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Lady Beetles (Coccinellidae: Coleoptera) in the West Bank of Palestine: Survey of species, geographic distribution and ecological significance

الدعسوقيات في الضفة الغربية من فلسطين: دراسة مسحية للأنواع المحلية، توزيعها الجغرافي وأهميتها البيئية

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Lady Beetles (Coccinellidae: Coleoptera) in the West Bank of Palestine: Survey of species, geographic distribution and ecological significance

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ملخص

الدعسوقيات منتشرة في فلسطين حيث تمثل عدوا طبيعيا للعديد من الآفات الزراعية. الدراسات المسحية للأنواع، توزيعها الجغرافي وأهميتها البيئية في فلسطين ما تزال قليلة ومبعثرة. لذلك، أتت هذه الدراسة لتكون مسحية شاملة لأنواع الدعسوقيات خاصة في جنوب الضفة الغربية وغور الأردن. كذلك، تعنى الدراسة بالتوزيع الجغرافي لكل نوع وأهميته البيئية. من أجل تنفيذ ذلك تم تحديد وزيارة 166 موقعا تمثل المناطق الجغرافية النباتية الأربعة في فلسطين، حيث تم جمع وتصنيف 1490 عينة من الدعسوقيات تنتمي ل 35 نوعا تتبع 19 جنسا ضمن 10 قبائل تمثل 6 تحت عائلات.

بينت نتائج الدراسة أن 7 أنواع من ال 35 نوعا يتم تسجيلها للمرة الأولى في المنطقة بالاضافة الى ان نوعا واحدا تم إدخاله عام 1986 إلى فلسطين (*Nephus peyerimhoffi*) ولكنه لم يتأقلم مع الظروف المناخية للمنطقة فسجل إختفائه ولكن تم خلال هذه الدراسة تسجيل تواجده في ثلاثة مواقع شملتها الدراسة. كذلك، أظهرت نتائج الدراسة أن 4 أنواع من الدعسوقيات التي تم تصنيفها هي أنواع دخيلة والباقي أنواع محلية أصيلة.

أظهرت نتائج الدراسة كذلك، أن 6 أنواع من الدعسوقيات سُجلت كأنواع شائعة في المنطقة (متواجدة في أكثر من 26 موقعا) و19 نوعا تم تسجيلها كأنواع نادرة جدا بسبب تواجدها في 5 مناطق أو أقل من مناطق الدراسة. أما الأنواع العشرة المتبقية فتعتبر نادرة كونها تتواجد في مناطق عددها بين 6-25.

تم عمل خرائط توزيع للدعسوقيات بناء على مناطق التوزيع النباتي كما تم نشره من قِبل زهري وتم تعديله من قِبل سوتو بيرلوف. تبين أن 29 نوعا (83%) من الدعسوقيات تتواجد في المنطقة الجغرافية النباتية المسماه "منطقة البحر الأبيض المتوسط" وأن عشرة أنواع من ال 29 نوعا تتواجد في هذه المنطقة دونا عن غيرها. هنالك عشرة أنواع تتواجد في منطقة الطور الايراني، اما منطقة الصحاري العربية، فيتواجد بها 14 نوعا من الدعسوقيات. وأخيرا، فإن منطقة التغلغل السوداني يتواجد بها 19 نوع من الدعسوقيات.

كذلك، بينت نتائج الدراسة أنه من أصل 35 نوعا تم تسجيلها، 5 أنواع فقط تنتشر على كافة المناطق الجغرافية النباتية الأربعة. أما أكثر أنواع الدعسوقيات إنتشارا فكان النوع الشائع والمسمى *Coccinella (Coccinella) septempunctata* حيث تم العثور عليه في 60 % من المواقع المدروسة.

جميع الأنواع التي تم جمعها خلال هذه الدراسة تعتبر أنواعا نافعة تتغذى على الأفات الزراعية مثل المَن والحشرات القشرية، وهذا التنوع الكبير للدعسوقيات في منطقة الدراسة يساعد في عمليات المكافحة الحيوية والحد من إنتشار الأفات الحشرية مما يساعد في الحفاظ على التوازن البيئي والتنوع الحيوي في المنطقة.

بالرغم من أن هذه الدراسة تشكل إسهاما كبيرا لدراسة الدعسوقيات في الضفة الغربية من فلسطين إلا أننا لا نزال بحاجة إلى المزيد من الدراسات حول العادات الغذائية لهذه الحشرات وإمكانية تربية وإنتاج الأنواع المحلية لاستخدامها في برامج المكافحة الحيوية.

وأخيرا، فإن غنى فلسطين بالتنوع الحيوي يوفر بيئة مناسبة لعمل الأبحاث وإجراء التجارب في مجال المكافحة الحيوية للأفات نظرا لتقبل المزارعين لتطبيق هذه الفكرة.

Lady Beetles (Coccinellidae: Coleoptera) in the West Bank of Palestine: Survey of species, geographic distribution and ecological significance

Summary

Lady beetles are common in Palestine and are important natural enemies to many plant pests. Studies about lady beetles in Palestine, their geographic distribution and their ecological significance are limited. Therefore, the present study aimed at surveying and identifying all species of lady beetles from the West Bank and exploring their geographic distribution and ecological significance. For this purpose, 166 localities representing the four phytogeographical zones of the West Bank were visited to collect ladybeetle samples. About 1490 specimens of lady beetles were collected and classified during the study. These specimens were found to be belonging to 35 species in 19 genera and 10 tribes representing six subfamilies of lady beetles. Seven of of these species were recorded for the first time in addition to one species (*Nephus peyerimhoffi*) that was introduced in 1986 and declared as disappeared, this species was recorded from three localities in the study area. Of the 35 species of coccinellids identified, four were introduced species (*Rodolia cardinalis, Nephus peyerimhoffi, Serangium parcesetosum and Cryptolaemus montrouzieri*).

Six species collected were considered common in the study area (found in more than 26 localities). These were *Adalia (Adalia) decempunctata, Coccinella (Coccinella) septempunctata, Hippodamia (Adonia) variegata, Oenopia conglobata, Nephus (Nephus) quadrimaculatus* and *Pharoscymnus fleischeri.*

Nineteen species were considered very rare species (with 5 or less records from the area studied). These were *Cheilomenes propinqua nilotica, Exochomus nigromaculatus, Harmonia*

quadripunctata, Platynaspis luteorubra, Hyperaspis polita, Hyperaspis syriaca, Cryptolaemus montrouzieri, Nephus (Bipunctatus) bipunctatus, Nephus crucifer, Nephus (Sidis) hiekei, Nephus peyerimhoffi, Scymnus flavicollis, Scymnus (Neopullus) limbatus, Scymnus nigropictus, Scymnus (Parapullus) abietis, Scymnus (Scymnus) interruptus, Diomus anemicus, Serangium parcesetosum and *Rodolia cardinalis.*

Ten species recorded during this study were considered rare (found in 6-25 localities). These were *Coccinella (Neococcinella) undecimpunctata, Rhyzobius lophanthae, Stethorus gilvifrons, Scymnus syriacus, Scymnus (Pullus) suturalis, Scymnus (Pullus) subvillosus, Scymnus (Scymnus), Exochomus quadripustulatus pallipediformis, Chilocorus bipustulatus, Exochomus pubescens.*

Distributions of coccinellids roughly follow the biogeographical zones of the West Bank as initially established by Zohary and modified by Soto-Berelov et al. (2015): Twenty-nine species (83%) were recorded from the Mediterranean zone with 10 of them restricted to this zone. Ten species were recorded from the Irano-Turranean zone with *Nephus (Bipunctatus) bipunctatus* as the distinctive species for this zone. The Saharo-Arabian zone was inhabited by 14 species with *Hyperaspis syriaca* as the distinctive species for this zone. The Sudanian Penetration zone was inhabited by 19 species with *Serangium parcesetosum* as the distinctive species.

Five species of lady beetles were recorded in the four phytogeographical zones (*Stethorus gilvifrons, Scymnus (Scymnus) pallipediformis, Oenopia conglobate, Hippodamia (Adonia) variegate, Coccinella (Coccinella) septempunctata*). The most common species of lady beetles from the West Bank was *Coccinella (Coccinella) septempunctata* (Recorded from 60% of localities visited).

All species recorded during the study are useful species that feed on agricultural pests such as aphids and scale insects. The large diversity of Coccinellids in the study area is particularly important in reducing the heavy use of pesticides and the spread of agricultural pests which maintaining ecological balance and biodiversity.

While this was a significant contribution to the Coccinellidae of this part of the World, much more needs to be done (e.g. on specifics of diets and rearing of potentially useful local species for integrated pest management). The rich biodiversity of Coccinellids in Palestine provides abundant material for research and development in areas of biological pest control. Farmers were noted to be receptive to this idea.

1. Introduction

There are estimates of up to 50 million species of non-microbial organisms on Earth (Scheffers et al., 2012). Among the animals, the largest diversity is in insects with over 1 million species described from an estimated total of 5.5 million species (Stork, 2017). The rich biodiversity that evolved over billions of years is critical for our planet and its conservation is a priority (Brooks et al., 2006). Over the past few decades, man has changed the ecosystem in order to meet the increasing demands for food, water and other life requirements at the expense of the ecosystem (Reid et al., 2005). Increasing human activities have brought the planet to the brink of collapse and the spread of famine and disease. These consequencies will continue to increase if people do not find suitable solutions to deal with the growing environmental problems.

In light of the World's tendency to increase food production, the use of agricultural pesticides has increased in order to reduce the loss of agricultural crops due to pests and diseases. The excessive use of pesticides has led to the spread of cancer and other diseases in humans as well as their harmful effects on the environment (Aktar et al., 2009). Hence, the need to find and use safer alternatives to control agricultural pests. One of these alternatives is to use biological methods of control (Huffaker, 2012) that represents an environmentally sound and effective way of controlling pests and reducing pest influences using natural enemies. Studies have shown the importance of using local varieties in the biological pest control operations to minimize the damage associated with the introduction and use of imported (alien) species to the region (Hajek et al. 2016; Kumschick et al. 2016).

Beetles represent almost one-fourth of all described species of the Class Insecta, the largest class of animals, with tens of thousands of species still to be described. Coccinellidae (Lady beetles) is a family of insects of the order Coleoptera and is considered of significant importance as natural predators of many plant pests. The family Coccinellidae includes approximately 6000 described species in some 360 genera and 42 tribes (Hodek et al., 2015).

The Coccinellidae species in Palestine were rarely studied and primary literature is sparse. However, it is thought that there are at least 70 known species (Halperin et al., 1995). Taxonomic studies are lacking and most studies provided descriptive morphological data with little informations about ecological significance. Common is the traditional knowledge about its beauty in the environment with a lack of awareness about its environmental role in biological control for pests.

Coccinellidae as pest control agents were little studied in western Asia. Some unpublished master theses in Palestine focused on observing plant pests, but few of these classified the ladybeetles that feed on these pests in the same area. The predaceous part of this Coleopteran family represents an important component of the natural enemies of Sternorrhyncha (aphids, coccids, aleyrodids and psyllids) (Giorgi et al., 2009). These sucking insects are among the most dangerous pests of crops. Under suitable conditions, populations of these pests increase exponentially, especially when parthenogenesis and viviparity occur, causing significant agricultural economic damage (Fisher et al., 1999). Modern types of biological control, involving conservation and augmentation, can become part of an integrated pest management. For the success of these methods of control, precise knowledge of existing native species, their behavior and ecological relations is indispensable. Hence, comes the importance of studies that identify the lady beetles, their geographic distribution and environmental significance in the West Bank of Palestine, as a prerequisite for any successful use of ladybeetles in biological control projects. In addition, this is important before any possible introduction of any kind of predator into the local environment. Comprehensive studies about the current situation of lady beetles in Palestine provide baseline for future studies regarding monitoring existing species of Coccinellids, their density and the presence of any newly introdeced species.

2. Literature Review

2.1. Review & Importance of the Coccinellidae

Coccinellids (English Common names Lady Birds, Lady Beetles, Lady Bugs) belong to the superfamily Cucujoidea of the Coleoptera suborder Polyphaga, and the family is a member of the phylogenetic branch frequently referred to as the Cerylonid complex or series of families, which is composed of Alexiidae, Cerylonidae, Coccinellidae, Corylophidae, Discolomatidae, Endomychidae and Latridiidae (Hodek et al. 2015).

The beetle family Coccinellidae (lady beetles) is a well-known, abundant, and diverse family with over 6000 species described from diverse habitats around the World. Coccinellids are of interest and importance in agriculture and forestry, since adults and larvae of most species are natural predators of herbivorous pests (Garzon et al. 2015). This led to the introduction of Coccinellidae species in programs for biological control in agricultural farms (Fisher et al. 1999). Biological Control is the action that maintains and manipulate populations of organisms to achieve reduction or improved regulation of pest populations by a natural control, which occurs without intervention. Eilenberg et al. (2001) suggested that we limit use of the term “biological control” to areas where living organisms are used to control populations of other living organisms. In contrast, classical biological control involves importing and releasing exotic species with the goal of establishing a self-perpetuating population in a novel geographic region that exerts permanent suppression of a specific pest. However, much is still needed to be learned about the impact of introduced species on native fauna (Hoddle, 2004; Majka and McCorquodale, 2010). Coccinellids have been widely used in biological control to create ecological balance between the plants and its natural enemies

(Obrycki & Kring, 1998). Native Coccinellidae in some cases are found in a higher proportion in agricultural habitats compared to non-agricultural habitats (Finlayson et al., 2008). Furthermore, certain species, either through intentional or accidental introductions, have garnered attention as invasive species with significant impacts on biodiversity and human economies beyond their contributions to biological control (Lucas et al., 2002). The use of local species in the biological control of pests has many advantages but, in many cases, we lack knowledge of those local species and their role in the local environment.

Coccinellid populations, like any other predator population, respond rapidly to availability of prey species (Costamagna and Landis, 2007). Local habitats also affect lady beetle abundance and richness (Egerer et al, 2017). However, habitat loss and fragmentation can change the density and diversity of insects that eat other insects (Grez et al., 2008). More research into these prey-predator systems is needed including on optimal interference strategy around farms and in attempts to modulate populations of both predators and prey (Fisher et al., 1999). Development in the scientific research led to use new techniques in the scientific analysis of the predators - prey relationship (Hatano et al., 2008). For example, one of the studies about the olfactory preference test showed that *Harmonia axyridis* adults preferred sunflower and dill among the ten potential companion plants tested, which means that it can be use in the biological control to attract the *Harmonia axyridis* adults to the area (Adedipe & Park, 2010). Coccinellids increase laying eggs in the case of a large amount of pests, because of the existence of sufficient food for larvae when hatching, which contributes to increase the control of the pests (Agarwala et al., 2009). Many other studies document the importance of prey and plant species in ladybeetle growth and reproductions (Frechette et al., 2006; Costamagna & Landis, 2007; Agarwala et al., 2008). Similarly, the effectiveness of *Coccinella septempunctata* (a species found in Palestine) as a natural enemy of aphids may be strongly affected by which species and cultivar of *Brassica* being grown (Girling &

Hassal, 2008). In the USA and Canada, two native species of Coccinellids became rare in their former ranges because of habitat change caused by human activities (Harmon et al., 2006). Coccinellids are the best natural enemy in biological control of aphids and other species. Finally, it is worth mentioning that, of all the predaceous beetle groups, perhaps the most familiar to non-specialists is the lady beetle family, Coccinellidae (Giorgi et al, 2009).

2.2. Morphology of Coccinellidae

The following is a brief description based on the work of Kovar (1996)

Adult coccinellids ranging in sizes between 0.8-18 mm long and it has oval body sometimes 3 times as long as wide. The dorsal surface is convex and the ventral surface always flat. The body surface is either bare or covered with short recumbent hairs and is more or less shiny. In the Sukunahikonini, there are also longer erect hairs in addition to the short recumbent ones. Sculpturing is in the form of fine or coarse punctures, densely arranged.

Head: The individual parts of the cranium (epicranium, frons, genae and clypeus) are fused. The anterior part of the cranium is simple and projects forwards, in the Chilocorinae it is strongly widened laterally. The antennae are inserted in front of the eyes in the dorsolateral comers of the frons, but ventrally in the Chilocorinae.

The lateral part of the cranium bears anteriorly large compound eyes with a finely, in the Coccidulinae and the Lithophilinae rather coarsely, faceted surface. Anteriorly, an indistinct suture separates the gula from the basal part of the labium (submentum), which forms a medial projection. Between this projection and the inner margin of the genae are deep grooves, which form the insertions for the basal parts of the maxillae.

The inner skeleton of the head (tentorium) is formed by narrow tentorial arms; the tentorial bridge is missing. The mouthparts are of biting type. The labrum is always much narrower than the anterior margin of the cranium and is clearly visible from above, except in the

Chilocorinae. The massive, wide, sickle-shaped mandible has incisor and molar parts on its inner side. The incisor part is formed by two teeth to give the mandible a bifid apex. The molar part is formed by the molar projection (mola) which usually consists of two teeth situated obliquely beside each other. Ventrally a membranous prostheca is present, growing between the incisor and molar areas and bearing a continuous row of bristles. The outer side of the mandible is simple, strongly curved and concave at the base. The base of the mandible is wide and has two condyles, of which the ventral one is stronger. Both ventral and dorsal sides of the mandible bear both setae and sensillae. According to the food of the beetle, various types of mandible can be distinguished; these differ particularly in the construction of the apex (incisor part) and the mola (molar part).

The phytophagous type can be characterized as highly specialized, adapted to biting-off and roughly preparing plant tissue, including the tough epidermis. Typically, the incisor part consists of four (three) large, apically round or blunt teeth carrying larger or lesser accessory teeth, including the teeth of the "molar region". The distinct molar projection is replaced by a row of coarse teeth, which form the molar part of the mandible *(Henosepilachna, Subcoccinella).* From this typical phytophagous mandible, other mandibles can be derived *(Affidentula)* in which a gradual reduction of accessory teeth (including the teeth of the "molar region" up to the reduction of the subapical tooth) and a strong shortening of apical teeth take place.

The carnivorous type is the basic and widely represented type of mandible in the family Coccinellidae and corresponds to the general description given earlier. Within this type, there are several trends. In aphidophagous coccinellids of the tribe Coccinellini, both the terminal teeth are comparatively small and split off each other near the top; the ventral tooth is also somewhat smaller. The inner part of the mandible is entirely smooth between the top and the mola; only in some genera, it is covered with minute, blunt teeth. This dentation is very conspicuous in *Tytthaspis sedecimpunctata*, (mycophagous species), and *Bulaea lichatschovi* (phytophagous species). In contrast, such dentation is missing in *Coleomegilla maculata* (polyphagous species, feeding on pollen and aphids). The ventral terminal tooth is relatively well developed in the Scymnini, Coccidulini, and Stethorini. In coccidophagous species the ventral tooth is of approximately the same size as the dorsal one (Noviini), or is reduced (Telsimiini), or is quite absent (some Chilocorini). In the subfamily Sticholotinae, the apex of the mandible is not divided and comprises a single tooth; the molar projection is either reduced or absent.

The mycophagous type can be derived from the basal carnivorous type with a mola. They occurs in part of the tribe Psylloborini. The apex of the mandible bears two teeth, of which the ventral one divides into a row of further teeth, the size of which diminishes towards the base. The number of teeth in this row is different in different species.

The maxilla consists of cardo, stipes, lacinia, galea and the maxillary palpus. The area called stipes consists of three sclerites, which form a tube-shaped structure. The galea articulates with the distal part of the stipes; in the Epilachninae, it is covered with many relatively short setae and is much longer than in carnivorous coccinellids. The lacinia is oblong and flat and bears setae similar to those on the galea on the ventral side. In carnivorous coccinellids, these setae are rather long and thin, in the Psylloborini stronger, curved setae are present in addition. The maxillary palpus is four-segmented; the apical segment is securiform, weakly divergent anteriorly or nearly parallel-sided; only in some Sticholotinae it is much elongated and conical. Two parts can be distinguished on the labium: the partly movable prelabium (prementum) and postlabiurn (mentum + submentum) which are connected by a membrane. The anterior margin of the prementum is densely covered with fine, spine-like hairs. In most small species, the prelabium is nearly quadrate, but in the Coccinellinae it projects strongly forwards and in the Epilachninae, by contrast, it is narrowed in front. The labial palp is threesegmented with a small basal segment, which is completely missing in the Noviini. The medial projection of submentum is more or less wide and is only narrow in the Sticholotinae. The basic shape of the antennae is eleven-segmented and weakly clavate (Coccinellinae, Epilachninae). In many groups, the number of segments and their size are variable.

The prothorax is bent forwards; the pronotum is convex and sharply separated along its whole length by a distinct ridge from the hypomeron. The anterior margin is most often widely emarginated to cover the basal parts of the head. The prosternum most often has the shape of the letter T. Its posterior, the intercoxal process, often bears distinct "prosternal carinae". The front transverse part of the sternum is well developed, and only rarely very narrow and reduced (Noviini). The front coxal cavities are partly closed at the back by a postcoxal process of the hypomeron, which joins medially onto the furcasternum. Most of the meso- and metanotum is covered by the elytra. The mesothoracic scutellum is the only visible part of the notum. The ventral side of the meso- and meta-thorax contains both sternal and pleural sclerites. The mesosternum is small. The mesothoracic pleural region is divided by a pleural suture into two sclerites, the episternum and epimeron. Basally, both these sclerites reach the lateral part of the middle coxal cavity. The metasternum forms the largest part of the ventral side of the metathorax. Medially, small sclerites between the posterior coxal cavities form the exterior part of furcasternum. Almost the whole metasternum is divided by a longitudinal medial suture, which is related to the well-developed inner skeleton (metendosternite). The metapleuron is divided into the larger episternum and the smaller epimeron.

