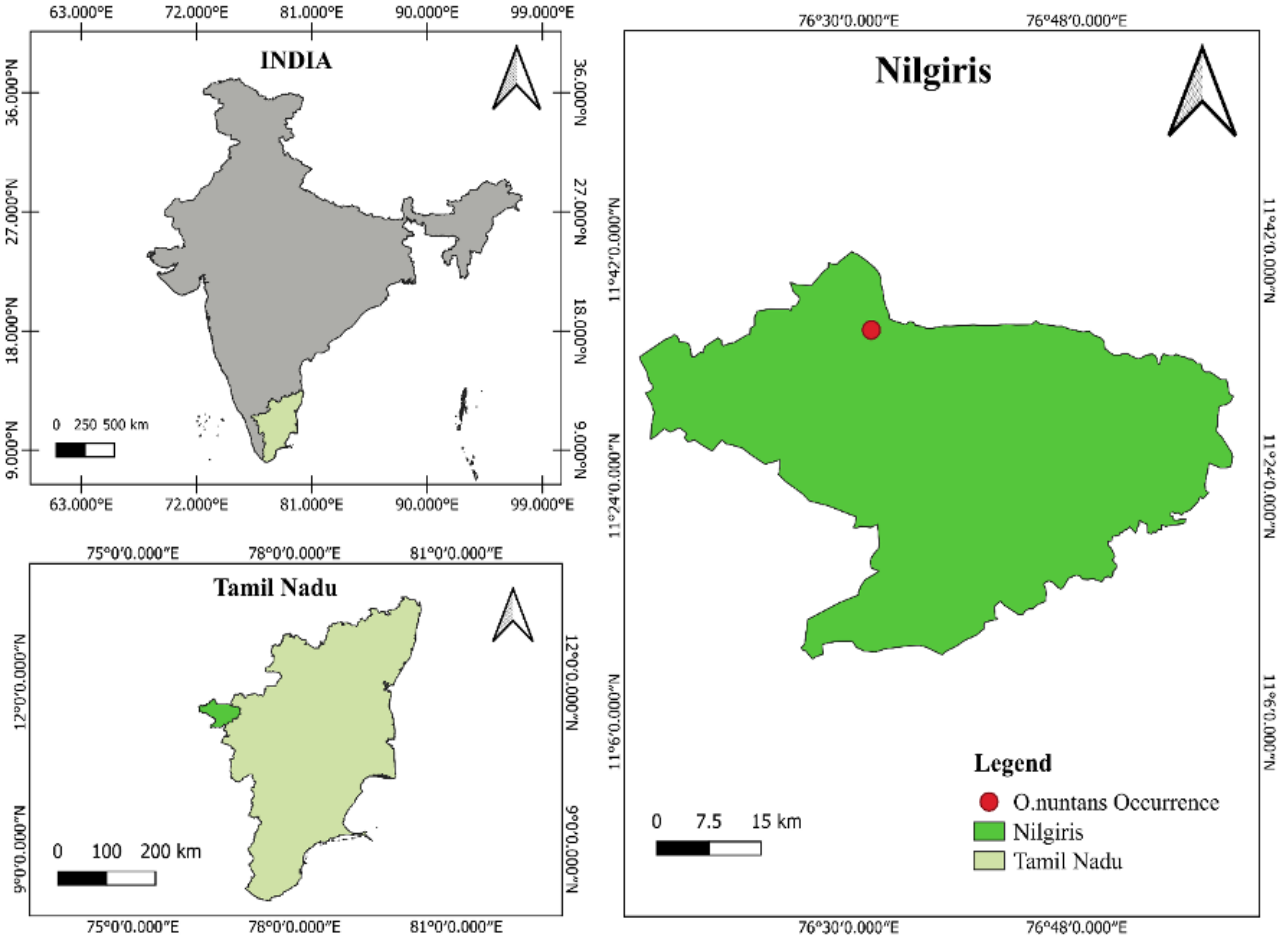


Figure 2. Occurrence record of *Ophiocordyceps nutans* in Nilgiris, Tamil Nadu.