Legs are well developed and of the running type. The construction of the coxae is regular; the front and the larger hind coxae are transversely oval, the middle coxa is almost round. The femur is elongated, slender (Coccinellinae), rather stout, unflattened in most small species, or very stout and flat (Platynaspini, Aspidimerini). In some groups, it has a shallow groove for the reception of the tibia. The tibia is slender or with a spine-like projection on its outer side.

The tarsus is trimerous (Noviini and a part of Scymnini), tetramerous (Lithophilinae) or more usually cryptotetramerous (pseudo-trimerous); the tarsal formula 3, 3, 3 or 4, 4, 4 is the same for both sexes. The elytra are convex to a varying degree and are never truncated at the apex. The lateral margin is sometimes expanded outwardly; the ventral flat part of the elytron (epipleuron) is narrowed apically.

The hind wings are functional and only rarely reduced *(Lithophilus, Cynegetis, and Rhizobius).* The nervature is of cantharoid type, with rather feebly developed veins. The abdomen is ten-segmented, the tergal part is represented by eight visible tergites of which only the last visible is well sclerotised. The ventral side includes only five or six visible sternites. The first and second stemites are fused together with the base of the third morphological sternite (the first visible stemite). The first visible sternite is the largest of all the abdominal sternites and bears (except only *Hippodamia)* the femoral line. The length of the seventh sternite (=fifth visible one) is often greater than the preceding sternites. The posterior margin is either round, completely covering the next (= eighth) stemite (Lithophilinae, Serangiini, Telsimiini and some other tribes), or is similar in shape to the previous sternite and does not completely cover the eighth (Coccinellinae, Epilachninae).

Usually, the parts of the ninth and tenth abdominal segments are designated as genitalia. The female genitalia consist of the paired ninth pleurites and a pair of coxites (ninth sternites) and the tenth tergite. The coxites usually carry a stylus. The shape of the coxites is variable and various types can be distinguished. In many coccinellid groups, the coxites are very elongate triangular structures and sometimes they function as an ovipositor. The genital sclerites of the males are formed by the ninth and tenth tergites and by the elongate, thin ninth stemite (apodema). The male genitalia proper have two parts, tegmen and sipho. The tegmen is variably thick, symmetrical or asymmetrical and consists of a basal piece, paired paramera (=lateral lobes), and a distinct median piece, sometimes erroneously called the "penis" or "aedeagus". The hypomera (= trabes) articulate with the ventral side of the basal piece of the tegmen. The sipho (= penis, aedeagus) is very long, tubular and ventrally curved. Its base is most often broadened forming a siphonal capsule. The apex of the siphon bears the gonopore, and the shapes of both sipho and tegmen are unique features in species and often used in taxonomy.

Sex can only be determined with some difficulty in coccinellids; the characters for distinguishing males and females cannot be generalized. Males are usually smaller than females and often have lighter colouration on the front part of head, sometimes even on the front part of pronotum and also other parts of the body may differ in color. The length of the antennae is slightly greater in males than in females. The number of visible sternites is usually the same in both sexes. In Chilocorini, the sixth stemite of the females is hardly visible, and only slightly visible in the males. To distinguish the sexes, it is possible in most species to use the appearance of the last abdominal sternites, and particularly the construction of the eight abdominal sternite (= the sixth visible stemite). In many species, there are differences in the form of the sixth visible stemite, which is more often in males than in females, is emarginated to a different degree at the middle of the hind margin.

2.3. Biology of the Coccinellidae

2.3.1 Life cycle

Below summary is based on Hodek (1973).

Coccinellidae are holometabolous, which mean they have a complete metamorphosis and pass through all the stages (egg, larva, pupa and adult). Eggs are usually elongate, oval or elliptic and they vary in color from almost transparent, light grey, yellowish, bright yellow to dark orange. Egg stage lasts 15 – 20% of the total preimaginal developmental time. Eggs are laid either singly or in clusters with an average size of 30- 40 eggs. The size of eggs is thus related to the average body size of the species; it is less than 0.4 mm in the smallest genera and over 2 mm in the largest genera and the mean duration of hatching of larvae within the same batch range between 2 to 7 days.

Larva of most coccinellid tribes have an elongate body and ellipsoidal in subfamilies like Hyperaspidini and hemispherical in the Platynaspidini. Structure of the first eight abdominal segments in the third and fourth instars are important in taxonomy and identification for the species because it differs according to their shape, with seven types: seta, chalaza, tubercule, struma, parascolus, sentus and scolus. In some species the mandibles of larvae have an apex ending with a single point and in other species have two apical teeth which depend on their food, whereas in the phytophagous Epilachninae, mandibles are equipped with four or five large teeth. The number of instars in the whole family is usually four, independent of the species size, developmental conditions, etc. The last fourth instar eventually stops feeding and attaches to a substrate, forming the so-called prepupa. Larva stage lasts 55-65% of the total preimaginal developmental time and duration of larval development is species specific are strongly dependent on the ambient temperature and also on the quality and quantity of their food. In well-fed larvae, the first instar takes about 24% of the total developmental time, the second 17%, the third 19% and the fourth 40% and the duration of larval development further depends on population density but in most species the development of the larva take 3-4 weeks.

Pupation stage lasts 20 – 25% of the total preimaginal developmental time, which take 4-7 days of the life cycle. The last (fourth) instar larva attaches itself by the tip of its abdomen (‘anal organ’, pygopod) to the substrate and prepares for pupation. Pupae of coccinellids are of the type pupa adectica obtecta, which means that all appendages (antennae, limbs, wing pads) are glued to the body by exuvial fluid. Prey quality and quantity during larval development, as well as the temperature during development are the main determinants for the size of the pupa of particular species and the developmental rate. Pupation takes place mainly on the foliage; bark of branches and on tree trunks.

After emerging from the pupa, females, and sometimes males, show a refractory period of a few days in their mating behavior. Slight protogyny (the first mating of females taking place at earlier age) could theoretically occur when females mate before sexual maturity and store sperm, while males mate only after maturity. The basic sex ratio in coccinellids is close to 50:50. The pre-oviposition period (the number of days between female emergence and the laying of the first egg batch) ranges between 0 and 10 days but in dormant females, it can last weeks or even months. Females are generally larger and heavier than males, although often not significantly so, due to high variability. Ladybirds mate often and for a long time, and change partners and the mating duration range of 40- 60 minutes. Hatching rate increased after multiple matings and at age had reached 10-30 days. Daily oviposition or reproductive rate increases rapidly during several days after adult eclosion, which lays eggs over two or three weeks, and then slowly decreases during the remaining life span of the female, which might be several months (No eggs were deposited at 15 °C or less). Coccinellidae population density increases with increase of prey density.

2.3.2 Feeding Habits

Below summary is based on Hodek & Evans (2015)

Most species of Coccinellidae have an economic impact like predaceous coccinellids have a wide range of Aphids, scale insects, Psyllids, whitefly, pollen grain and Adelgids so their food was studied actively (Wallace & Hain, 2000; Escalona et al, 2017). Ladybeetles are a natural enemies of aphid, coccid and mite pests but predaceous coccinellids are mostly aphidophagous feeding on Homoptera and phytophagous mites, they often prey also on young instars of Lepidoptera, Coleoptera and Hymenoptera, small nematocerous, Diptera and Thysanoptera. Most of the Coccinellidae are predators, feeding during larval and adult stages on aphids, scale insects, whiteflies, mites and occasionally on eggs and young larvae of Lepidoptera, Coleoptera and other insects; some are mass-reared and applied in biological control. The body size of aphidophagous ladybeetles and aphid prey plus nutritional and chemical qualities of prey are important factors that effect on the feeding habits of the coccinellids with variability between the species. When the suitable food be shortening and scarce the adult coccinellids are able to starve for quite a long time by take a limited amount of food, or switch to a different substitutive food (insect or plant origin (pollen and nectar) as well as fungi) to survive and reduced the mortality tell the insect prey appear again.

2.3.3 Distribution and Habitat

Below summary is based on Honek (2015).

Coccinellidae is found worldwide but the highest number of species is reported in tropical regions. Landscape, host plant, microclimate and prey as well as natural enemies constitute the main determinants of distribution of the ladybeetles. Local distribution and reproduction for the Coccinellids is determined by prey availability as adults lay their eggs and increase numbers in proportion to their prey population. Coccinellids aggregate more on plants in groups rather than on isolated plants infested with aphids because of prey density and potential prey population growth (Evans, 2003). Two adjacent and evenly developed crops of different cereal species, two rows of garden trees each of a different species may represent a uniform habitat because of the absence of any difference that is important for the coccinellids. Coccinellids can distinguish and select habitats with the qualities important to them and where the eggs are hatched but the adults move in response to light and temperature conditions because they are mostly day active.

2.3.4 Effects of Climate

Below summary is based on Hodek (2015).

Coccinellids are exotherms which means that they dependent on the external temperature to determine the survival rate and appearance (i.e. they have limited capacity for thermoregulation). Temperature determines the length of development of the immature stages, the length of the teneral period (soft after molting), adult ecdysis to first oviposition, the quantity and duration of oviposition, and the length of life. Coccinellids emergence in the spring with the temperature increase and exceed 15^{o} C and active in this period after the exit from Winter hibernation, to begin the process of laying eggs and reproduction on plants infected with pests (mostly aphids) to be as food for larvae after hatching eggs. Coccinellids continue to be active in the spring and early summer periods, where they begin to decline because of increasing the temperatures above 30° C (Khalil, 2006).

2.3.5. Predators & Diseases

The red and black or yellow and black patterns on many adult members of Coccinellidae usually serve as aposematic (warning) coloration but this did not prevent the lady beetles to be eaten by various vertebrate and invertebrate predators. Birds are the most common vertebrate predators (Mizer, 1970) but they are also consumed by spiders (Richardson & Hanks, 2009), reptiles, and other animals. Insects not belonging to the same guild as their predatory ladybeetles prey include dragonflies (Conrad, 2005), robber flies (Ghahari et al., 2007) or vespid wasps (Gambino, 1992). Other predatory insects known to hunt phytophagous ladybirds include beetles, true bugs, neuropterans, butterflies (larvae of some Noctuidae), earwigs, and ants (Ohgushi, 1986, Majerus et al., 2007). It is also known that some species of Coccinellids may prey on other species of the same family but even eggs of its own species (cannibalism) especially when prey is limited (Hironori & Katsuhiro, 1997). Coccinellids are also susceptible to diseases like infection by acarina like Phoretic mites, fungal pathogens and bacteria (Otsu et al., 2003).

2.3.6 Diapause & Dormancy

Below summary is based on Hodek (2015).

Diapause is induced mainly by an absence of food or due to changing climatic conditions that are compatible with their existence. When aphids are lacking, the coccinellids may consume alternative foods (like nectar of flowers or pollen). Most coccinellid adults accumulate energy reserves for hibernation before migrating to hibernation sites, while others continue to feed after the main phase of migration and deposit sufficient fat for aestivation hibernation. Aggregating is a specific behavioral feature connected with dormancy in many Coccinellidae. Coccinellids are led to form aggregations when brought passively (wind currents) and actively to the same locality. After arriving at the site, the beetles are led to specific portions of habitats by their responses to physical factors (hydrotaxis, thermotaxis), and negative phototaxis leading them to microhabitats such as summits of hills, large rocks or high buildings or a forest edge, a certain shrub or a tree. At the end of dormancy, the beetles gradually change their behaviour to increase their mobility and then mating on the trees (especially on young pines) in the dormancy site before dispersal.

2.4. Coccinellidae of Palestine

Palestine connects Africa with Eurasia and is in the western part of the Fertile Crescent where the first humans migrated out of Africa and also where agriculture first developed. The geologic activities over the past 100 million years and especially the formation of the Great Rift Valley ensured varied and rich topography, which resulted in a burst of speciation producing many endemic species of plants and animals inhabiting five ecozones and four biogeographical regions (Por, 1975; Qumsiyeh, 1985, 1996). Studies of biodiversity in Palestine have been limited in contrast to those of nearby areas of Palestine and research in general still lags behind (Qumsiyeh and Isaac, 2012). The area has been sporadically studied before by visitors to the “Holy land” from Tristram (1865, 1884) to David Harrison in the

1960s (Harrison & Bates, 1991). Palestine has a rich Fauna and Flora in spite of its small area due to its geographical position as a meeting point between Asia and Africa, and Europe where four biogeographical regions found: The Mediterranean, Irano-Turanian, Saharo-Arabian and Sudano-Ethiopian (Qumsyieh, 1996).

Many studies show the importance of studying the Palestinian environment and especially in view of a decline in biodiversity due to human activity (Amr et al., 2016; Hammad and Qumsiyeh, 2013; Khlaif and Qumsiyeh, 2016; Qumsiyeh et al., 2014a). Very limited information is available on the invertebrates of the West Bank. However, Palestine Museum of Natural History (PMNH) started to collect invertebrates since 2013 for scientific studies. This resulted in a number of scientific publications on butterflies, freshwater snails, grasshoppers, scorpions, and dragonflies (Qumsiyeh et al., 2013; Handal et al., 2015; Handal et al., 2016; Abusarhan et al., 2016; Qumsyieh et al., 2014b; Adawi et al., 2017; Abusarhan et al., 2017). These studies showed high biodiversity and yet ongoing habitat destruction and environmental deterioration.

The family Coccinellidae (lady beetles) is well known, abundant, and diverse family that is of great interest and importance in agriculture and forestry, since adults and larvae of most species are natural predators of herbivorous pests. Because of its positive impact on the environment and on agricultural operations, the lady beetles received wide interest by the world. The first list of Coccinellidae of Palestine was compiled by Bodenheimer (1937) and he recorded 37 species. Subsequently the number of species in our area increased substantially with additional studies including in nearby areas (Table 1).

Table 1: Reports on the species number of land snails in Palestine and nearby countries

Country	Number of Species	Reference
Palestine	71	Halperin et al., 1995
Palestine	90	Mendel et al., 2017

Jordan	16	Allawi, 1989
South of Syria	51	Khalil, 2006
Lebanon	30	Abu Nasr, 1956
Egypt	53	Alfieri, 1976
Yemen (incl. Socotra)	91	Raimondi et al., 2006
Saudi Arabia	34	Fursch, 1979
Iran	110	Jafari et al., 2015
Iraq	61	Ali et al., 1990

Most studies provide descriptive alpha level data with little ecological data. The area of the West Bank of Jordan (the occupied Palestinian territories is notably deficient in recorded species (Table 2). Za'aqiq (2007) recorded 4 species of Coccinellids feeding on grapevine aphid in Al-Arroub Agricultural Experimental Station, two of those species *Chilocorus kuwanae* and *Olla abdominalis* are indemic species to our area was introduced to attack the plants pests in the 1961 and 1980 (Mendel et al. 2017), but Halperin, et al. (1995) did not record them in his list for the coccinellids in Palestine in 1995. *Hippodamia convergens* was recorded in Za'aqiq (2007) but might have been identified incorrectly because it seems to be *Hippodamia (Adonia) variegate.* Some unpublished master theses in Palestine focused on observing plant pests, but few of these investigated the ladybeetles that feed on these pests in the same area. Therefore, it is important to investigate thoroughly the taxonomy and ecology of coccinellids in our area.

Table 2. Coccinellid species recorded in historic Palestine (Halperin, et al. 1995; Mendel et al. 2017) with those recoded in the West Bank prior to this study Za'aqiq (2007).

Species Recorded in Palestine	Species Previously Recorded in WB
***Adalia (Adalia) decempunctata* (L.)**	
***Anisosticta novemdecimpunctata* (L.)**	
***Bulaea lichatschovi albiventris* (Fursch)**	
***Cheilomenes propinqua nilotica* (Mulsant)**	
Chilocorus bipustulatus	
Chilocorus bisugus infernalis	
Chilocorus infernalis	

Chilocorus kuwanae	**Recorded by Za'aqiq (2007).**
Chilocorus nigritus	
***Clitostethus arcuatus* (Rossi)**	
Coccinella (Coccinella) septempunctata (L.)	**Recorded by Za'aqiq (2007).**
Coccinella (Neococinella) undecimpunctata (L.)	
***Coccinella sinuatomarginata* (Faldermann)**	
***Coccinula quatuordecimpustulata* (L.)**	
***Coelopterus salinus (*Mulsant)**	
***Cryptolaemus montrouzieri (*Mulsant)**	
Delphastus Pallidus	
Delphastus Pusillus	
***Exochomus nigromaculatus* (Goeze)**	
***Exochomus ntgripennis* (Erichson)**	
***Exochomus pubescens (*Kiister)**	
***Exochomus quadripustulatus* (L.)**	
***Exochomus undulatus (*Weise)**	
Halmus (Orcus) chalybeus	
***Harmonia quadripunctata* (Pontoppidan)**	
***Henosepilachna argus* (Fourcroy)**	
***Henosepilachna elaterii* (Rossi)**	
***Hippodamia (Adonia) variegata* (Goeze)**	**Recorded by Za'aqiq (2007) as *Hippodamia convergens***
***Hyperaspis guttulata (*Fairmaire)**	
***Hyperaspis polita (*Weise)**	
***Hyperaspis reppensis quadrimaculata (*Redtenbacher)**	
***Hyperaspis syriaca (*Weise)**	
Hyperaspis trifurcate	
***Lithophilus cribratellus (*Fairmaire)**	
***Lithophilus grandis (*Pic)**	
***Lithophilus marginatus (*Reitter)**	
***Lithophilus ovipennis* (Crotch)**	
Nephaspis oculatus	
***Nephus (Geminosipho) fenestratus* (J. Sahlberg)**	
***Nephus (N.) quadrimaculatus pictus* (Gglb.)**	
***Nephus (S.) hiekei riyadensis (*Fursch)**	
***Nephus (Sidis) biflammulatus* (Motschulsky)**	
***Nephus (B.) kiesenwetteri* (Mulsant)**	
***Nephus (B.) nigricans* (Weise)**	
***Nephus (Bipunctatus) includens (*Kirsch)**	
***Nephus (D.) rubidus* (Motschulsky)**	
***Nephus (Diomus) anemicus (*Fiirsch)**	
***Nephus (N.) merkli (*Fursch)**	
***Nephus (Nephus) ludyi* (Weise)**	
***Nephus (S.) macilentus (*Stenius)**	
Nephus flavifrons	
Nephus peyerimhoff	
Nephus reunion	
Novius cruentatus	
***Oenopia conglobata* (L.)**	
***Oenopia oncina* (Olivier)**	
Olla abdominalis	**Recorded by Za'aqiq (2007)**

***Pharoscymnus fleischeri* (Weise)**	
***Pharoscymnus numidicus* (Pic)**	
***Pharoscymnus ovoideus* (Sicard)**	
***Pharoscymnus pharoides* (Marseul)**	
***Pharoscymnus setulosus* (Chevrolat)**	
Pharoscymnus tomeensis	
***Platynaspis luteorubra* (Goeze)**	
***Propylea quatuordecimpunctata* (L.)**	
***Psyllobora bisoctonata* (Mulsant)**	
***Rhyzobius chrysomeloides* (Herbst)**	
Rhyzobius forestieri	
***Rhyzobius litura* (F.)**	
***Rhyzobius lophantae* (Blaisdell)**	
***Rodolia cardinalis* (Mulsant)**	
Rodolia iceryai	
***Scymnus (M.) mediterraneus* (Khnzorian)**	
***Scymnus (P.) belophallus* (Capra)**	
***Scymnus (P.) fraxini* (Mulsant)**	
***Scymnus (P.) auritus* (Thunberg)**	
***Scymnus (Pullus) araraticus* (Khnzorian)**	
***Scymnus (S.) mimulus* (Capra et Fiirsch)**	
***Scymnus (Mimopullus) flagellisiphonatus* (Fursch)**	
***Scymnus (P.) subvillosus* (Goeze)**	
***Scymnus (P.) syriacus* (Marseul)**	
***Scymnus (S.) flavicollis* (Redtenbacher)**	
***Scymnus (S.) pallipediformis* (Giinther)**	
***Scymnus (S.) bivulnerus* (Capra et Fiirsch)**	
***Scymnus (S.) levaillanti* (Mulsant)**	
***Scymnus (S.) quadriguttatus* (Fursch et Kressl)**	
***Scymnus (Scymnus) apetzi* (Mulsant)**	
Scymnus reunion	
Serangium parcesetosum	
***Stethorus gilvifrons* (Mulsant)**	

Objectives

Lady beetles are common in Palestine and are important natural enemies to many plant pests. Studies about the species of lady beetles endemic to Palestine, their geographic distribution and their ecological significance are still poorly studied. The present study aims at:

1. Surveying and identifying all species of lady beetles in the south of the West Bank and the Jordan Valley of Palestine.

2. Identifying the geographic distribution of each species in those areas.

3. Investigating the ecological significance of the species in the area

3. Materials and Methods

3.1. The Study Area

Historical Palestine are located on the coast of Mediterranean Sea between 29° and 33° North Latitude and between 35° and 39° E Longitude. The West Bank (including East Jerusalem), is the central areas of Palestine that were occupied by Israel in 1967. The geographical location of the West Bank is between 31°13' and 32°33' Latitude, and between 34°13' and 35°34' Longitude. Despite its small geographical area, it is characterized by a great variation in topography and climate. Palestine belongs to the sub-tropical zone and the climate is mostly of Mediterranean type with a long hot and dry summer, short cool and rainy winter. The temperature increases toward the south and towards the Jordan Valley (east). The rainfall is from <100 mm in the Dead Sea area to >700 mm in the mountains (Isaac, 2002).

Based on the geographic distribution of plant species, the West Bank encompasses four phytogeographical regions (Figure 1) (Zohary 1947). The Mediterranean region extends along the coastal plain to the north of Gaza Strip, the Hebron Mountains, and the northern part of the Jordan Rift Valley and the western slopes of the Nablus and Jerusalem and Hebron Mountains, ending 65 km south of Jerusalem. The climate of this area is typical of the Mediterranean region, with a minimum annual rainfall more than 400 mm. The Irano-Turanian region consists of a narrow longitudinal belt to the east of the Mediterranean zone. It covers the southern parts of the West Bank in the Jerusalem and Hebron wilderness, central Jordan Rift Valley and adjacent steppes and rocky areas facing the southern part of the Jordan

Rift Valley. The annual rainfall ranges between 150 and 300 mm. The Saharo-Arabian region is characterized by large expanses of gravels, curculios, salines, and sand dunes along with the complete lack of cultivation, except for a considerable number of seasonal plant communities in and around springs and some trees near frequent water resources. Annual rainfall ranges between 50 and 150 mm. The Sudanese Penetration Region is a transitional zone of penetration through the Great Rift Valley where areas like Jericho falling significantly below sea level get high winter temperatures and support the growth of many Sudanese species in the (EQA, 2015).

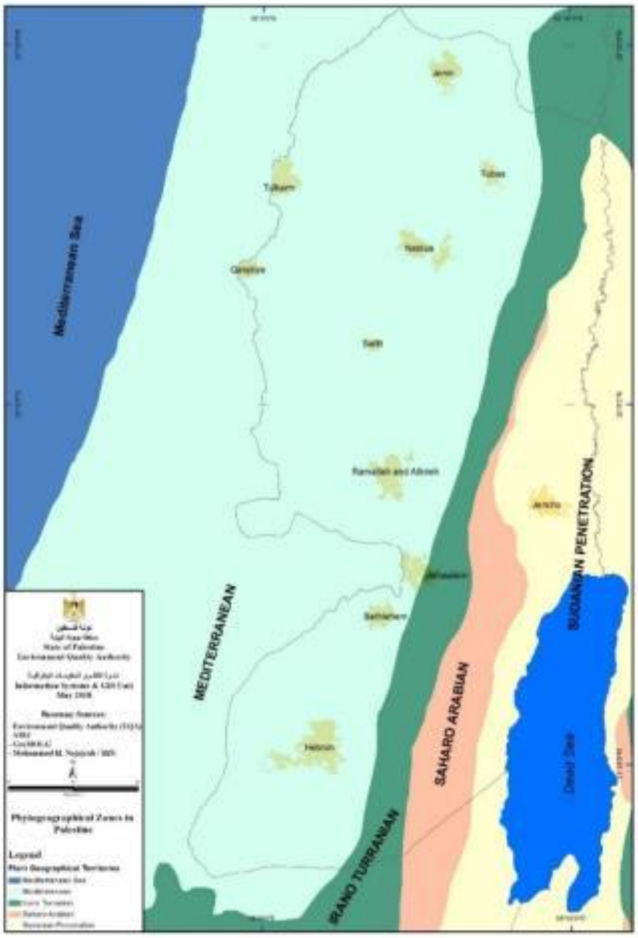

Figure 1. Phytogeographical zones in Palestine based on older literature but see Soto-Berelov et al. (2015) for an updated map and see our discussion.

During the study period, samples were collected from the plant level of 0-2.5 m and different habitats were covered from natural reserves and protected areas to agricultural lands. Table 3 shows a list of the common plants existing in the study areas.

Table 3. List of the common plants in the study area

Natural Plants	Agricultural Plants
Acacia	Almond
Ajuga	Apple
Atriplex	Bananas
Carop	Barley
Ceratonia	Bean
Chaste	Cabbage
Cucumis	Cauliflower
Cupressus	Citrus
Dodonaea	Common purslane
Fennel	Corn
Hawthorn	Eggplant
Inula	Grape
Jasmin	Molochia
Jeranuom	Okra
Jujube	Olive
Ligustrum	Onions
Oak	Palm
Pine	Parsley
Pistacia	Peach
Prosopis	Pear
Retama	Pepper
Rosa sp.	Pomegranate
Rosemary	Spinach
Sumac	Squash
Tamarix	Thyme
Wattles	Tobacco
Weeds	Tomato
Ziziphus	Watermelon
	Wheat and Barley
	Rocket
	Maize

3.2. Collection Period

A total of 166 sites representing various habitats within the four biogeographical regions of the south of the West Bank and the Jordan Valley of Palestine were surveyed from March to May 2018. Field trips were conducted daily from 8:00 AM to 7:00 PM over two months. Each site was carefully inspected for the presence of the lady beetles. Each site was photographed, and coordinates were recorded to construct distribution maps. The bias in the collection may arise because of the temperature and fluctuations of the weather in the West Bank. Some 25 specimens collected by PMNH staff before the study period were also examined (they belonged to only two species).

3.3. Tools (Field & Lab)

The tools that was used in the field included entomological forceps (soft and hard), urine cups, Eppendorf types, aspirator, 70% alcohol, pipets, sweep nets, beating sheet, sticks, plastic bags, vest, marker, notebooks, pens, camera, GPS unit, magnifying glass 40X, map and a car for transportation.

The tools that was used in the lab included entomological forceps (soft and hard), Eppendorf types, 70% alcohol, 95% alcohol, 100% alcohol, 10% KOH, Insect pins, petri dishes, pipettes, slides, collection boxes, flashcards, scissors, notebooks, plastic files, papers, markers, freezer, dissecting microscope 16X-100X, optical microscope 40X -100X, and laptop computer.

3.4. Collection and Preservation of Samples

Plans for the field trips mainly in the south of the West Bank and the Jorden Valley were done depending on the literature review for the ecological relationships, habitat associations and physical characteristic maps of the West Bank. Different localities covering the four phytogeographical zones in the study area were chosen. Driving to each site, in addition to walking in the natural habitats and collecting the samples randomly was done. Random farms were chosen to do line transects inside the farm and the surrounding areas around the farm in each locality. Fieldwork for the coccinellids covered the breeding season in the spring and the beginning of the summer season. First, sampling sites were examined carefully for the presence of active Coccinellids on the plants (adults, pupae and larvae). Thereafter, sites were examined for the presence of aphids, scale insects, and pollen grains on the plants because they form the food to which the coccinellids presence is related during the collection period. Five different methods were used to study and collect the coccinellids in each site:

1) Field observations for the large species.

2) Observation for the most relative abundance indicator species like aphids and scale insects.

3) Line transects were done over the length of the farms investigated.

4) Random sampling in the natural areas, natural reserves and protected areas. In each site random collection of samples using beating sheet and shaking the plants by a stick. Specimens that fell on the beating sheet were collected by using an aspirator and entomological forceps (soft and hard).

5) Stratified sampling was correlated with the vegetation type on some localities to find out if the samples on this vegetation cover were similar.

Samples of Adult beetles were preserved in urine cups and Eppendorf tubes; larvae were preserved in Eppendorf tubes with 70% alcohol. Each sample from each locality was marked with the name of the locality, date, plant level and type (in general). All samples of adult beetles from each locality were collected in one plastic bag and kept in the car for a maximum of 36 hour with some aphids as a food source before killing the samples by freezing.

Working on the samples to separate them and preserve them in the freezer for a long time was done at the end of each week in the lab of Palestine Museum of Natural History (PMNH) under a dissecting microscope (16X-100X) using entomological forceps (soft and hard), Eppendorf tubes, 70% alcohol, insect pins, Petri dishes, Collection boxes and flashcards. Each sample was provided with a field number with all the information collected about the samples and a catalogue file for all these information was prepared.

3.5. Classification of the Specimens

Classification for the samples was done in the lab of Palestine Museum of Natural History by using a dissecting microscope (16X-100X) and an Optical Microscope (40X-100X). Classification was done depending on identification keys of the lady beetles available in literature and on already identified specimens. Specimens that have been examined were recorded in the results as {Locality (Field Number, Number of specimens and Date of collection)}.

Classification was dependent on keys provided by the following publications: Correa & Almeida, 2010; Hodek, Emden & Honek, 2015; Chapin, 1971; Khalil, 2006; Ali et al, 2015; Chapin, 1965; Larson, 2013; Biranvand et al, 2017; Tomaszewska et al, 2017; Kova, 2005; Ashfaque et al, 2015; Li et al, 2016; Raimundo & van Harten, 2000; Hodek & Honek, 1996;. Halperin et al., 1995; Raimundo et al., 2006; Khormizi et al, 2016; Canepari, 2009.

3.6. Laboratory Work

Preparation of the genitalia of insects in the laboratory was based on Khalil (2006) and (Dreisbach, 1952) with some modifications as follows:

Samples were remove from the freezer for 10 minutes to thaw, and then placed in a water bath (50^{o}C) for 3 minutes. Thereafter, samples were put into a Petri dish and placed under the dissecting microscope with extra light (Temperature 30-33^{o}C). The anatomy was done using needles prepared manually by removing the head of the insect pins and placing it at the end of the matchstick to be used for extracting the genitalia. The abdomen was separated by turning the sample to the ventral side and placing the needles between the first abdominal ventrites and the third coxal cavities in the abdominal post coxal line, which leading to the separation of the abdomen from the rest of the body without causing any damage to the external shape of the specimen. Thereafter, the abdomen was turned on the upper face in terms of being the tenderest and most susceptible to genital extraction by the needle. Genitalia extracted were transferred to 6 ml 10% KOH on a hotplate at 70° C for 5 minutes with suction and pumping several times by the pipette within the same dish. After that, genitalia were removed from the KOH into a petri dish and then washed using 3 ml distilled water for 1 minute through suction and pumping several times by the pipette within the same dish. Distilled water was removed and genitalia were washed with 3 ml 70% alcohol for one minute and thin washed again with 3 ml 95% alcohol for 1 minute. Finally, genitalia were washed with 3 ml 100% alcohol for 1 minute, while maintaining the suction and pumping alcohol several times during this operation. After washing was complete, genitalia were moved using a needle to a pre-labeled slide bearing the sample number. When, the details of the genitalia were not visible under the microscope, they were dyed with Eosin Y stain for 5 minutes and then washed with distilled water. The genitalia were placed on the slide again with a drop of Canada Media and a cover slip to have a permanent slide as a reference for the future classifications.

4. Results

Field trips were conducted on a daily basis to 166 localities in the West Bank of Palestine (Table 4). Sampling localities concentrated in the southern parts of the West Bank and in the Jordan Valley (Figure 2). Figures 3 & 4 show habitat variability (natural and cultivated) representing the sampling areas in the four phytogeographical zones of the West Bank visited between March and May 2018.

Table 4. List for the sampling localities visited during this study in the West.

Number	Locality name	Latitude (N)	Longitude (E)	Sea level	Date
1.	Abda	N 31°27'59.9"	E 035°01'19.6"	727m	15.4.2018
2.	Abu Nujaym 1	N 31°39'47.9"	E 035°11'32.8"	805m	25.3.2018
3.	Abu Nujaym 2	N 31°39'40.2"	E 035°12'24.2"	704m	27.3.2018
4.	Ad Deir	N 32°23'01.3"	E 035°32'13.0"	-237m	7.3.2018
5.	Ad-Dhahiriya 1	N 31°26'10.1"	E 034°59'24.7"	671m	11.3.2018
6.	Ad-Dhahiriya 2	N 31°24'46.5"	E 034°55'48.5"	641m	5.4.2018
7.	Al Aroub	N 31°37'27.0"	E 035°07'36.1"	867m	3.4.2018
8.	Al Aroub (Al Qarn)	N 31°37'06.3"	E 035°07'21.1"	928m	2.4.2018
9.	Al Baqa'a 1	N 31°31'51.3"	E 035°08'01.1"	982m	9.4.2018
10.	Al Baqa'a 2	N 31°31'52.9"	E 035°08'51.1"	900m	9.4.2018
11.	Al Buweib	N 31°27'48.0"	E 035°09'34.9"	807m	9.4.2018
12.	Al Carmel 1	N 31°25'12.3"	E 035°08'40.8"	746m	11.3.2018
13.	Al Carmel 2	N 31°25'25.1"	E 035°08'07.3"	806m	12.4.2018
14.	Al Dayr	N 31°39'32.0"	E 035°01'55.8"	445m	3.4.2018

15.	Al Hijra	N 31°29'11.7"	E 035°03'32.8"	763m	12.4.2018
16.	Al Rushayda	N 31°34'37.3"	E 035°13'50.8"	660m	27.3.2018
17.	Al-Auja 1	N 31°56'48.5"	E 035°29'09.7"	-290m	6.3.2018
18.	Al-Auja 2	N 31°56'48.2"	E 035°28'32.0"	-253m	6.3.2018
19.	Al-Auja 3	N 31°57'20.2"	E 035°28'52.5"	-270m	6.3.2018
20.	Al-Auja 4	N 31°56'52.1"	E 035°30'03.5"	-290m	6.3.2018
21.	Al-Khader	N 31°42'06.4"	E 035°09'29.1"	852m	22.3.2018
22.	Alkhas	N 31°42'53.1"	E 035°15'14.6"	561m	18.3.2018
23.	Al-Kum	N 31°31'57.4"	E 034°58'07.6"	457m	5.4.2018
24.	Al-Ramadin	N 31°22'50.5"	E 034°54'40.1"	596m	5.4.2018
25.	Al-Rayhiyya	N 31°28'22.9"	E 035°04'36.3"	744m	12.4.2018
26.	Al-Shawawra	N 31°41'26.3"	E 035°15'39.5"	555m	18.3.2018
27.	AlShuyukh	N 31°34'26.1"	E 035°09'07.7"	911m	9.4.2018
28.	Alsira	N 31°27'47.7"	E 034°59'43.1"	763m	15.4.2018
29.	AlTabqa 1	N 31°29'51.8"	E 035°00'30.1"	858m	15.4.2018
30.	AlTabqa 2	N 31°30'01.3"	E 034°59'42.4"	790m	15.4.2018
31.	An-Nabi Musa	N 31°47'35.8"	E 035°25'38.2"	-112m	16.4.2018
32.	Asakra	N 31°39'52.3"	E 035°13'28.2"	560m	27.3.2018
33.	As-Samu	N 31°24'07.1"	E 035°03'34.9"	668m	12.4.2018
34.	As-Samu (Amnyzl)	N 31°22'24.3"	E 035°04'34.9"	717m	11.3.2018
35.	At-Tuwani	N 31°24'38.4"	E 035°09'09.6"	762m	11.3.2018
36.	Bani Na'im 1	N 31°30'30.6"	E 035°09'48.9"	952m	9.4.2018
37.	Bani Na'im 2	N 31°30'10.1"	E 035°11'16.7"	663m	9.4.2018
38.	Bani Na'im 3	N 31°29'38.7"	E 035°12'00.4"	550m	9.4.2018
39.	Bardala 1	N 32°23'19.3"	E 035°29'21.8"	-107m	7.3.2018
40.	Bardala 2	N 32°23'26.5"	E 035°28'46.0"	-76m	7.3.2018
41.	Bardala 3	N 32°23'35.4"	E 035°29'42.7"	-139m	7.3.2018
42.	Battir 1	N 31°43'42.3"	E 035°08'19.3"	642m	21.3.2018
43.	Battir 2	N 31°43'16.6"	E 035°07'52.3"	608m	21.3.2018
44.	Bayt al-Rush	N 31°27'08.9"	E 034°55'38.0"	512m	5.4.2018
45.	Bayt Amra	N 31°26'43.6"	E 035°03'08.8"	711m	12.4.2018
46.	Bayt Fajar 1	N 31°38'04.7"	E 035°08'22.3"	938m	2.4.2018
47.	Bayt Fajar 2	N 31°37'27.7"	E 035°08'58.6"	928m	2.4.2018
48.	Bayt Jala 1	N 31°42'31.1"	E 035°10'21.9"	880m	22.3.2018
49.	Bayt Jala 2	N 31°42'52.4"	E 035°11'20.7"	787m	31.3.2018
50.	Bayt Kahil	N 31°33'53.6"	E 035°03'36.1"	806m	4.4.2018
51.	Bayt Mirsim	N 31°27'02.4"	E 034°55'11.9"	516m	5.4.2018
52.	Bayt Sahur 1	N 31°42'12.0"	E 035°14'14.5"	635m	1.4.2018
53.	Bayt Sahur 2	N 31°42'26.1"	E 035°13'49.3"	625m	2.4.2018
54.	Bayt Ta'mar	N 31°40'26.0"	E 035°14'57.5"	611m	18.3.2018
55.	Bayt Ula 2	N 31°36'37.2"	E 034°59'59.8"	423m	4.4.2018
56.	Bayt Ula1	N 31°36'27.5"	E 035°00'25.6"	467m	4.4.2018
57.	Bayt Ummar	N 31°37'17.0"	E 035°06'50.0"	933m	3.4.2018
58.	Bethlehem 1	N 31°43'03.4"	E 035°12'19.4"	716m	1.4.2018
59.	Bethlehem 2	N 31°41'54.5"	E 035°11'27.8"	789m	2.4.2018
60.	Bi'r Al Qaws	N 31°37'46.1"	E 035°00'29.5"	378m	4.4.2018
61.	Burj	N 31°26'11.2"	E 034°54'24.7"	488m	5.4.2018
62.	Dayr Al'Asal	N 31°27'50.2"	E 034°56'01.6"	431m	5.4.2018
63.	Dayr Balut	N 32° 03'23.8"	E 035° 01'36.1"	152m	4.2017
64.	Dayr Kremzan 1	N 31°43'36.6"	E 035°10'14.6"	833m	31.3.2018
65.	Dayr Kremzan 2	N 31°43'46.6"	E 035°10'04.4"	870m	31.3.2018
66.	Dayr Samet	N 31°31'02.3"	E 034°58'17.4"	437m	5.4.2018
67.	Deir Hajla	N 31°49'14.3"	E 035°30'06.8"	-324m	16.4.2018

68.	Deir Krntl 1	N 31°52'17.3"	E 035°26'23.2"	-190m	23.4.2018
69.	Deir Krntl 2	N 31°52'19.8"	E 035°26'14.6"	-145m	23.4.2018
70.	Deir Razih	N 31°28'16.3"	E 035°02'21.7"	836m	11.3.2018
71.	Deir Razih 2	N 31°28'18.7"	E 035°02'41.7"	811m	15.4.2018
72.	Duma	N 31°26'05.3"	E 034°59'07.4"	661m	15.4.2018
73.	Dura 1	N 31°30'17.4"	E 035°01'44.5"	846m	15.4.2018
74.	Dura 2	N 31°29'46.5"	E 035°02'58.9"	788m	21.4.2018
75.	Dura 3	N 31°30'49.6"	E 035°01'15.9"	821m	21.4.2018
76.	Ein Al 'Auja	N 31°57'16.8"	E 035°23'31.1"	-17m	16.4.2018
77.	Ein Al Fawwar	N 31°50'24.4"	E 035°20'56.7"	76m	16.4.2018
78.	Ein AlBeida 1	N 32°23'18.7"	E 035°29'55.8"	-139m	8.3.2018
79.	Ein AlBeida 2	N 32°23'09.2"	E 035°30'29.2"	-170m	8.3.2018
80.	Ein Al-Duok Al foqa	N 31°53'32.5"	E 035°25'39.2"	-137m	4.3.2018
81.	Ein Al-Sakout 1	N 32°21'48.2"	E 035°31'47.9"	-212m	7.3.2018
82.	Ein Fasa'll	N 32°03'02.0"	E 035°24'21.3"	-81m	16.4.2018
83.	Ein Hasaka	N 31°33'56.6"	E 035°05'16.7"	877m	21.4.2018
84.	Ein Samiya	N 31°59'15.4"	E 035°20'06.0"	438m	3.3.2018
85.	Far'a El-Giftlik 1	N 32°08'39.7"	E 035°29'31.0"	-239m	8.3.2018
86.	Far'a El-Giftlik 2	N 32°08'43.0"	E 035°29'27.0"	-245m	8.3.2018
87.	Hadab Al Fawar	N 31°28'36.4"	E 035°03'32.9"	754m	12.4.2018
88.	Hadab Al'Alaqa	N 31°27'12.8"	E 034°59'59.8"	735m	15.4.2018
89.	Halhul 1	N 31°35'15.4"	E 035°06'34.6"	963m	4.4.2018
90.	Halhul 2	N 31°36'08.4"	E 035°04'54.8"	904m	4.4.2018
91.	HaRasa	N 31°29'15.1"	E 035°00'50.6"	772m	15.4.2018
92.	Hebron	N 31°29'49.4"	E 035°04'18.2"	870m	21.4.2018
93.	Hindaza Bredhaa	N 31°41'03.0"	E 035°12'14.7"	634m	25.3.2018
94.	Husan	N 31°42'55.2"	E 035°07'41.5"	677m	21.3.2018
95.	Idhna 1	N 31°34'20.3"	E 034°58'48.4"	417m	5.4.2018
96.	Idhna 2	N 31°32'36.1"	E 034°57'18.9"	375m	5.4.2018
97.	Irtas 1	N 31°41'21.9"	E 035°10'15.2"	800m	25.3.2018
98.	Irtas 2	N 31°41'15.8"	E 035°11'13.2"	684m	25.3.2018
99.	Jinsafut	N 32o11'03.9"	E 035o08'04.2"	416m	22.1.2018
100.	Jenin	N 32°27'06.1"	E 035°18'39.4"	263m	12.4.2016
101.	Jericho 1	N 31°50'53.6"	E 035°27'25.4"	-250m	23.4.2018
102.	Jericho 2	N 31°51'16.6"	E 035°27'12.4"	-252m	23.4.2018
103.	Jericho 3	N 31°51'47.7"	E 035°27'58.8"	-263m	23.4.2018
104.	Jericho 4	N 31°51'48.2"	E 035°29'09.2"	-285m	23.4.2018
105.	Jubbet ad-Dhib	N 31°40'02.0"	E 035°14'48.0"	637m	18.3.2018
106.	Kardala	N 32°23'04.6"	E 035°29'43.2"	-127m	8.3.2018
107.	Karme	N 31°27'10.8"	E 035°01'23.2"	660m	11.3.2018
108.	Khallet Al-Mia	N 31°26'18.7"	E 035°07'50.1"	793m	12.4.2018
109.	Khallet Hamad	N 31°33'48.0"	E 035°14'38.2"	574m	27.3.2018
110.	Kharas 1	N 31°38'06.2"	E 035°00'45.8"	388m	3.4.2018
111.	Kharas 2	N 31°36'30.1"	E 035°02'45.9"	545m	4.4.2018
112.	kharisa	N 31°26'41.9"	E 035°07'27.7"	773m	12.4.2018
113.	Khirbat Safa 1	N 31°38'56.9"	E 035°05'42.5"	815m	3.4.2018
114.	Khirbat Safa 2	N 31°39'17.3"	E 035°05'23.7"	781m	3.4.2018
115.	Kisan	N 31°36'54.6"	E 035°13'26.0"	770m	27.3.2018
116.	kreisa	N 31°31'47.0"	E 035°00'24.7"	678m	21.4.2018
117.	Kufr al-Dik	N 32°03'37.3"	E 035°04'38.7"	234m	10.2017
118.	Mar Saba	N 31°43'05.0"	E 035°19'03.7"	445m	18.3.2018
119.	Marj Na'je 1	N 32°10'55.8"	E 035°32'30.1"	-272m	6.3.2018
120.	Marj Na'je 2	N 32°11'08.6"	E 035°32'29.8"	-273m	6.3.2018