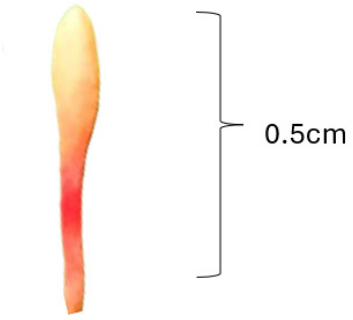
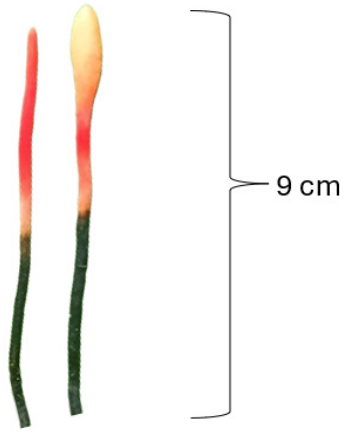
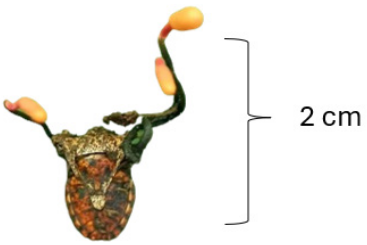
1783) commonly known as the Stink Bug, which was identified using taxonomic keys (Biswas, *et al.,* 2014). The distribution status of *Erthesina fullo* in India was recorded in Chhattisgarh, Assam, Andhra Pradesh, Andaman and Nicobar Islands, Kerala, Meghalaya, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand, and West Bengal.

Ophiocordyceps nutans was identified using the taxonomic keys provided by Sung, *et al.* (2007). Ophiocordyceps is a diverse group of fungi that infect arthropods. Several species have black pigmentation and are found in the juvenile stages of hosts buried in dirt or decomposing wood. Exceptions are notable for both characteristics in organisms that prey

on the mature stages of hosts. The stromata or subiculum can be darkly pigmented or occasionally brilliantly coloured and are rigid, fibrous, or pliant (Hywel, 1995). Sridhar and Karun (2017) observed a similar scenario where *Halyomorpha halys* was reported to be infected with *O. nutans*. Several instances of *Erthesina fullo* infected with *O. nutans* were observed across the study area. Infected bugs displayed characteristic symptoms such as the attachment to vegetation and the emergence of fungal hyphae from the host's body (Figure 1), forming a distinctive stalk and spore-bearing structure (Table 1). The stipes were observed to emerge from the thorax and the abdomen region. They were black, with a bright yellowish orange bulbous head. Further research is warranted to understand the prevalence, dynamics, and effectiveness of this fungal infection as a biocontrol strategy within the forest ecosystem. Previous studies have reported that *O. nutans* has been only found in high-altitude landscapes with temperatures ranging from 21 to 24 °C. In this study, EPF is recorded in the Kargudi region of Nilgiris which provides the optimum environmental conditions to promote its growth and distribution within the area.

In conclusion, the discovery of *Ophiocordyceps nutans* infecting *Erthesina fullo* in Tamil Nadu highlights the potential of

Table 1. Description of Fungal Anatomy and Morphology of *Ophiocordyceps nutans*.

Sl. No	Observation	Scale for Reference	Description
1	Stroma		Yellowish - orange Stroma was measured to be around (0.52-1.27) cm (n=3)
2	Stipe		Two or three wiry blackish green stipe (8.9-9.4) cm (n = 3)
3	Stink Bug cadavers infected with *Ophiocordyceps nutans*		*O. nutans* infection observed on the abdominal area of the stink bug

entomopathogenic fungi for environmentally friendly pest control methods. The study emphasizes the need for further ecological research to support sustainable agriculture and biodiversity conservation.

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Short Communication

The First Record of a Scalariform Shell of *Metafruticicola berytensis* (Pfeiffer, 1841) from the West Bank in the Occupied Palestinian Territories

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Abstract: specimen of *Metafruticicola berytensis* (Pfeiffer, 1841) was found in Ajoul Village in the Ramallah district in the occupied Palestinian territories – West Bank with Scalariform. This is considered the first record of this malformation for this species. This specimen was collected during a survey to study the land snail of the West Bank between 2015 and 2018 by the Palestine Institute for Biodiversity and Sustainability.

key words: *Metafruticicola berytensis*, shell abnormalities, Palestine, West Bank.