121.	Marj Na'je 3	N 32º10'52.6"	E 035º32'12.8"	-265m	6.3.2018
122.	Mu'arrajat	N 31°55'00.8"	E 035°20'20.0"	645m	3.3.2018
123.	Nablus	N 32º14'55.8"	E 035º18'38.8"	228m	3.2014
124.	Nahalin 1	N 31º41'19.3"	E 035º05'53.1"	565m	20.3.2018
125.	Nahalin 2	N 31º40'45.9"	E 035º07'33.5"	691m	20.3.2018
126.	Nahalin 3	N 31º40'35.3"	E 035º07'12.3"	781m	20.3.2018
127.	Nuba	N 31º36'52.1"	E 035º01'51.7"	510m	4.4.2018
128.	Nu'eima 1	N 31°53'23.3"	E 035°26'09.1"	-144m	5.3.2018
129.	Nu'eima 2	N 31°52'50.8"	E 035°27'45.6"	-175m	5.3.2018
130.	Nu'eima 3	N 31º53'13.4"	E 035º26'49.5"	-188m	5.3.2018
131.	Nu'eima altahta 1	N 31º53'12.8"	E 035º27'44.0"	-232m	23.4.2018
132.	Nu'eima altahta 2	N 31º52'29.8"	E 035º27'35.4"	-245m	23.4.2018
133.	Qumran	N 31º44'30.5"	E 035º27'37.4"	-345m	16.4.2018
134.	Ruq'a	N 31º27'26.4"	E 035º07'47.9"	812m	12.4.2018
135.	Salfit	N 32º05'05.6"	E 035º10'03.8"	455m	3.2015
136.	Si'ir	N 31º35'09.2"	E 035º07'48.0"	929m	9.4.2018
137.	Sika	N 31º29'12.3"	E 034º56'34.6"	412m	5.4.2018
138.	Surif	N 31º39'14.4"	E 035º02'34.0"	487m	3.4.2018
139.	Susiya	N 31º23'12.3"	E 035º06'45.4"	781m	11.3.2018
140.	Taibe	N 31º58'31.5"	E 035º17'53.2"	924m	12.4.2013
141.	Tapuah	N 31º32'13.7"	E 035º03'43.5"	816m	21.4.2018
142.	Tarama	N 31º28'54.4"	E 035º02'03.8"	805m	15.4.2018
143.	Tarqumiyah (Wadi Al Quff Reserve) 1	N 31º34'36.1"	E 035º01'47.3"	627m	4.4.2018
144.	Tarqumiyah (Wadi Al Quff Reserve) 2	N 31°34'37.4"	E 035°02'27.7"	600m	4.4.2018
145.	Tel Alsamrat	N 31º51'57.3"	E 035º26'12.6"	-202m	23.4.2018
146.	Tulul Abu Al-Ala'iq 1	N 31º51'18.3"	E 035º26'46.2"	-234m	23.4.2018
147.	Tulul Abu Al-Ala'iq 2	N 31º51'24.3"	E 035º26'15.7"	-208m	23.4.2018
148.	Tuqu'	N 31º37'49.3"	E 035º12'42.2"	768m	18.3.2018
149.	Ubeidiya	N 31º43'12.5"	E 035º16'50.2"	598m	18.3.2018
150.	Umm Al-Kear	N 31º25'47.8"	E 035º11'31.4"	711m	11.3.2018
151.	Umm al-Tut	N 32º26'36.2"	E 035º20'31.0"	268m	13.6.2013
152.	Umm Salmuna	N 31º38'55.3"	E 035º09'53.2"	927m	27.3.2018
153.	Wadi Abu Al-Qamarah	N 31º30'03.7"	E 035º02'33.6"	819m	21.4.2018
154.	Wadi Al Joz	N 31º30'36.6"	E 035º04'06.9"	786m	21.4.2018
155.	Wadi Al'Ara'is	N 31º42'32.0"	E 035º16'28.2"	530m	18.3.2018
156.	Wadi Al-Makhrur	N 31º43'00.0"	E 035º09'33.1"	793m	22.3.2018
157.	Wadi AlNaar	N 31º43'43.6"	E 035º17'10.1"	390m	13.4.2013
158.	Wadi AlZurqa AlEulwii	N 32º03'03.2"	E 035º04'51.1"	240m	15.4.2017
159.	Wadi Fukin 1	N 31º42'36.2"	E 035º06'47.0"	712m	21.3.2018
160.	Wadi Fukin 2	N 31º41'46.2"	E 035º05'28.1"	571m	21.3.2018
161.	Wadi Kelt	N 31º50'10.7"	E 035º22'53.0"	-31m	16.4.2018
162.	Wadi Qana	N 32º09'29.5"	E 035º07'03.2"	240m	17.4.2018
163.	Yata	N 31º27'31.9"	E 035º03'40.4"	685m	12.4.2018
164.	Za'tara	N 31º39'51.0"	E 035º15'57.1"	550m	18.3.2018
165.	Zif 1	N 31º27'58.8"	E 035º08'18.8"	840m	9.4.2018
166.	Zif 2	N 31º28'48.6"	E 035º07'45.0"	844m	12.4.2018

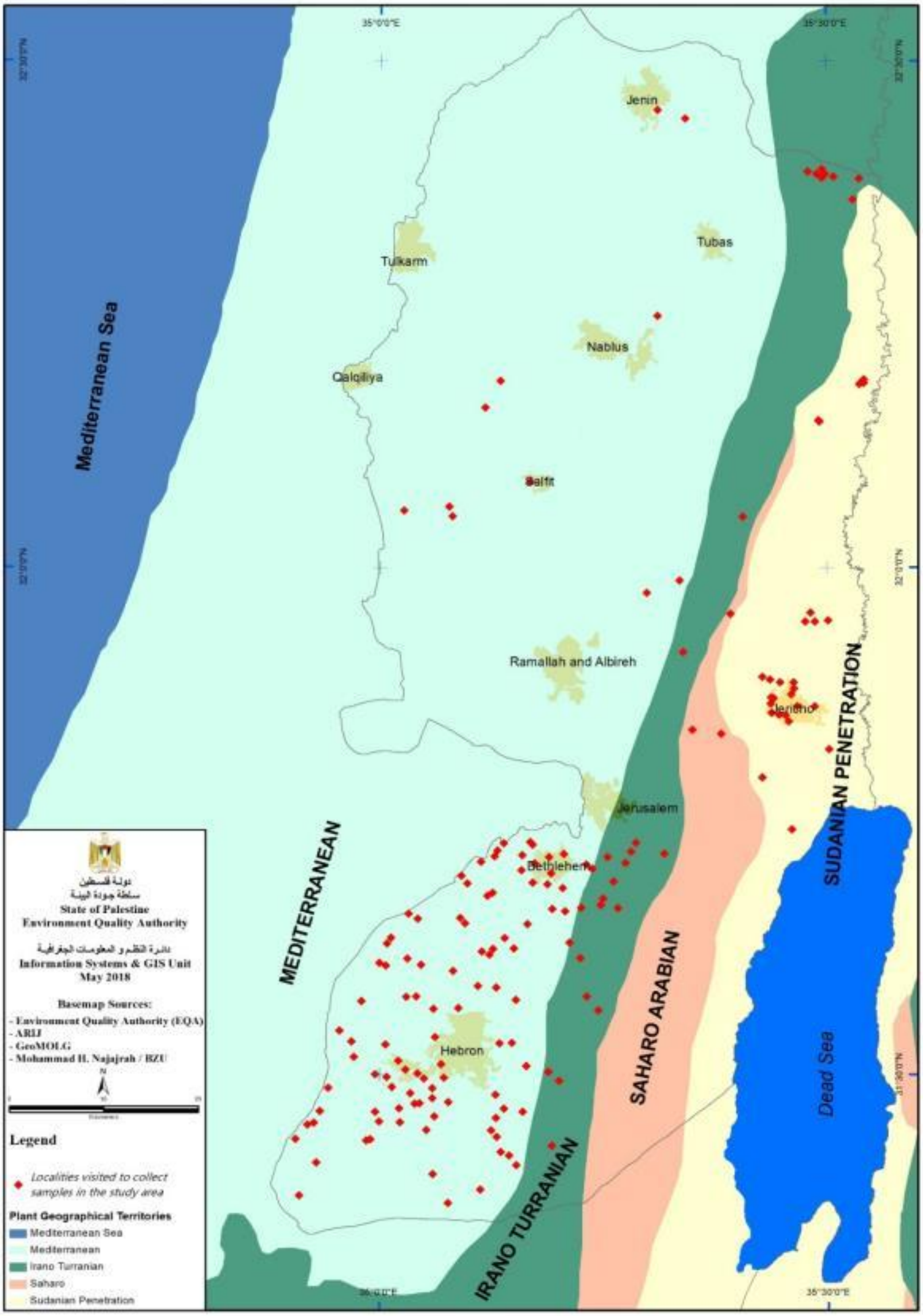

Figure 2: Map of the study area showing 166 localities visited to collect samples from the West Bank.

Figure 3. Varied habitats representing natural sampling areas in the four phytogeographical zones (a) Mediterranean maquis type vegetation near Beit Jala (Dayr Kremzan), (b) *Pine* and *Cupressus* forest near Nahalin (Nahalin 3), (c) Area near Beit Jala (Al Makror) with typical Mediterranean maquis forest mostly of oak and pistacia and (d) Arid area near the Dead Sea.

Figure 4. Varied habitats representing cultivated sampling areas in the four phytogeographical zones (a) Banana and palm farms near Jericho, (b) Intensive and polyculture farm near Jericho (Ein Al-Duok Al Foqa), (c) Tomato farm (Monocropping) near Jericho, (d) Polyculture (eggplant, squash and pepper) near Jericho, (e) Citrus farm near Ein AlBeida and (f) Apple and peach farm near Al Aroub.

4.1. Systematics of Coccinellidae Samples Collected and Their Geographic Distribution

Subfamily Coccinellinae

During this study, seven species of Coccinellinae belonging to tribe Cocinelli were recorded. Among these, four were belonging to the most common species recorded in this study and two were belonging to the very rare species.

Tribe Cocinelli:

Adalia (Adalia) decempunctata (Linnaeus, 1758) (Fig. 5)

Material: Nu'eima (Field#34, 1, 5 March 2018). Marj Na'je 1 (Field#76, 1, 6 March 2018). Ein Samiya (Field#98, 1, 4 March 2018). Al-Auja 2 (Field#137, 1, 5 March 2018). Bayt al-Rush (Field#311, 8, 5 April 2018). Bayt Sahur 1 (Field#329, 3, 1 April 2018). Dayr Kremzan 2 (Field#338, 3, 31 March 2018). Ad-Dhahiriya 2 (Field#358, 2, 5 April 2018). Halhul 1 (Field#384, 1, 4 April 2018). Burj (Field#397, 1, 5 April 2018. Bayt Fajar 1 (Field#411, 2, 2 April 2018). Bayt Ula 2 (Field#466, 1, 4 April 2018). Halhul 2 (Field#487, 1, 4 April 2018). Surif (Field#511, 3, 3 April 2018). Deir Razih 2 (Field#560, 3, 15 April 2018). AlTabqa 2 (Field#630, 1, 15 April 2018). Si'ir (Field#678, 1, 9 April 2018). Ruq'a (Field#686, 3, 12 April 2018). HaRasa (Field#746, 2, 15.4.2018). Tarama (Field#759, 2, 15 April 2018). Hebron (Field#791, 2, 21 April 2018). Tapuah (Field#810, 2, 21 April 2018). Deir Krntl 1 (Field#824, 1, 23 April 2018). Kharas 1 (Field#884, 3, 3 April 2018). Bayt Kahil (Field#885, 4, 4 April 2018). Bethlehem 1 (Field#886, 1, 1 April 2018). Duma (Field#889, 1, 15 April 2018). Bayt Jala 2 (Field#893, 3, 31 March 2018). Bayt Sahur 2 (Field#898, 6, 2 April 2018). Al-Rayhiyya (Field#899, 1, 12 April 2018).

Remarks: *Adalia (Adalia) decempunctata* is a common species that feeds on many types of pests and mostly found in the Mediterranean region on trees and shrubs (Rana et al., 2002). This species was noted preying on *Monelia* aphids on Pecan trees in Palestine (Wysoki & Izhar, 1978) and in Turkey (Apak & Aksit, 2016). During this study, this species was observed on almond and pine trees preying on aphids in the Mediterranean and the Saharo Arabian penetration zones (Figure 6).

Figure 5. *Adalia (Adalia) decempunctata* (Linnaeus, 1758) with various morphs.

Scale bar = 5mm.

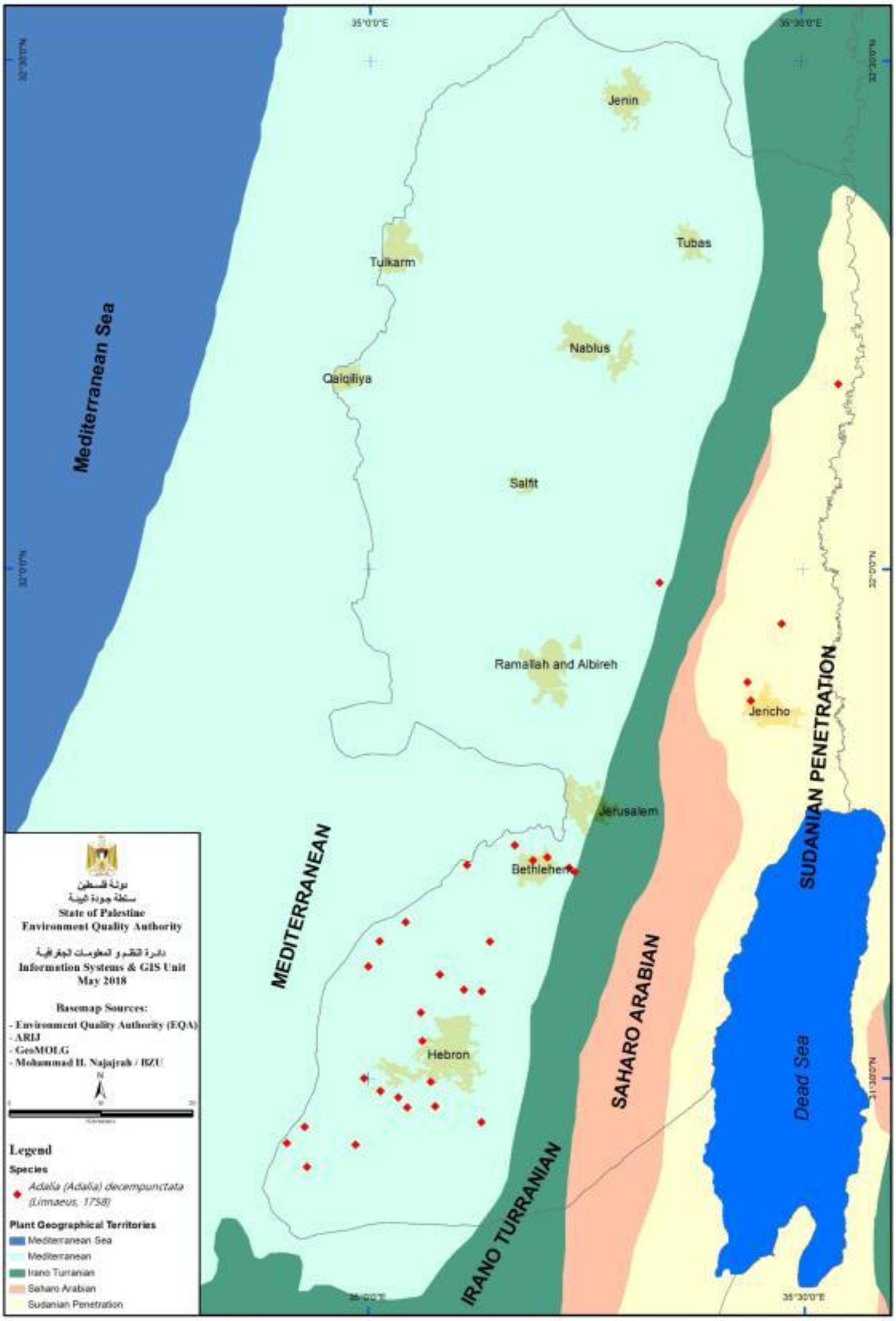

Figure 6. Geographical distribution map of *Adalia (Adalia) decempunctata.*

Cheilomenes propinqua nilotica (Mulsant, 1850), (Fig. 7)

Material: Bayt Ula 2 (Field#465, 1, 4 April 2018).

Remarks: Halperin et al., (1995) recorded this species as a very common species in more than 100 localities in inside the greenline borders. However, in the present study, it was recorded only in one site in the south of the West Bank, praying on aphids on almond trees (Figure 8).

Figure 7. *Cheilomenes propinqua nilotica* (Mulsant, 1850).

Scale bar = 5mm.

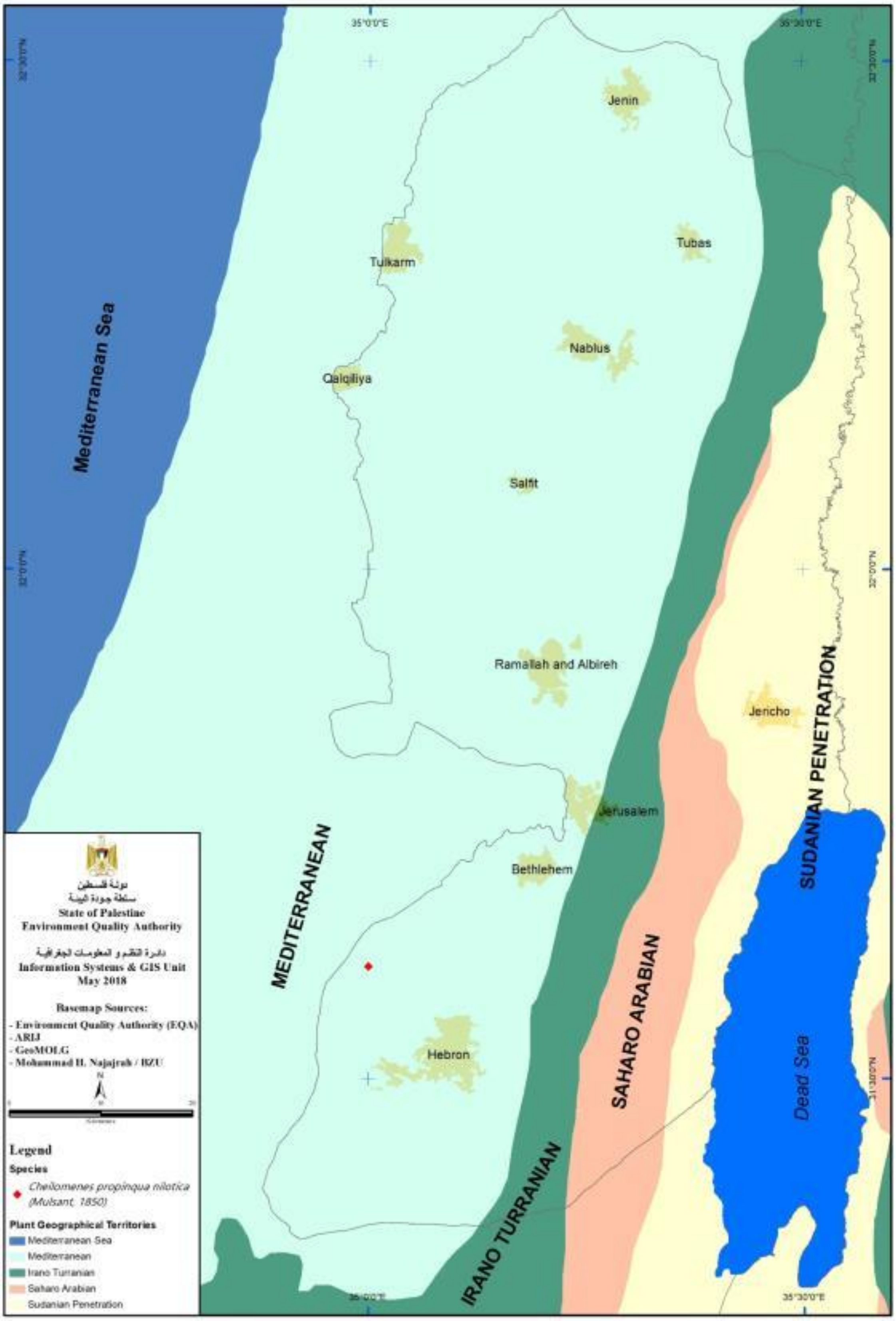

Figure 8. Collection site of *Cheilomenes propinqua nilotica* in the South of the West Bank.