Introduction

Shell abnormalities in snails (marine, freshwater, and terrestrial snails) have been a matter of concern and interest for several malacologists and researchers for a long period of time (HarTmann, 1841–1844; Rossmässler,1853; Meisenheimer, 1912; Drozdowski, 1962; Koralewska-BaTura, 1997; Jackiewicz *et al.,* 1998 and 1999).

Snail shell malformations have been described in several cases in both of the aquatic snail species (Jackiewicz, 1972 and 2000; Checa and Jiménez-Jiménez, 1997; Okumura *et al.,* 2008; Zuykov *et al.*, 2011 and 2012) and the terrestrial snail species (Okumura *et al.,* 2008; Książkiewicz, 2011). Several factors have been stressed and considered as tools to explain snail shell malformation and abnormalities; these include genetic abbreviation related to radiation (Bloszyk *et al.,* 2015), disturbances during the embryonic development phase, population density, and parasitic infections (Bidwell *et al.,* 1986; Panova *et al.,* 1999; żBikowska and żBikowski 2005; Zuykov *et al.,* 2011 and 2012). According to malacologists, snail shell malformation is classified into two major types which have been intensively studied over the years: sinistral (deviato sinistrorsa) and scalariform (deformatio scalaris) (Checa and Jiménez- Jiménez, 1997; Okumura *et al.,* 2008; Zuykov *et al.,* 2012; Dépraz *et al.,* 2009; Bloszyk *et al.,* 2015; Foon and Marzuki, 2022).

The land snail *Metafruticicola berytensis* (Pfeiffer, 1841) is a species of the family Hygromiidae. This species has a wide range of distribution across Turkey, the eastern tip of Cyprus, Syria, and Lebanon reaching as far as central Palestine (Bank *et al.,* 2013).

The genus *Metafruticicola* was revised in the Mediterranean basin by Bank *et al.* (2013), and nowadays the *Metafruticicola fourousi* is considered as a synonym for *Metafruticicola berytensis*. It usually inhibits mountain slopes with low vegetation covers. It is considered a widespread and quite an abundant species to be found mainly under stones, in piles of stones and under shrubs; This species is categorized as a Least Concern according to the IUCN (Triantis, 2013).

Having a unique variety of geography, climate, and habitats, Palestine plays a role in the great diversity of land snails in a small distributional area. However, climate change could be a future force in the decline of the majority of the land snail species (Amr *et al.,* 2018).

Between 2015 and 2018, the Palestine Institute for Biodiversity and Sustainability (PIBS) and the Palestine Museum of Natural History (PMNH) conducted several field trips to study the Malcofauna of the West Bank

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and visited more than 140 locations. This came under a project funded by the Internal Research Grant at Bethlehem University and constituted a part of the author's master's thesis.

Location Under Study

All specimens were collected by hand from the field and were deposited at the PMNH . A specimen of the *Metafruticicola berytensis* (Figure 1) species with a scalarifom shell was collected on February 28, 2017, by the author from Ajoul village (N: 32°01'05.9" E: 35°10'58.9") near Rawabi city in the Ramallah district. However, the specimen was found dead, and only the shell remained under an oak tree among the leaf litter. Ajoul village falls in the Mediterranean phytogeographic zone, with an elevation of 872 ASL, receiving an annual rainfall ranging from 500 to 600 mm per year.