Coccinella (Coccinella) septempunctata (Linnaeus, 1758), (Fig. 9)

Material: Jeansafot (Field#26, 7, 22 January 2018). Nu'eima 2 (Field#27, 3, 5 March 2018). Ein alBeida (Field#43, 1, 8 March 2018). Nahalin 2 (Field#48, 5, 10 March 2018). Bardala 1 (Field#54, 1, 8 March 2018). Ein Al-Sakout 1 (Field#63, 4, 7 March 2018). Marj Na'je 1 (Field#80, 10, 6 March 2018). Al-Auja 1 (Field#125, 1, 6 March 2018). Al-Auja 2 (Field#132, 2, 5 March 2018). Al-Khader (Field#152, 1, 22 March 2018). Nahalin 1 (Field#171, 2, 20 March 2018). Wadi Fukin 2 (Field#192, 6, 21 March 2018). Battir 2 (Field#202, 1, 21 March 2018). Battir 1 (Field#215, 2, 21 March 2018). Al-Shawawra (Field#216, 7, 18 March 2018). Za'tara (Field#218, 6, 18 March 2018). Wadi al'Ara'is (Field#222, 1, 18 March 2018). Abu Nujaym 1 (Field#247, 10, 27 March 2018). Bethlehem 1 (Field#269, 7, 1 April 2018). Al Rushayda (Field#275, 5, 27 March 2018). Khallet Hamad (Field#279, 2, 27 March 2018). Irtas 2 (Field#304, 5, 25 March 2018). Bayt al-Rush (Field#315, 1, 5 April 2018). Dayr Kremzan 1 (Field#317, 1, 31 March 2018). Bayt Sahur 1 (Field#328, 2, 1 April 2018). Dayr Al'Asal (Field#332, 4, 5 April 2018). Ad-Dhahiriya 2 (Field#353, 2, 5 April 2018). Khirbat Safa 2 (Field#362, 4, 3 April 2018). Idhna 2 (Field#367, 1, 5 April 2018). Bayt Mirsim (Field#376, 3, 5 April 2018). Halhul 1 (Field#378, 2, 4 April 2018). Burj (Field#389, 45, 5 April 2018). Bayt Fajar 1 (Field#405, 2, 2 April 2018). Al Dayr (Field#418, 3, 3 April 2018). Sika (Field#426, 3, 5 April 2018). Bethlehem 2 (Field#434, 2, 2 April 2018). Bayt Jala 2 (Field#448, 6, 31 March 2018). Kharas 1 (Field#462, 10, 3 April 2018). Al-Ramadin (Field#471, 2, 5 April 2018). Al-Kum (Field#480, 1, 5 April 2018). Halhul 2 (Field#486, 2, 4 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 1 (Field#499, 2, 4 April 2018). Bayt Ula 1 (Field#505, 2, 4 April 2018). Surif (Field#516, 5, 3 April 2018). Nuba (Field#518, 2, 4 April 2018). Al Aroub (Field#533, 5, 3 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 2 (Field#536, 2, 2 April 2018). Bayt Ummar (Field#544, 1, 3 April 2018). Deir Razih 2 (Field#567, 2, 15 April 2018). Al Hijra (Field#570, 2, 12 April 2018). As-Samu (Field#591, 1, 12 April 2018). Zif 1 (Field#595, 2, 9 April 2018). Bayt Amra (Field#603, 2, 12 April 2018). Alsira (Field#605, 3, 15 April 2018). Al-Rayhiyya (Field#618, 2, 12 April 2018). Hadab al Fawar (Field#626, 2, 12 April 2018). Bani Na'im 1 (Field#638, 3, 9 April 2018). Bani Na'im 2 (Field#640, 3, 9 April 2018). At-Tuwani (Field#641, 3, 12 April 2018). AlShuyukh (Field#647, 1, 9 April 2018). Bani Na'im 3 (Field#655, 2, 9 April 2018). Al Baqa'a 1 (Field#656, 2, 9 April 2018). Al Baqa'a 2 (Field#664, 4, 9 April 2018). Si'ir (Field#677, 3, 9 April 2018). Al Buweib (Field#682, 4, 9 April 2018). Ruq'a (Field#687, 4, 12 April 2018). Zif 2 (Field#694, 3, 12 April 2018). Al Carmel 2 (Field#703, 1, 12 April 2018). Hadab Al'Alaqa (Field#726, 3, 15 April 2018). Duma (Field#730, 2, 15 April 2018). Abda (Field#743, 3, 15 April 2018). HaRasa (Field#747, 3, 15 April 2018). Dura 1 (Field#751, 2, 15 April 2018). Tarama (Field#757, 3, 15 April 2018). Dura 2 (Field#771, 3, 21 April 2018). Wadi abu al-Qamarah (Field#777, 2, 21 April 2018). Kreisa (Field#781, 1, 21 April 2018). Ein Hasaka (Field#782, 2, 21 April 2018). Hebron (Field#790, 4, 21 April 2018). Wadi Al Joz (Field#793, 3, 21 April 2018). Dura 3 (Field#803, 2, 21 April 2018). Jericho 2 (Field#819, 3, 23 April 2018). Deir Krntl 1 (Field#827, 1, 23 April 2018). Jericho 4 (Field#832, 2, 23 April 2018). Jericho 3 (Field#836, 2, 23 April 2018). Tulul Abu Al-Ala'iq 2 (Field#840, 2, 23 April 2018). Nu'eima Altahta 1 (Field#844, 1, 23 April 2018). Tulul Abu Al-Ala'iq 1 (Field#846, 2, 23 April 2018). Umm al-Tut (Field#859, 1, 13 June 2013). Bayt Fajar 2 (Field#860, 4, 23 August 2014). Wadi Kelt (Field#865, 1, 4 April 2015). Ein Fasa'll (Field#863, 2, 14 January 2015). Ein Samiya (Field#864, 1, 12 April 2013). Wadi Kelt (Field#865, 1, 4 April 2015). Irtas 1 (Field#866, 1, 12 August 2014). Jenin (Field#871, 2, 12 April 2016). Bardala 2 (Field#872, 1, 18 April 2014). Salfit (Field#873, 2, March 2015). Wadi AlNaar (Field#875, 1, 13 April 2013).

Jericho 1 (Field#880, 1, 6 February 2018). Wadi AlZurqa AlEulwii (Field#881, 1, 15 April 2017).

Remarks: *Coccinella septempunctata* is the most widely distributed and common coccinellid in the World found mostly in the Palearctic region. Although initially thought to include several species, molecular data show that all these populations belong to one species (Marin et al. 2010). It is the most common species collected during the present study from the south of the West Bank but also penetrates near human populations in the Jordan Valley (Figure 10). This species avoids the arid regions (the Saharo Arabian areas). This species is the most well known one to local people, especially farmers. Its larvae and pupae were observed in more than 50 localities and it was the most common one that feed on the aphids on both wild plants and agricultural crops in all localities. In Abu Nujaym 2, adults were noted feeding on their own larvae in the absence of aphid prey. In Alkhas, some ants were observed handling some larvae of this species.

Figure 9. *Coccinella (Coccinella) septempunctata* (Linnaeus, 1758).

Scale bar = 5mm.

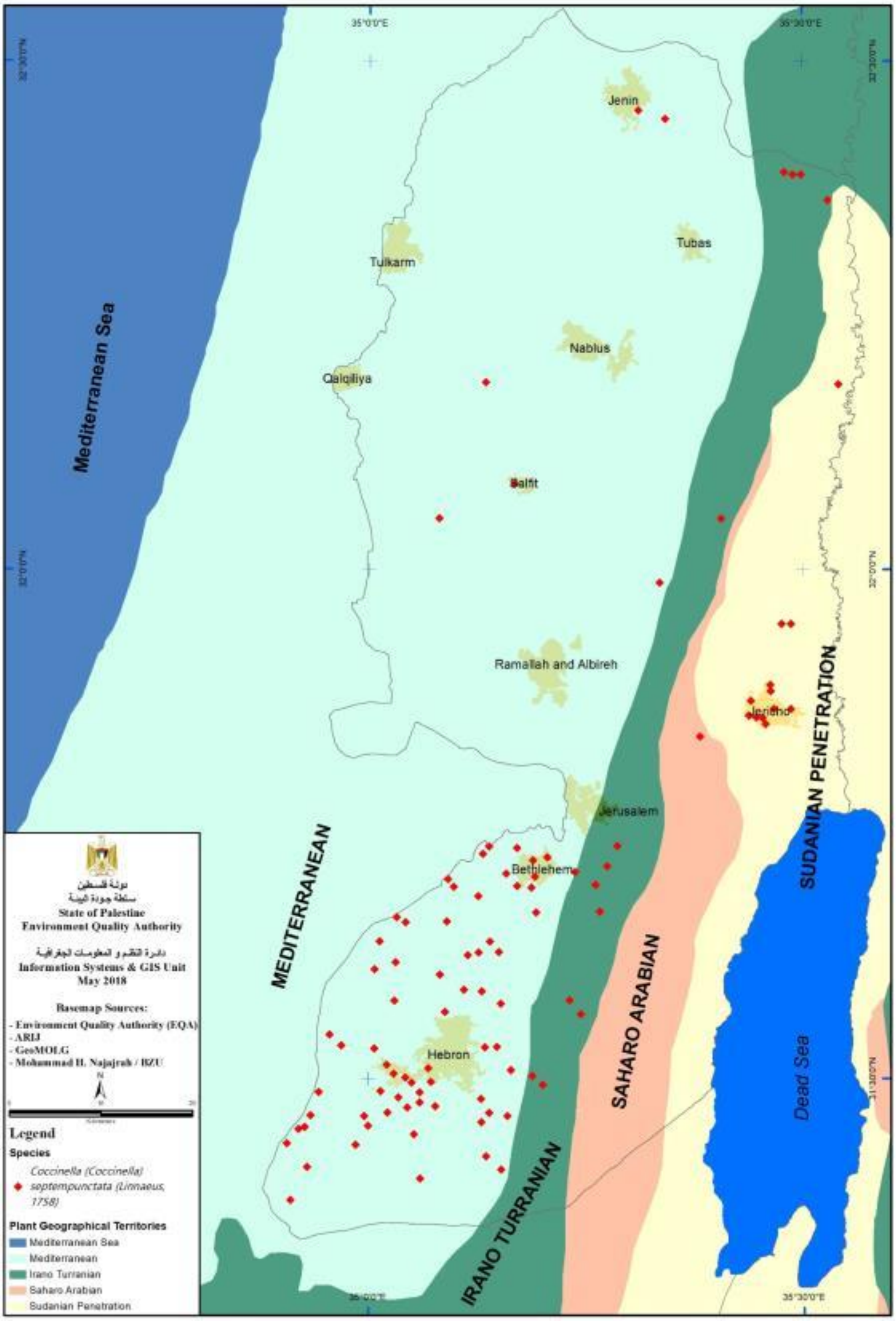

Figure 10. Geographical distribution map of *Coccinella (Coccinella) septempunctata*.

Coccinella (Neococcinella) undecimpunctata (Linnaeus, 1758), (Fig. 11)

Material: Marj Na'je 1 (Field#73, 2, 6 March 2018). Jericho 2 (Field#817, 1, 23 April 2018). Jericho 4 (Field#834, 1, 23 April 2018). Taibe (Field#870, 1, 12 April 2013). Nablus (Field#878, 1, March 2014). Dayr Balut (Field#882, 1, 25 March 2017). Al-Auja 1 (Field#901, 1, 6 March 2018).

Remarks: It is surprising that with extensive collections in the area of the South West Bank; we were able to note this species only in Jericho and Auja and a couple of other localities in the northern parts of the West Bank (Fig. 12). The use of this species in the Integrated Pest Management (IPM) is very common because of its specialization in feeding on aphids and because it is less susceptible to selective pesticides that kill aphids (Cabral et al., 2011). *Coccinella undecimpunctata* suffers from intraguild predation by the competitor coccinellids *Harmonia axyridis* (Felix & Soares, 2004).

Figure 11. *Coccinella (Neococcinella) undecimpunctata* (Linnaeus, 1758).

Scale bar =5mm.

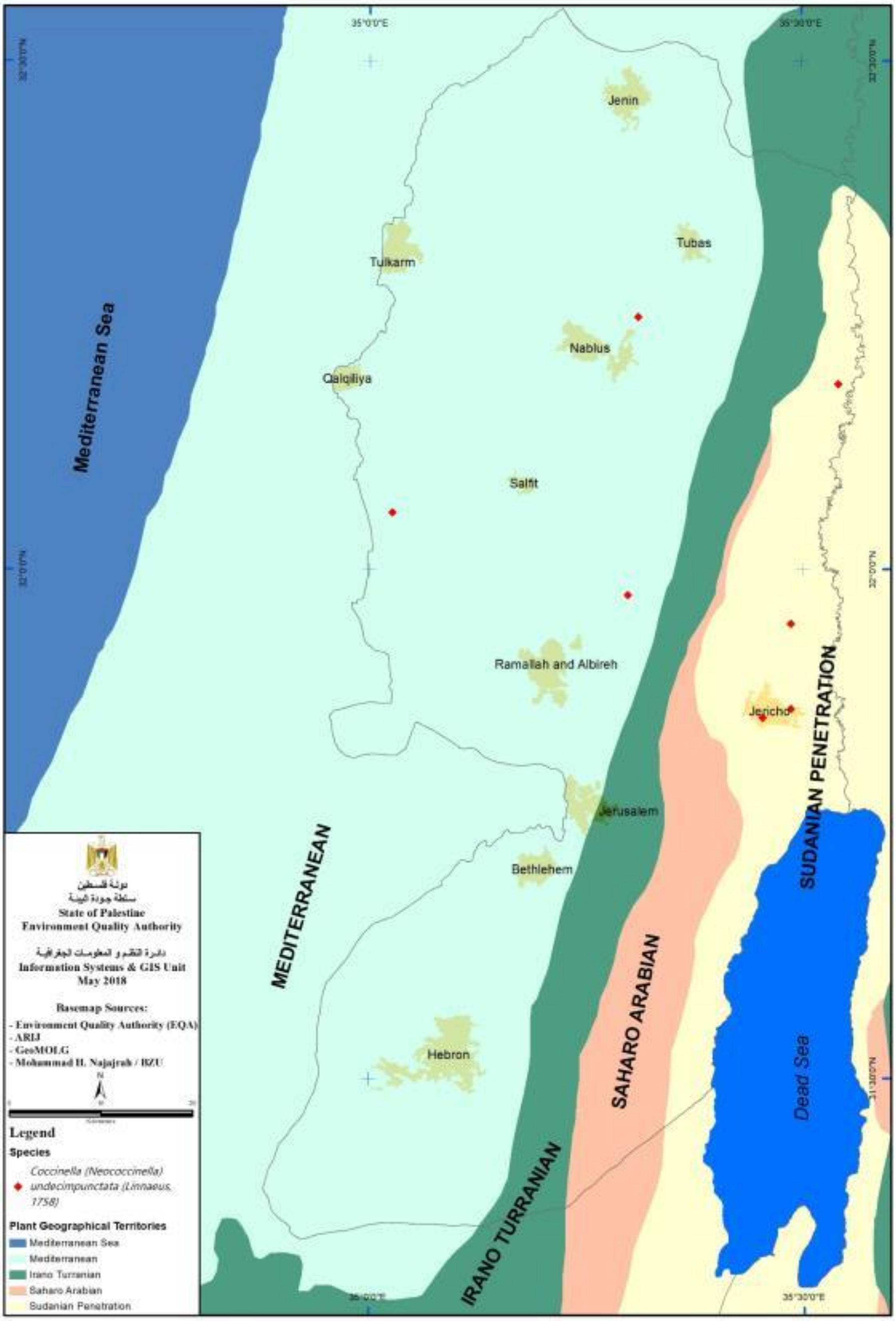

Figure 12. Geographical distribution map of *Coccinella (Neococcinella) undecimpunctata*.

Harmonia quadripunctata (Pontoppidan, 1763), (Fig. 13)

Material: Wadi Fukin 1 (Field#190, 1, 21 March 2018). Bethlehem 1 (Field#906, 1, 20 June 2018).

Remarks: *Harmonia quadripunctata* is a native species to the Palaearctic region (Vandenberg, 1990), mostly found feeding on aphids of the pine and cypress trees (Khalil, 2006). The climate change rapidly this species by reducing its fertility, which limits its ability to be an aggressive species (Belyakova et al., 2016). It was found in two areas in the Mediterranean zone (Figure 14).

Figure 13. *Harmonia quadripunctata* (Pontoppidan, 1763).

Scale bar = 5mm.