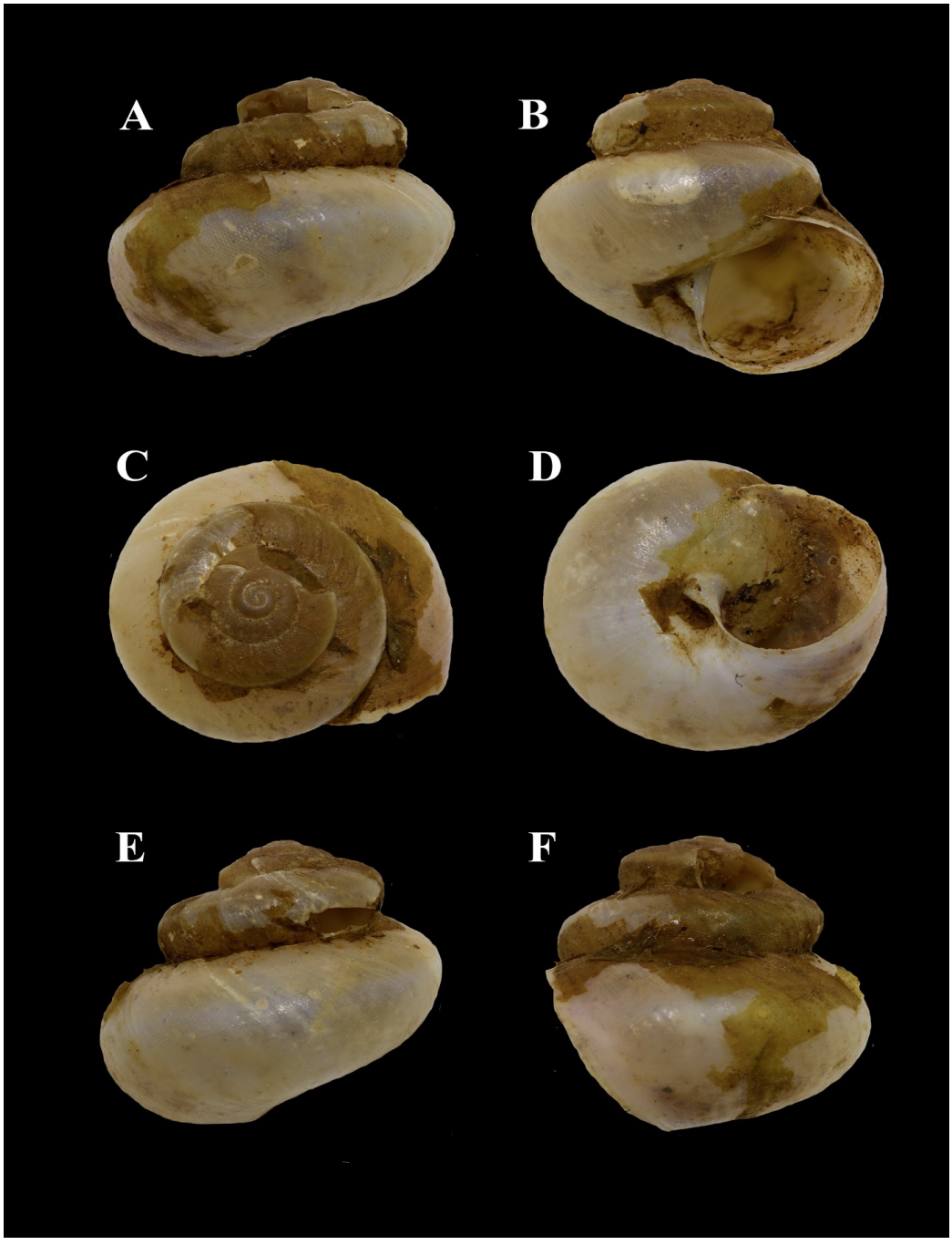

Figure 1. *Metafruticicola berytensis* (Pfeiffer 1841). **A:** Posterior view, **B:** Anterior view, **C:** Dorsal view, **D:** Ventral view, **E:** Left lateral, **F:** Right lateral. Snail width = 11.4 and height = 10.2 mm.

Description of the Normal Shell

Normal *Metafruticicola berytensis* shells are medium in size, reaching up to 20 mm in height and 25 mm in diameter. Number of whorls 5-6, Protoconch covered with radial folds, while other whorls are covered with tubercles arranged in vertical or diagonal rows. Umbilicus narrow and deep. Aperture rounded with the lip folded outwards (Heller, 2009).

Description of the Scalariform Shell

The abnormal *Metafruticicola berytensis* shell shows a scalariform condition, it has thickened bands (whorl) in the third and fourth whorl, and its arrangement resembles the rungs of a ladder. The snail shell exhibits five whorls, with the width of 11.4 mm, and a height of 10.2 mm.

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The Royal Society for the Conservation of Nature

Is a national organization devoted to the conservation of Jordan's wildlife. It was founded in 1966 under the patronage of His Majesty the late King Hussein and has been given responsibility by the government to establish and manage protected areas and enforce environmental laws. As such, it is one of the few non-governmental organizations in the Middle East to be granted such a public service mandate.

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