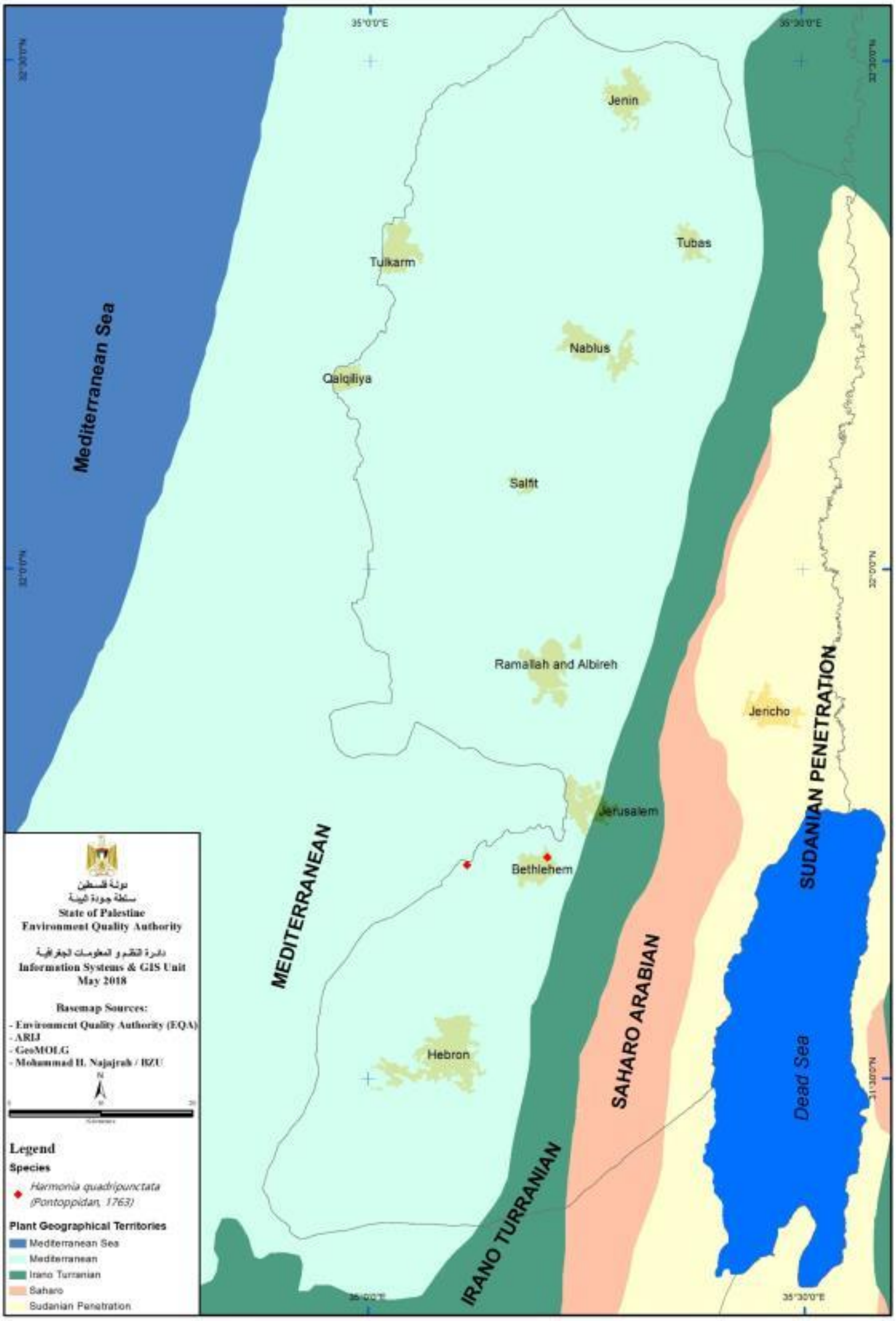

Figure 14. Geographical distribution map of *Harmonia quadripunctata.*

Hippodamia (Adonia) variegata (Goeze, 1777), (Fig. 15)

Material: Nahalin 1 (Field#3, 1, 20 August 2017). Nu'eima 2 (Field#28, 1, 5 March 2018). Bardala 1 (Field#57, 1, 8 March 2018). Marj Na'je 2 (Field#77, 1, 6 March 2018). Ein Al-Duok Al foqa (Field#112, 2, 4 March 2018). Al-Auja 1 (Field#124, 8, 6 March 2018). Dayr Balut (field#198, 1, April 2017). Al Rushayda (Field#278, 1, 27 March 2018). Irtas 2 (Field#308, 5, 25 March 2018). Idhna 2 (Field#368, 1, 5 April 2018). Al Dayr (Field#420, 4, 3 April 2018). Bayt Jala 2 (field#456, 2, 31 March 2018). Surif (Field#515, 1, 3 April 2018). Deir Razih 2 (Field#566, 1, 15 April 2018). Wadi Kelt (Field#578, 1, 16 April 2018). Bayt Amra (Field #599, 1, 12 April 2018). An-Nabi Musa (Field#612, 1, 16 April 2018). Bani Na'im 1 (Field#634, 1, 9 April 2018). AlShuyukh (Field#648, 1, 9 April 2018). Al Baqa'a 2 (Field#663, 1, 9 April 2018). Si'ir (Field#676, 1, 9 April 2018). Ruq'a (Field#688, 4, 12 April 2018). Zif 2 (Field#691, 5, 12 April 2018). Ein Al Fawwar (Field#704, 1, 16 April 2018). Hadab Al'Alaqa (Field#727, 3, 15 April 2018). Duma (Field#728, 2, 15 April 2018). Tarama (Field#760, 1, 15 April 2018). Wadi Qana (Field#766, 1, 17 April 2018). Dura 2 (Field#770, 3, 21 of April 2018). Ein Hasaka (Field#784, 3, 21 April 2018). Hebron (Field#788, 1, 21 April 2018). Tel Alsamrat (Field#812, 1, 23 April 2018). Jericho 2 (Field#815, 5, 23 April 2018). Nu'eima Altahta 2 (Field#820, 9, 23 April 2018). Jericho 4 (Field#831, 1, 23 April 2018). Jericho 3 (Field#835, 8, 23 April 2018). Tulul Abu Al-Ala'iq 2 (Field#838, 3, 23 April 2018). Nu'eima Altahta 1 (Field#843, 1, 23 April 2018). Tulul Abu Al-Ala'iq 1 (Field#847, 5, 23 April 2018). Al Carmel 2 (Field#883, 1, 25 April 2018). Bayt Sahur 2 (Field#896, 1, 6 May 2018). Bayt Sahur 2 (Field#897, 1, 1 April 2018).

Remarks: *Hippodamia variegata* originated from the Palaearctic region. However, because it is considered as an efficient aphidophagous lady beetle, it gained a widespread distribution globally (Soleimani & Madadi, 2015). Because of the good relationship between *Hippodamia variegata* and the *Coccinella septempunctata* the lack of competition between them on their aphid prey (under the availability of food conditions), they have been found with each other in most places feeding on the same aphids on the same weeds (Figure. 16).

Figure 15. *Hippodamia (Adonia) variegata* (Goeze, 1777).

Scale bar = 5mm.

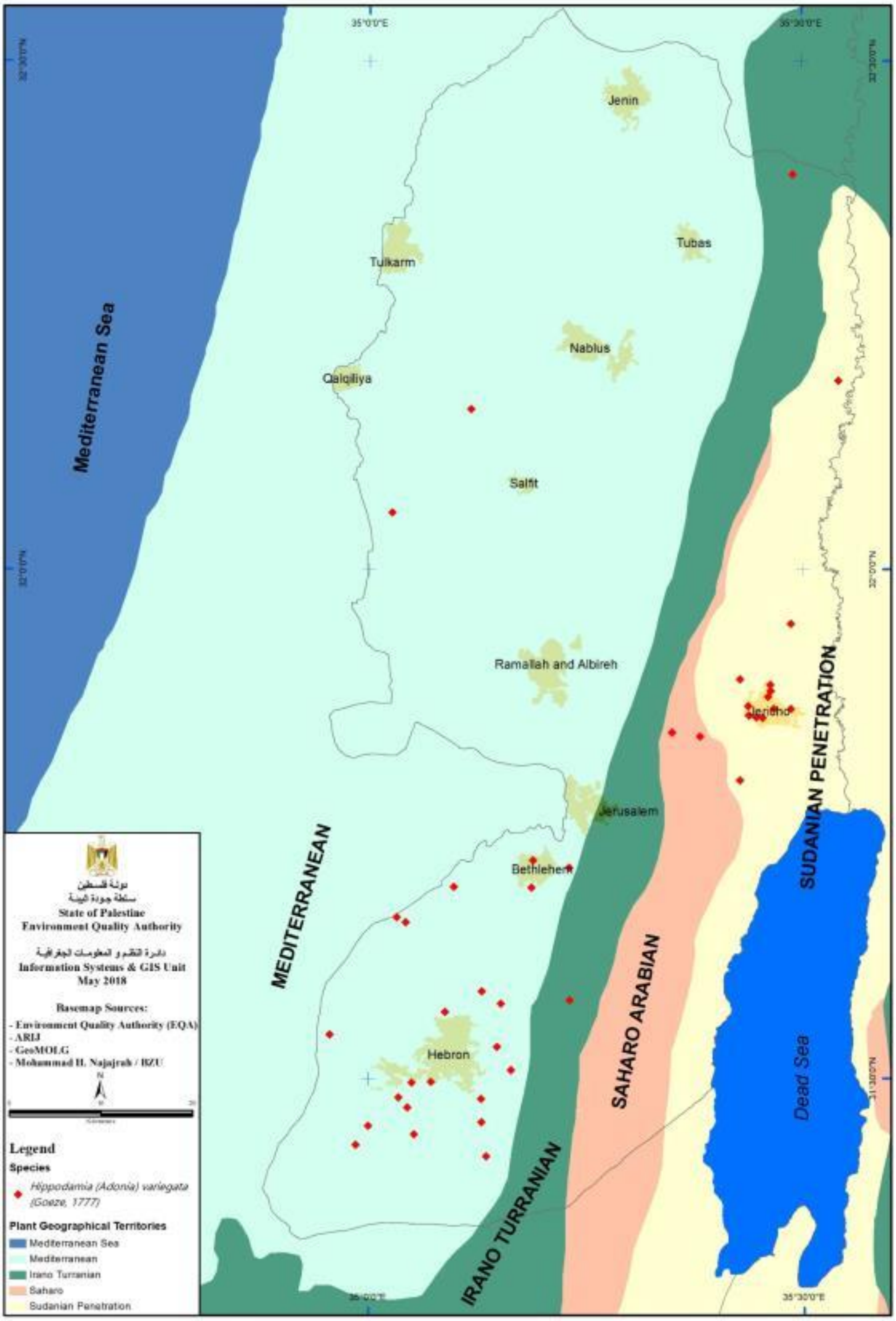

Figure 16. Geographical distribution map of *Hippodamia (Adonia) variegate.*

Oenopia conglobata (Linnaeus, 1758), (Fig. 17)

Material: Nu'eima 1 (Field#36, 1, 5 March 2018). Ein AlBeida 1 (Field#37, 3, 8 March 2018). Bardala 1 (Field#55, 2, 8 March 2018). Ein Al-Sakout 1 (Field#67, 1, 7 March 2018). Ein Samiya (Field#97, 2, 4 March 2018). Ein Al-Duok Al foqa (Field#117, 1, 4 March 2018). Wadi Fukin 1 (Field#191, 3, 21 March 2018). Umm Salmuna (Field#227, 1, 27 March 2018). Kisan (Field#243, 1, 27 March 2018). Hindaza Bredhaa (Field#251, 1, 25 March 2018). Bethlehem 1 (Field#273, 1, 1 April 2018). Al Rushayda (Field#274, 1, 27 April 2018). Dayr Kremzan 1 (Field#322, 1, 31 March 2018). Bayt Sahur 2 (Field#331, 22, 1 April 2018). Dayr Al'Asal (Field#333, 1, 5 April 2018). Dayr Kremzan 2 (Field#337, 1, 31 March 2018). Ad-Dhahiriya 2 (Field#361, 23, 5 April 2018). Idhna 2 (Field#371, 2, 5 April 2018). Bayt Mirsim (Field#374, 2, 5 April 2018). Halhul 1 (Field#383, 1, 4 April 2018). Burj (Field#393, 1, 5 April 2018). Bayt Fajar 1 (Field#410, 1, 2 April 2018). Sika (Field#427, 1, 5 April 2018). Bethlehem 2 (Field#437, 1, 2 April 2018). Bayt Kahil (Field#443, 1, 4 April 2018). Bayt Jala 2 (Field#457, 7, 31 March 2018). Kharas 1 (Field#460, 7, 3 April 2018). Bayt Ula 2 (Field#464, 4, 4 April 2018). Al-Ramadin (Field#472, 4, 5 April 2018). Bayt Sahur 2 (Field#475, 2, 2 April 2018). Al-Kum (Field#485, 1, 5 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 1 (Field#497, 3, 4 April 2018). Surif (Field#512, 9, 3 April 2018). Nuba (Field#517, 5, 4 April 2018). Bayt Ummar (Field#543, 2, 3 April 2018). Bethlehem 1 (Field#549, 4, 1 April 2018). Deir Razih 2 (Field#555, 4, 15 April 2018). Al Hijra (Field#574, 2, 12 April 2018). Wadi Kelt (Field#577, 3, 16 April 2018). Wadi Kelt (Field#579, 1, 16 April 2018). Ein al 'Auja (Field#589, 1, 16 April 2018). As-Samu (Field#590, 4, 12 April 2018). An-Nabi Musa (Field#613, 3, 16 April 2018). Bani Na'im 1 (Field#637, 2, 9 April 2018). Bani Na'im 2 (Field#639, 1, 9 April 2018). At-Tuwani (Field#643, 1, 12 April 2018). Al Baqa'a 1 (Field#660, 1, 9 April 2018). Al Baqa'a 2 (Field#666, 1, 9 April 2018). Al Carmel 2 (Field#696, 2, 12 April 2018). Ein Al Fawwar (Field#706, 3, 16 April 2018). Hadab Al'Alaqa (Field#722, 1, 15 April 2018). Duma (Field#735, 4, 15 April 2018). Abda (Field#736, 2, 15 April 2018). HaRasa (Field#748, 1, 15 April 2018). Tarama (Field#762, 1, 15 April 2018). Dura 2 (Field#768, 1, 21 April 2018). Dura 2 (Field#774, 5, 21 April 2018). Tapuah (Field#805, 3, 21 April 2018). Jericho 2 (Field#816, 2, 23 April 2018). Nu'eima Altahta 2 (Field#822, 1, 23 April 2018). Tulul Abu Al-Ala'iq 1 (Field#848, 1, 23 April 2018). Jericho 1 (Field#850, 4, 23 April 2018). Irtas 2 (Field#887, 1, 25 March 2018). Ein Al-Duok Al Foqa (Field#888, 1, 4 March 2018).

Remarks: In the Mediterranean region, *Oenopia conglobata* is among the most common lady beetles found in residential areas (Lumbierres et al., 2018). This species was collected from almond trees infested with aphids in 90% of the localities visited (Figure 18). Intraguild predation between *Coccinella septempunctata* and *Oenopia conglobata* on the almond trees was observed. It was also observed that the trees were dominated by one species or the other but not both. However, always Coccinella predated on *Oenipia* larva.

Figure 17. *Oenopia conglobata* (Linnaeus, 1758).

Scale bar = 5mm.

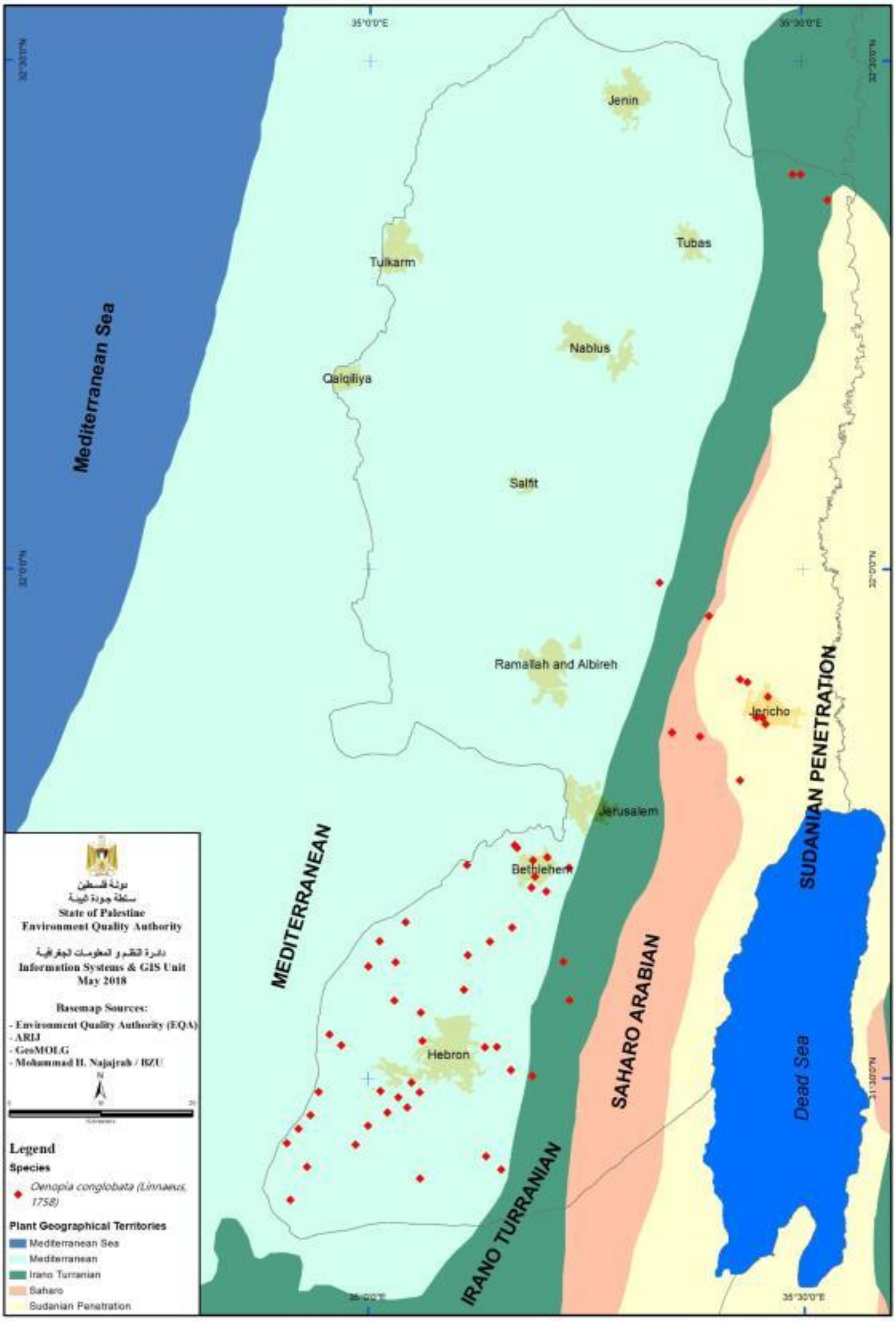

Figure 18. Geographical distribution map of *Oenopia conglobata*.

Subfamily Chilocorinae

Chilocorinae was represented by five rare and vary rare species belonging to two tribes in the study area.

Tribe Chilocorini

Chilocorus bipustulatus (Linnaeus, 1758), (Fig. 19)

Material: Ein Samiya (Field#86, 4, 4 March 2018). Bayt Jala 1 (Field#157, 4, 22 March 2018). Nahalin 3 (Field#166, 6, 20 March 2018). Irtas 1 (Field#296, 2, 25 March 2018). Dayr Kremzan 2 (Field#339, 1, 31 March 2018). Halhul 1 (Field#382, 2, 4 April 2018). Bethlehem 2 (Field#441, 3, 2 April 2018). Kharas 2 (Field#500, 1, 4 April 2018). Deir Razih 2 (Field#563, 2, 15 April 2018). Al Baqa'a 1 (Field#657, 1, 9 April 2018). Al Baqa'a 2 (Field#665, 2, 9 April 2018). Dura 2 (Field#775, 1, 21 April 2018). Dura 3 (Field#798, 1, 21 April 2018).

Remarks: This species was found in in few localities in the West Bank, all of which were within the Mediterranean zone (Fig. 20). Most samples of *Chilocorus bipustulatus* were collected from oak and cypress trees. Kaplan et al. (2016) observed this species feeding on the olive psyllid in Turkey. Similar predation habit for this species was observed in Kharas 2.

Figure 19. *Chilocorus bipustulatus* (Linnaeus, 1758).

Scale bar = 5mm.

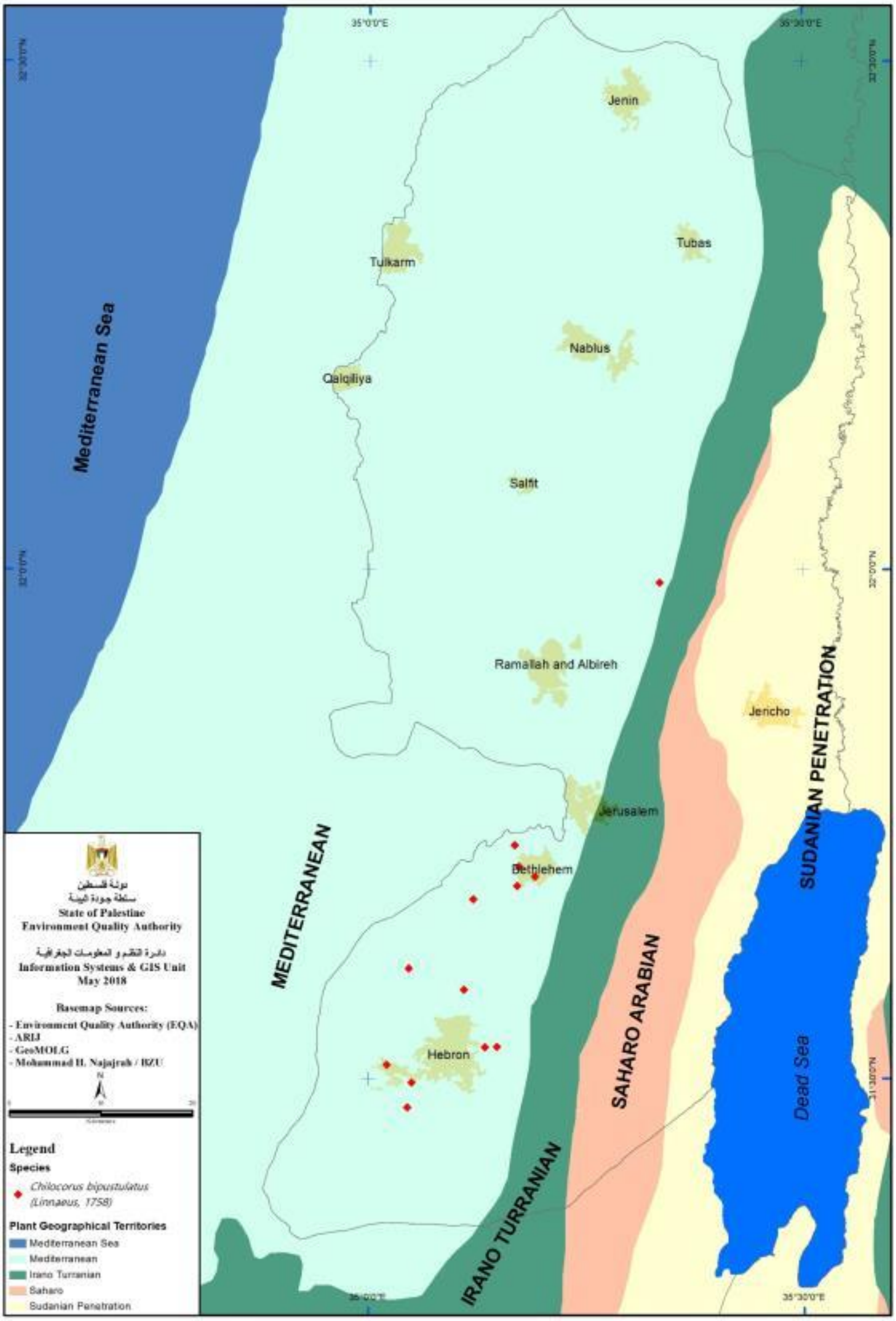

Figure 20. Geographical distribution map of *Chilocorus bipustulatus.*

Exochomus nigromaculatus (Goeze, 1777), (Fig. 21)

Material: Bethlehem 1 (Field#12, 1, 28 July 2017). Bethlehem 1 (Field#22, 3, 21 July 2017). Dura 3 (Field#801, 1, 21 April 2018).

Remarks: In 1948 areas of Palestine, Helprin et al. (1995) recorded *Exochomus nigromaculatus* in many localities however, in the present study it was observed only in two localities, *Cupressus* woods near Dura in the Hebron Mountains and *Cupressus* woods near Bethlehem region (Fig. 22). *Exochomus nigromaculatus* are considered as endangered (at least in the Eastern Mediterranean) according to the IUCN red list. This species was reported from areas in Belgium and Netherlands (Adriaens et al., 2015).

Figure 21. *Exochomus nigromaculatus* (Goeze, 1777).

Scale bar = 5mm.

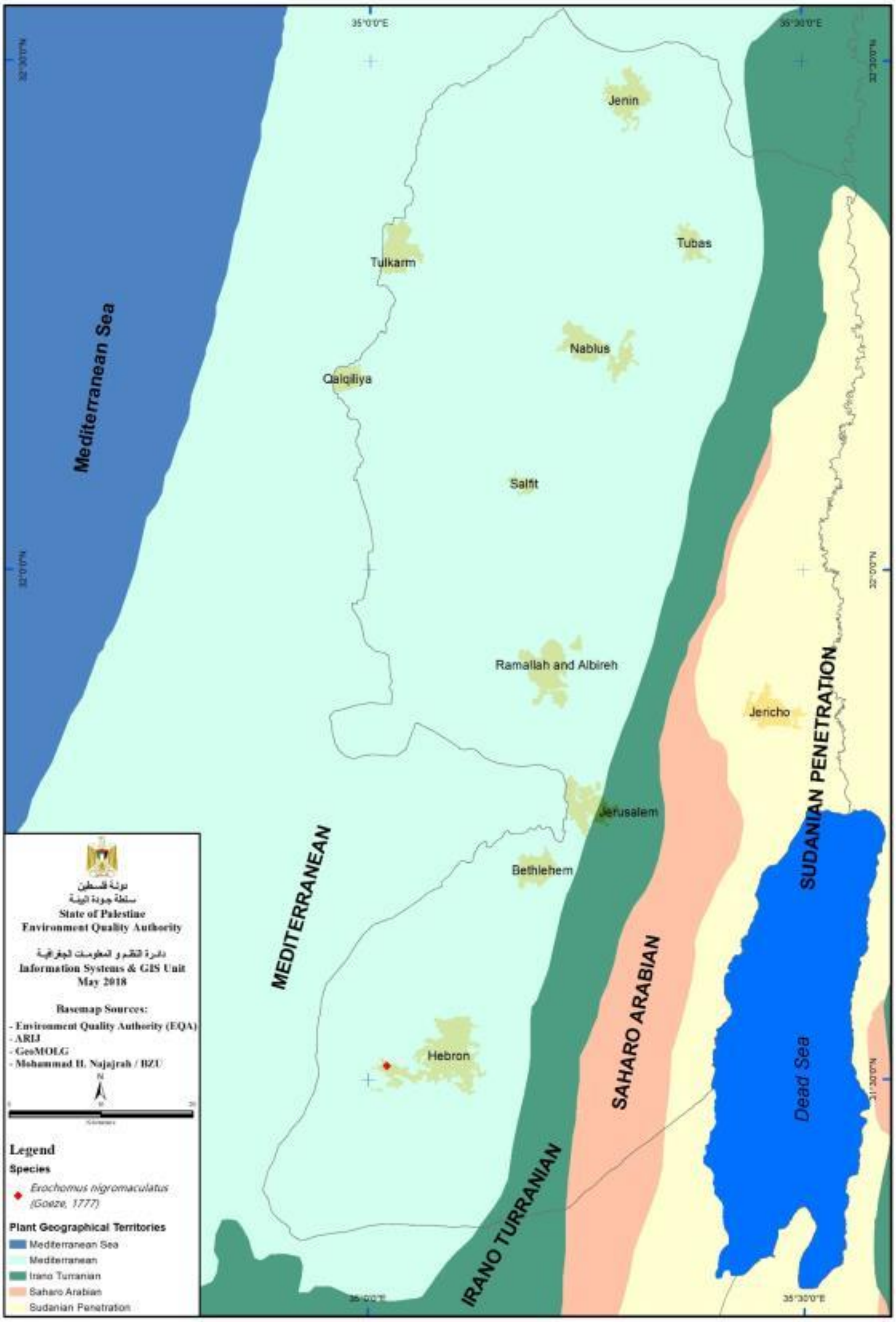

Figure 22. Collection site of *Exochomus nigromaculatus* in the south of the West Bank

Exochomus pubescens (Kuster, 1848), (Fig. 23)

Material: Al-Auja 2 (Field#136, 3, 5 March 2018). Al Carmel 2 (Field#702, 2, 12 April 2018). Deir Krntl 1 (Field#825, 4, 23 April 2018). Tulul Abu Al-Ala'iq 2 (Field#837, 5, 23 April 2018). Nu'eima Altahta 1 (Field#842, 1, 23 April 2018).

Remarks: *Exochomus pubescens* was recorded as one of the most common species in the Iranian cotton fields (Ghahari et al., 2009). It was observed feeding on *Bemisia tabaci* in Iran (Modarres-Awal, 2002). In the present study, *Exochomus pubescens* was collected from *Atriplex* plants around the farms and from the natural area only in the Jordan valley and one locality in the eastern slopes of Hebron hills at Al-Carmel (Fig. 24). Further work on the distribution of this species may be warranted.

Figure 23. *Exochomus pubescens (Kuster, 1848).*

Scale bar = 3mm.

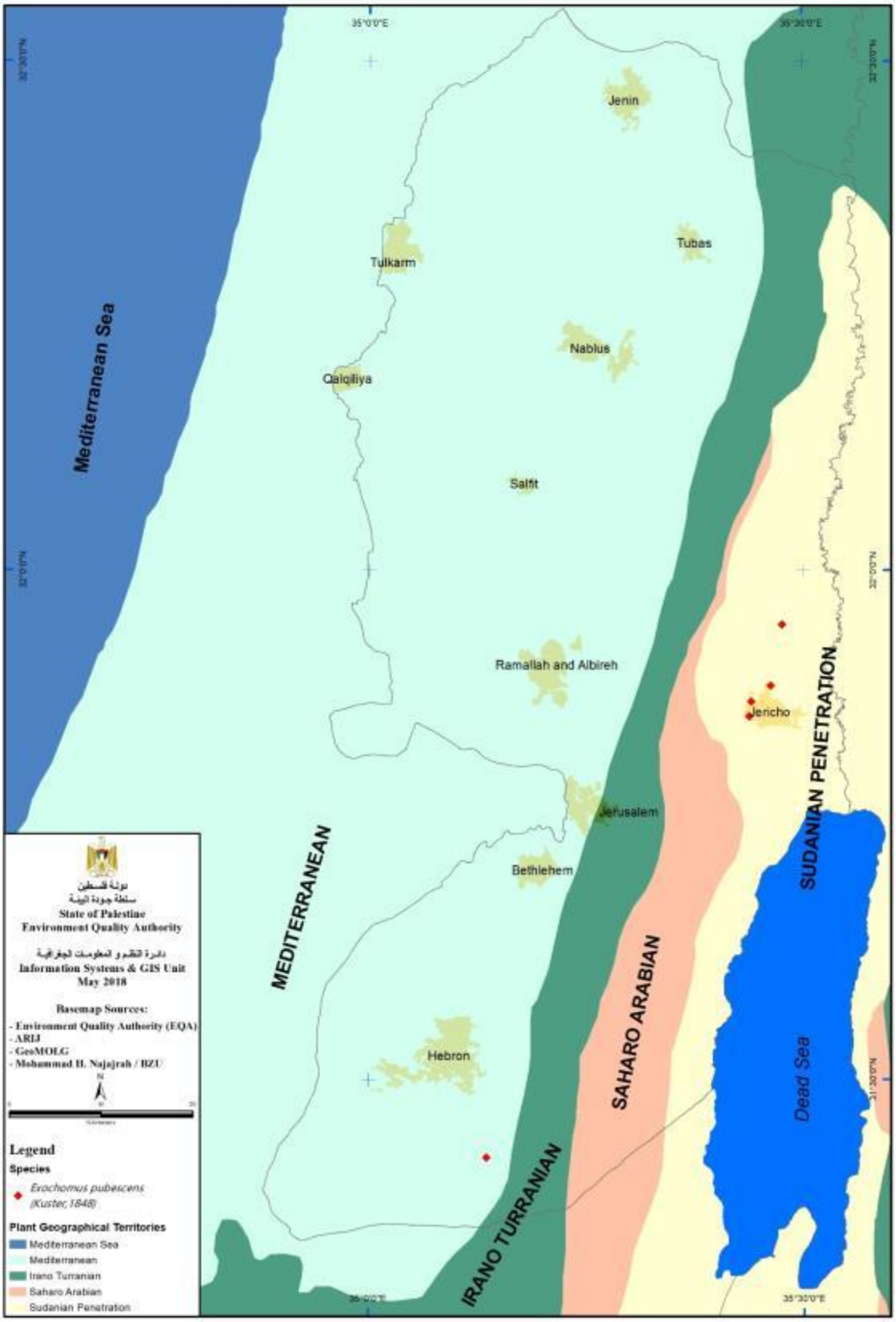

Figure 24. Geographical distribution map of *Exochomus pubescens.*

Exochomus quadripustulatus (Linnaeus, 1758), (Fig. 25)

Material: Husan (Field#185, 1, 21 March 2018). Umm Salmuna (Field#229, 2, 27 March 2018). Abu Nujaym 2 (Field#245, 4, 27 March 2018). Irtas 2 (Field#306, 2, 25 March 2018). Dayr Kremzan 1 (Field#320, 1, 31 March 2018). Khirbat Safa 2 (Field#365, 1, 3 April 2018). Bayt Fajar 2 (Field#414, 1, 2 April 2018). Bethlehem 2 (Field#431, 3, 2 April 2018). Bayt Ummar (Field#542, 1, 3 April 2018). Bayt Amra (Field#600, 1, 12 April 2018). AlShuyukh (Field#649, 1, 9 April 2018). Al Baqa'a 1 (Field#659, 1, 9 April 2018). Tapuah (Field#765, 1, 21 April 2018). Dura 2 (Field#772, 1, 21 April 2018). Ein Hasaka (Field#783, 3, 21 April 2018). Wadi Al Joz (Field#795, 1, 21 April 2018).

Remarks: Oak trees are characteristic of Mediterranean region. *Exochomus quadripustulatus* was observed on oak trees infested with scale insects in Turkey (Ulgenturk & Toros, 2016). In the present study, it was collected from oak trees in all sites (Fig. 26). In one site (Bayt Amra), it was found on olive trees infested with psyllids.

Figure 25. *Exochomus quadripustulatus (Linnaeus, 1758).*

Scale bar = 5mm.

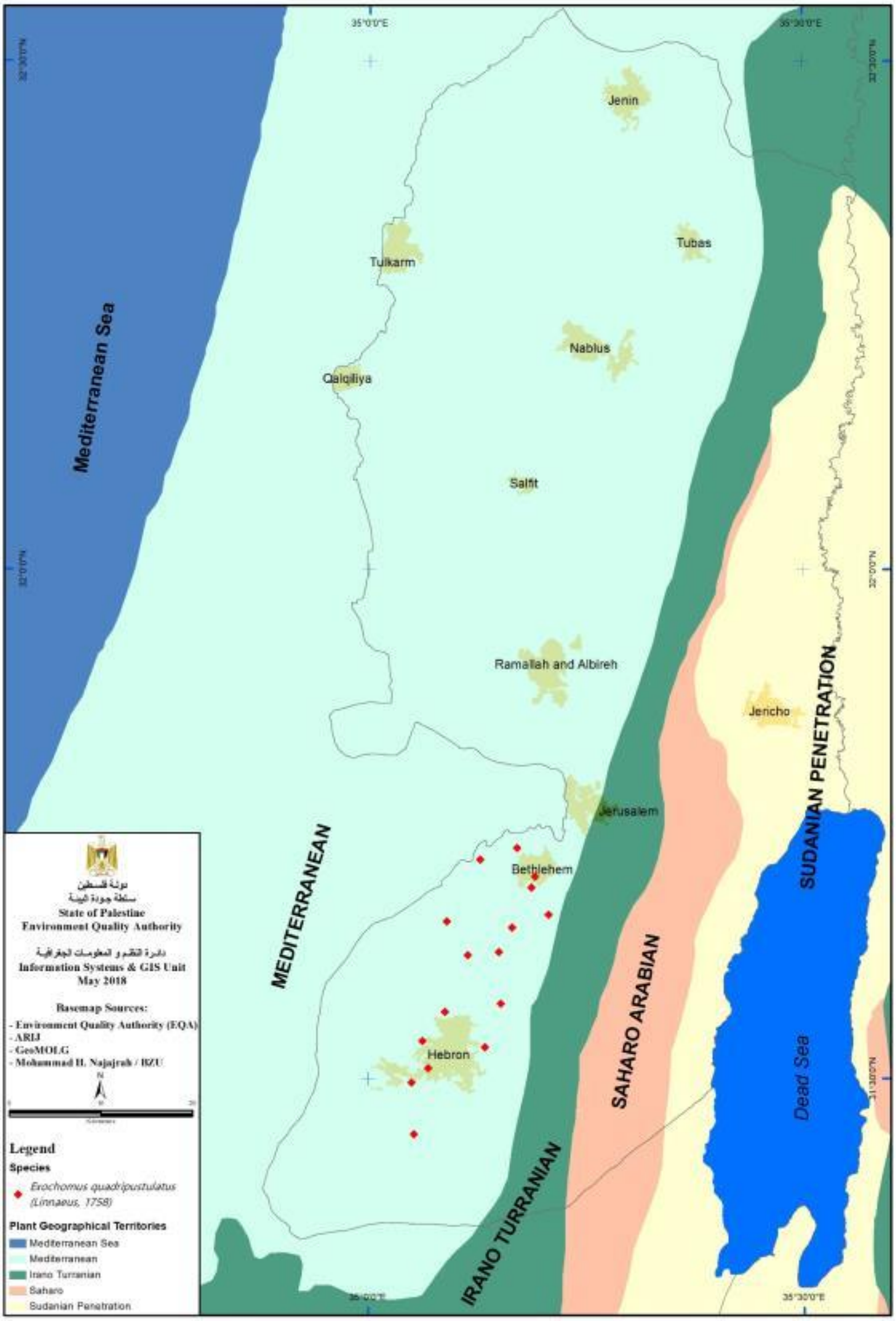

Figure 26. Geographical distribution map of *Exochomus quadripustulatus.*

Tribe Platynaspini

Platynaspis luteorubra (Goeze, 1777), (Fig. 27)

Material: Battir 2 (Field#203, 1, 21 March 2018). Bethlehem 1 (Field# 905, 1, 13 June 2018).

Remarks: Helprin et al. (1995) recorded *Platynaspis luteorubra* in 1948 lands of Palestine as a rare species. Khalil (2006) observed this species on the pine, apple, pomegranate, maize and rose plants in south Syria. In this study, *Platynaspis luteorubra* was collected from pine trees in two localities in the study area (Fig. 28).

Figure 27. *Platynaspis luteorubra (Goeze, 1777).*

Scale bar = 3mm.

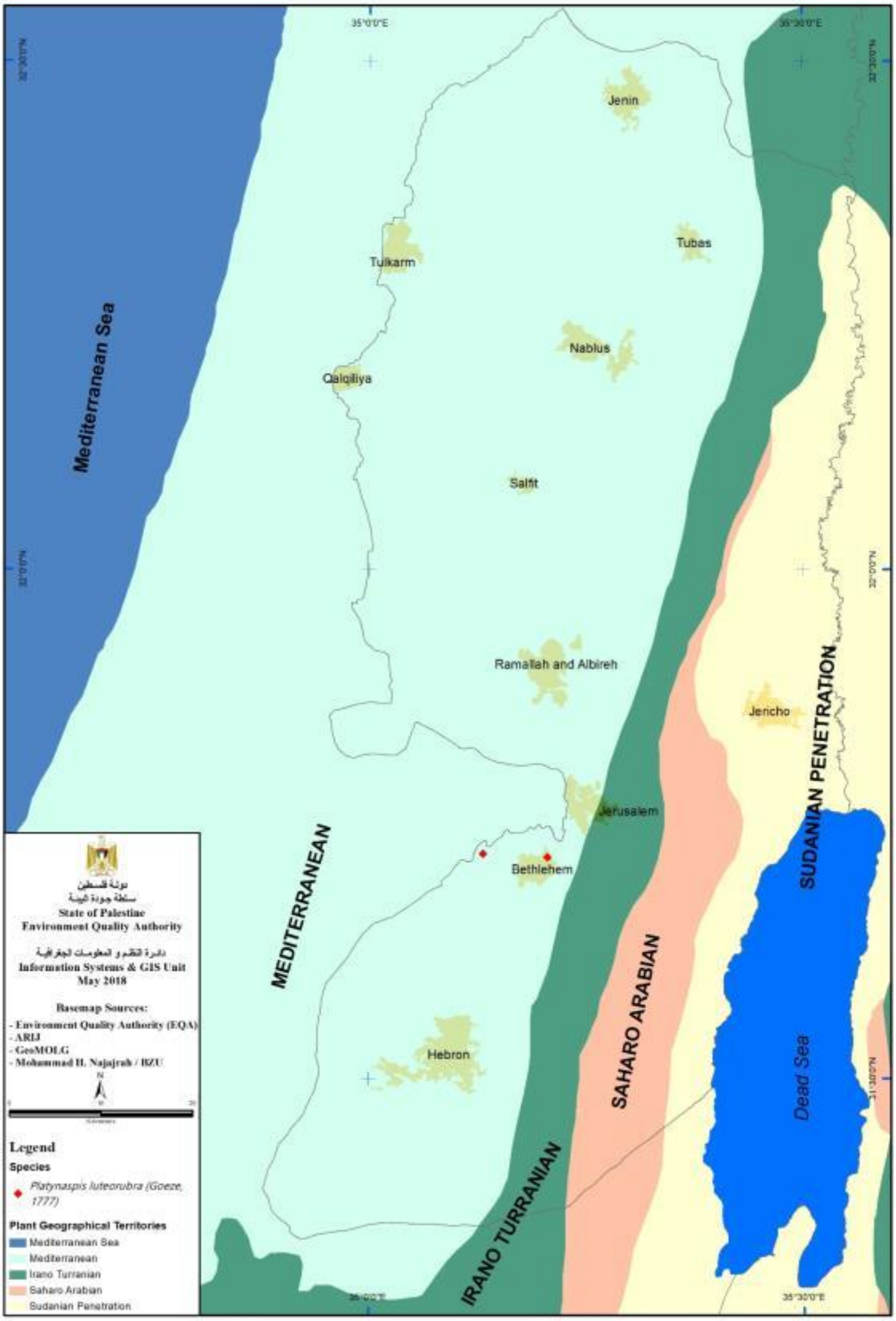

Figure 28. Collecting site of *Platynaspis luteorubra* in the south of the West Bank.

Subfamily Scymninae

With 18 species belonging to three tribes, Scymninae includes the largest number of species found in the study area.

Tribe Hyperaspidini

Hyperaspis polita (Weise, 1885), (Fig. 29)

Material: Irtas 1 (Field#289, 2, 25 March 2018). Dayr Balut (Field#904, 1, 2 September 2017).

Remarks: *Hyperaspis polita* is one of the important predators for the cotton mealybugs (Spodek et al. 2018; Seyfollahi et al. 2016). It was reported in the 1948 lands of Palestine as a common species (Halperin et al. 1995) but in the study area in the West Bank it was collected from Irtas 1 on a geranium plant and from Dayr Balut on a Fennel plant (Fig. 30).

Figure 29. *Hyperaspis polita* (Weise, 1885).

Scale bar = 3mm.

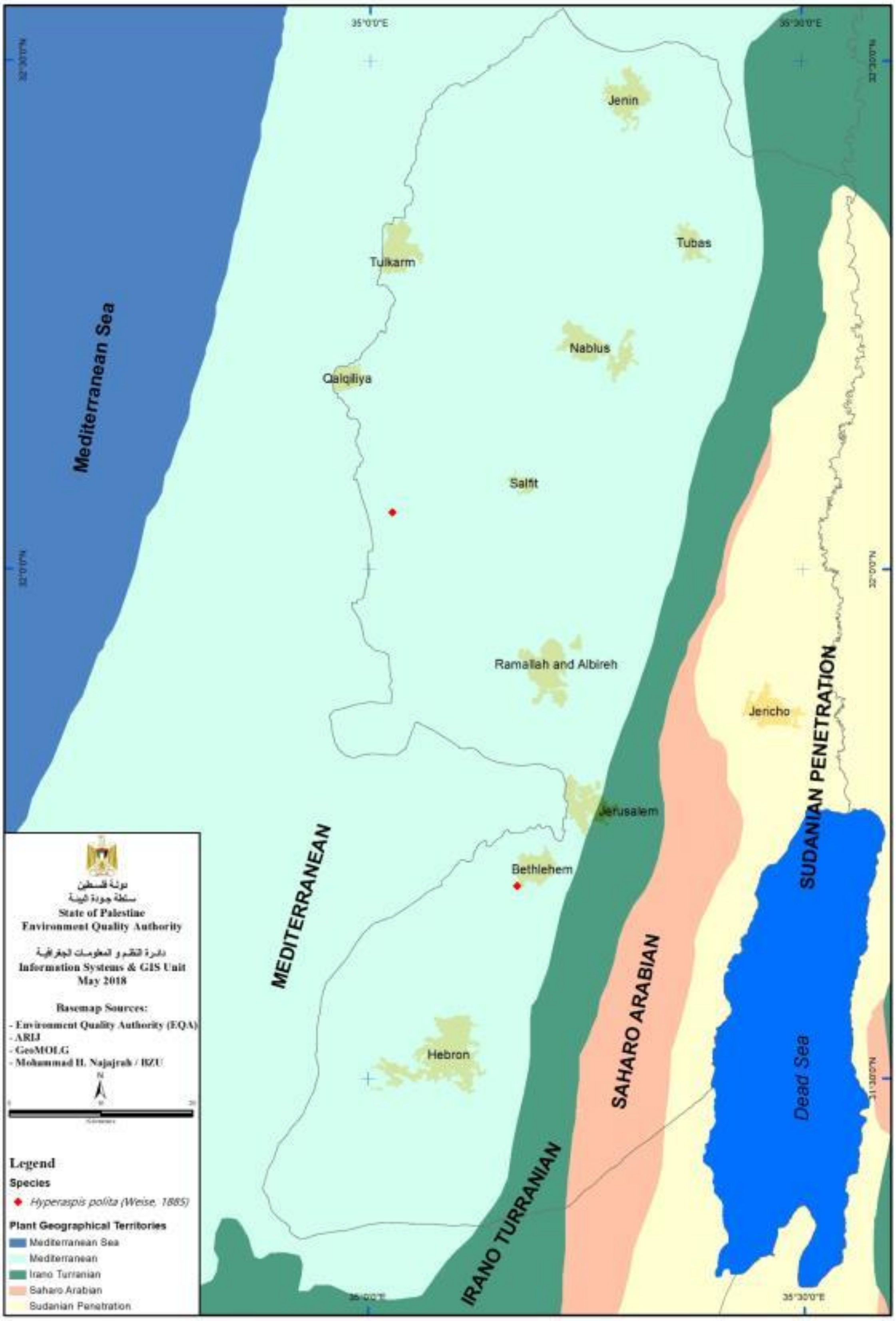

Figure 30. Collection site of *Hyperaspis polita* in the south of the West Bank.

Hyperaspis syriaca (Weise, 1885), (Fig. 31)

Material: Ein al 'Auja (Field#584, 2, 16 April 2018). Ein Al Fawwar (Field#711, 16, 16 April 2018).

Remarks: *Hyperaspis syriaca* was recorded in more than 25 sites in Israel and it was observed in Israel and South of Syria on *Vitex agnus-castus* (Helprin, 1995; Khalil, 2006). In the study area of the West Bank it was collected from two sits on *Vitex agnus-castus* (Fig. 32).

Figure 31. *Hyperaspis syriaca* (Weise, 1885).

Scale bar = 3mm.

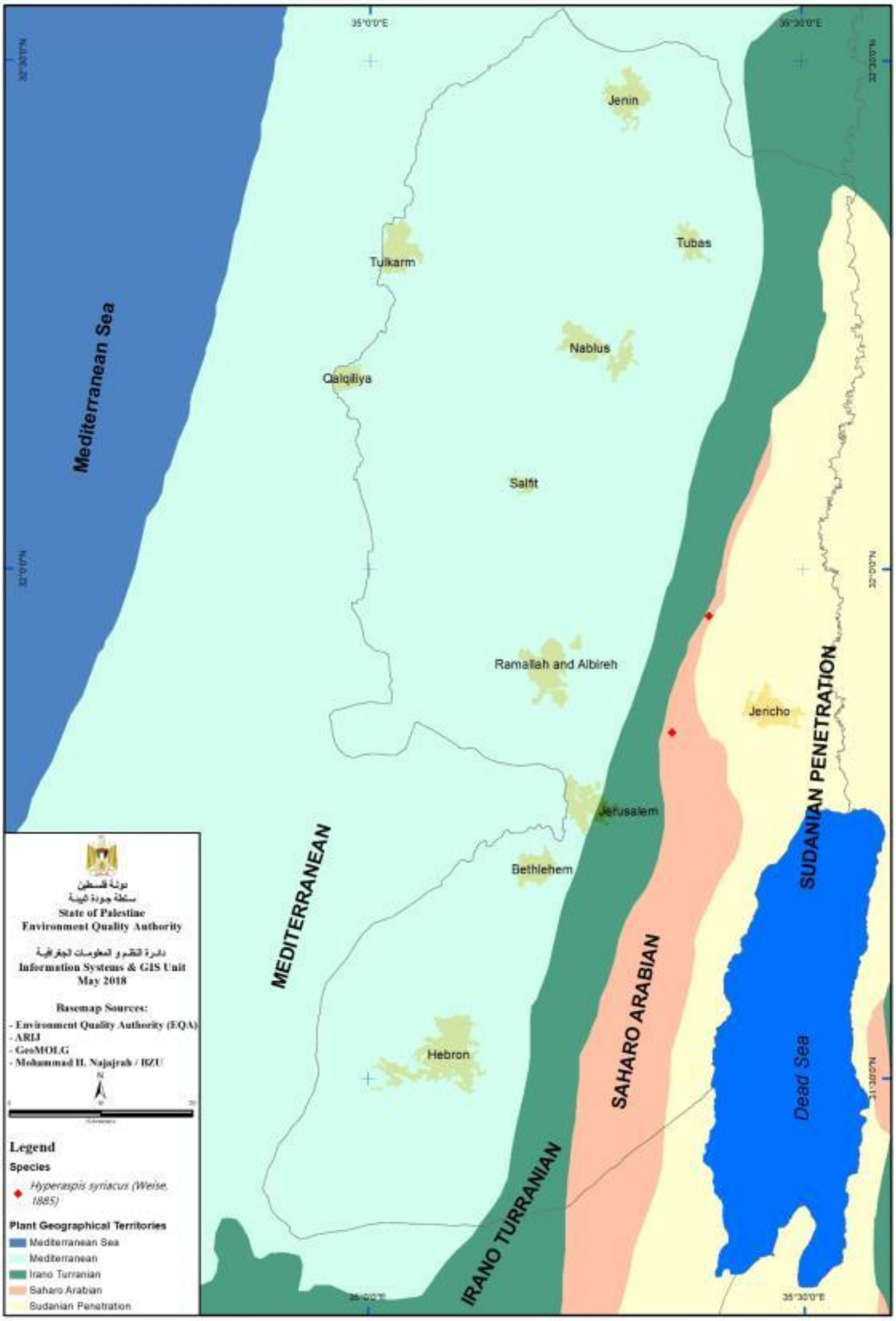

Figure 32. Geographical distribution map of *Hyperaspis syriaca.*

Tribe Scyminini

Cryptolaemus montrouzieri (Mulsant, 1853), (Fig. 33)

Materials: An-Nabi Musa (Field#615, 1, 16 April 2018). Ein Al Fawwar (Field#709, 1, 16 April 2018). Tel Alsamrat (Field#811, 1, 23 April 2018).

Remarks: *Cryptolaemus montrouzieri* was collected only from three localities (Jericho, west to Jericho and in the Jerusalem hills). It was collected from *Atriplex* plants and has a significant impact on the control of the mealybugs (Fig. 34). It is one of three introduced species recorded in the West Bank during the present study. It feeds on pollen grains lowering its dependence on mealybugs and other prey (Xie, 2017). This fact may help in mass production of this species in the lab for the biological control purposes. It is one of 24 introduced species of Coccinellids in our region (Mendel et al. 2017).

Figure 33. *Cryptolaemus montrouzieri* (Mulsant, 1853).

Scale bar = 3mm.

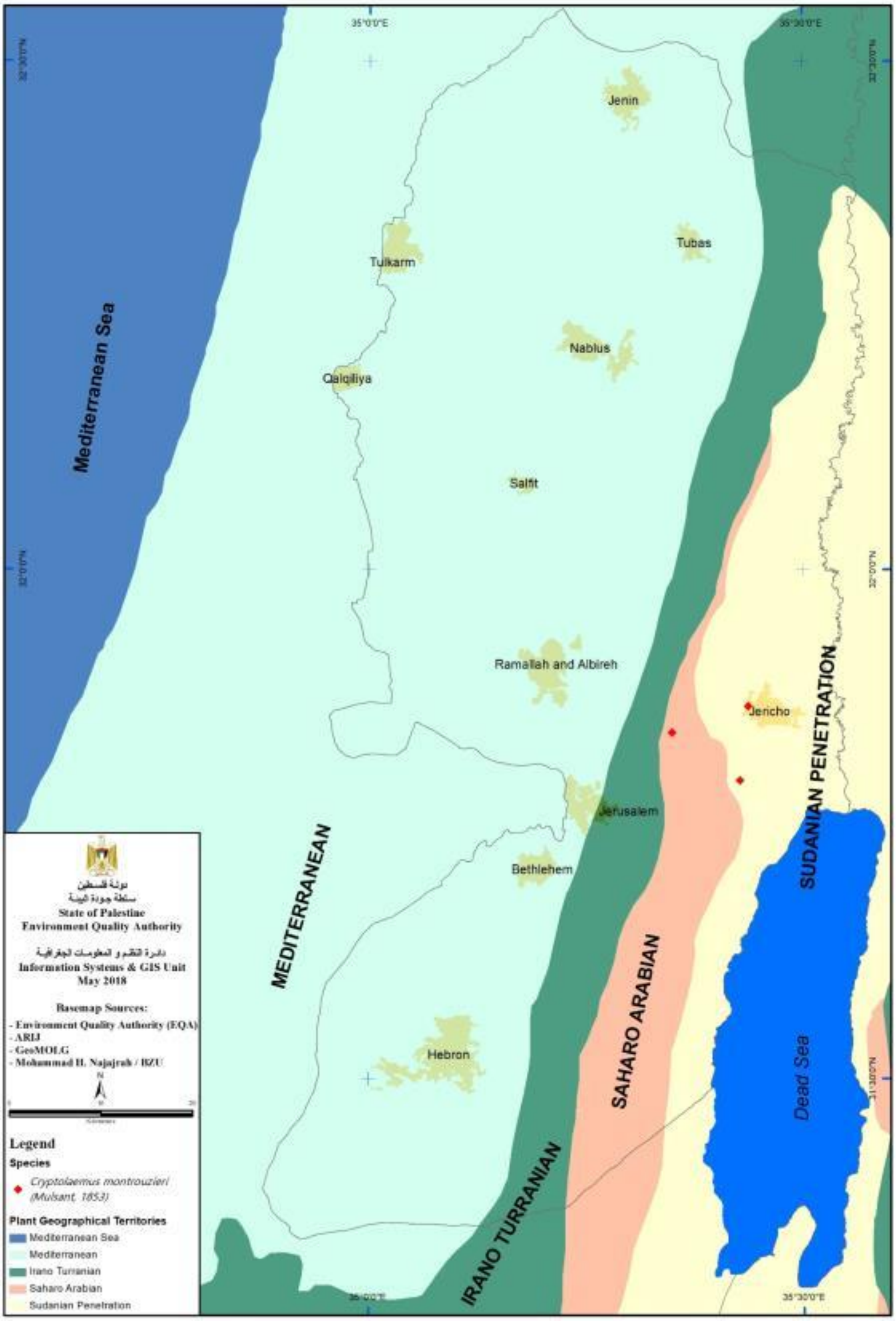

Figure 34. Geographical distribution map of *Cryptolaemus montrouzieri*.

Nephus (Bipunctatus) bipunctatus (Kugelann, 1794), (Fig. 35)

Material: Kisan (Field#241, 1, 27 March 2018).

Remarks: *Nephus bipunctatus* has been found on cypress plants from one site in the study area. *Nephus bipunctatus* is characterized by a one of 13 predators being effective natural enemies against the infection by mealybugs on the cypress trees (Lotfalizade & Ahmadi, 2000). This species was introduced to Palestine in 1986 but did not manage to get established (Halperin et al. 1995). In the present study, it was recorded only from one locality (Kisan) in the West Bank (Fig.36).

Figure 35. *Nephus (Bipunctatus) bipunctatus* (Kugelann, 1794).

Scale bar = 2mm.

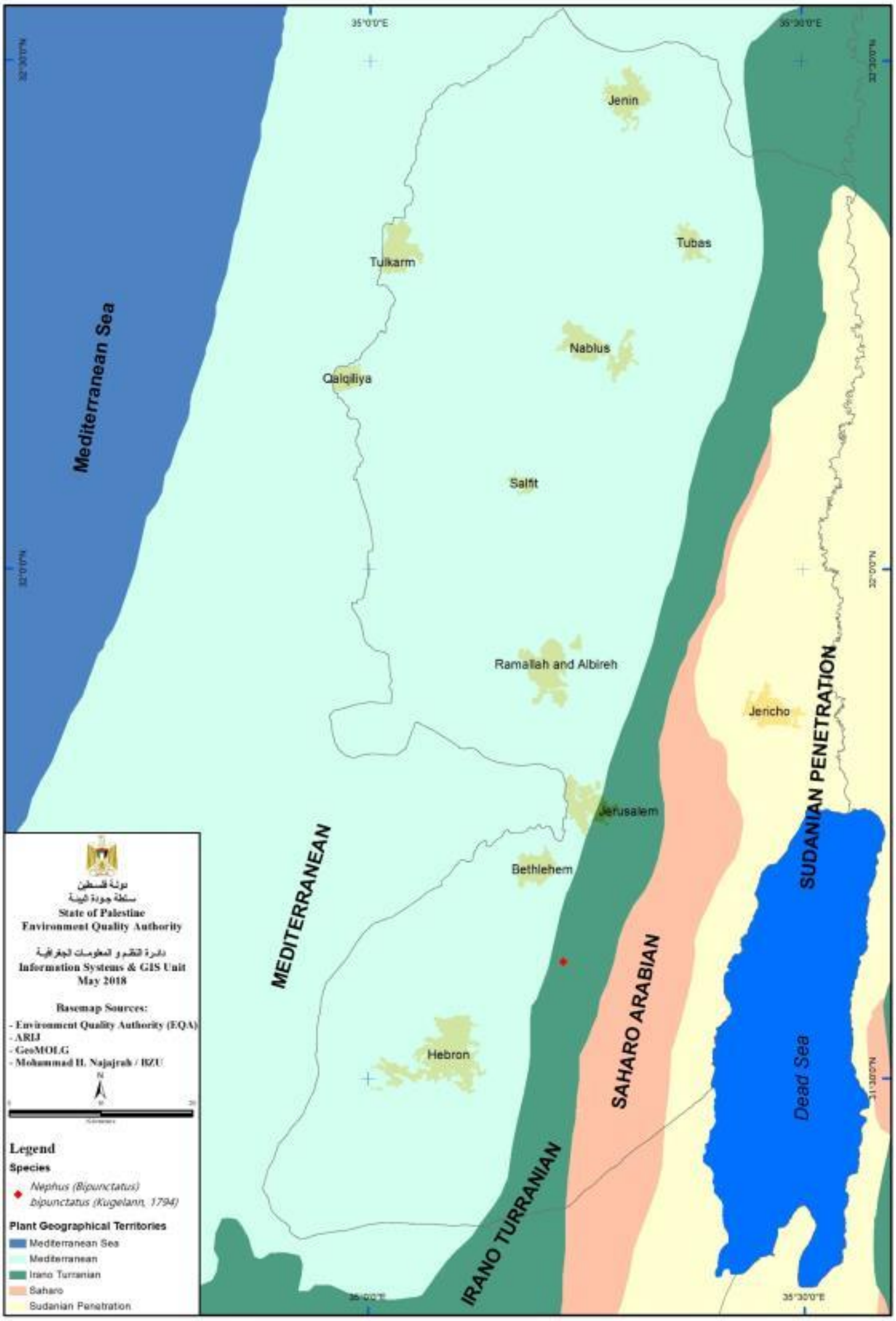

Figure 36. Collection site of *Nephus (Bipunctatus) bipunctatus* in the south of the West Bank.

Nephus crucifer (Fleischer, 1900), (Fig. 37)

Material: Zif 2 (Field#692, 1, 12 April 2018), Dura 3 (Field#804, 1, 21 April 2018). Jericho 1 (Field#856, 1, 23 April 2018).

Remarks: *Nephus crucifer* was collected during the present study from cypress and citrus trees. It is known from Turkestan, Yemen and Saudi Arabia (Raimundo & van Harten 2000). In the present study, this species was recorded from 3 localities in the West Bank (Fig 38). This is the first time to record this species from Palestine,

Figure 37. *Nephus crucifer* (Fleischer, 1900).
Scale bar = 3mm.

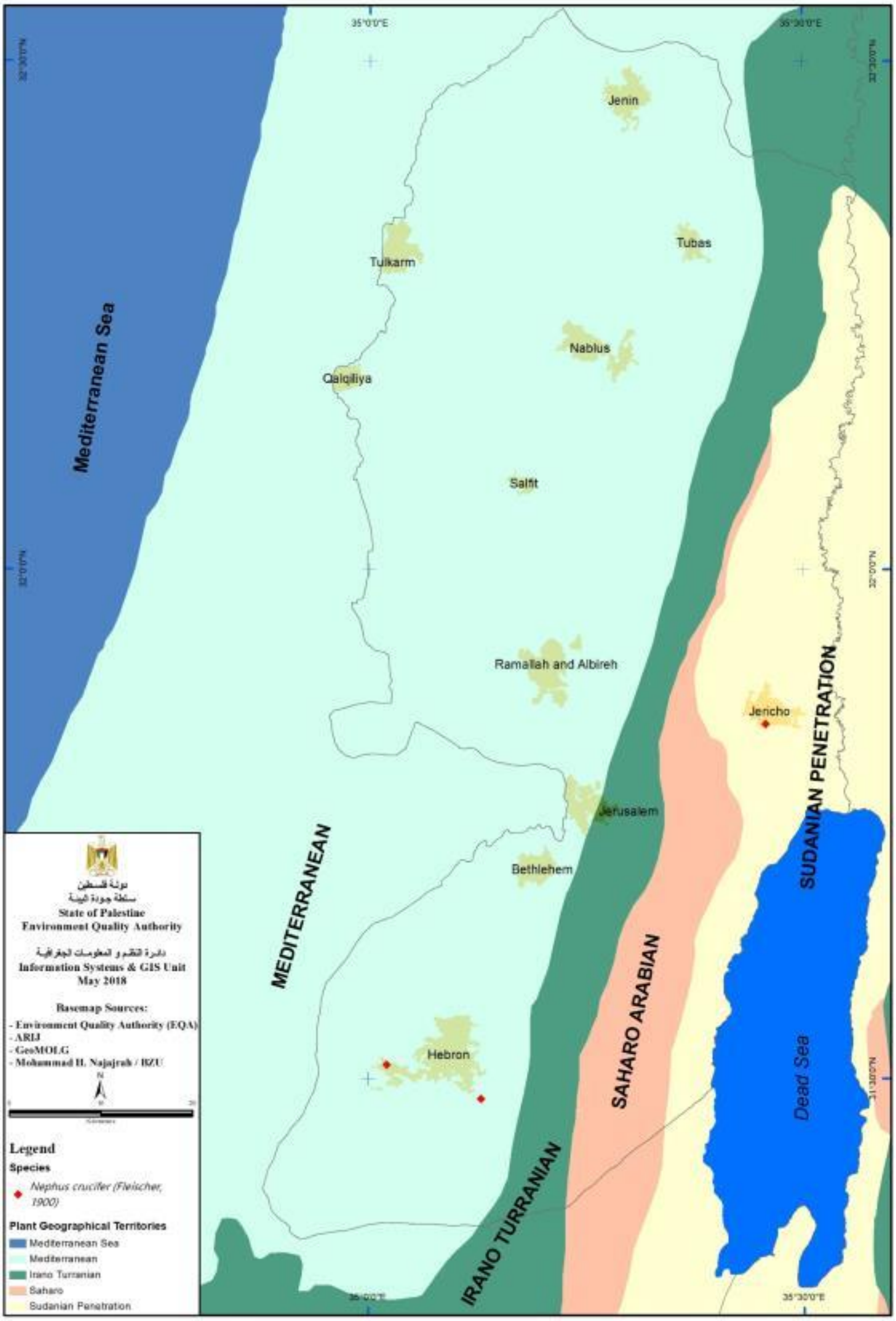

Figure 38. Geographical distribution map of *Nephus crucifer*.

Nephus (Sidis) hiekei (Fursch, 1965), (Fig. 39)

Material: Dura 1 (Field#752, 1, 15 April 2018).

Remarks: *Nephus (Sidis) hiekei* is a common species in the Mediterranean area in historic Palestine (Helprin et al. 1995). In the present study, it was found in one locality in the south of the West Bank (Fig 40). This species preys on mealybugs and whiteflies (Raimundo & van Harten 2000). The species is preyed upon by the hymenopteran *Homalotylus turkmenicus (*Fallahzadeh et al. 2016).

Figure 39. *Nephus (Sidis) hiekei* (Fursch, 1965).
Scale bar = 3mm.

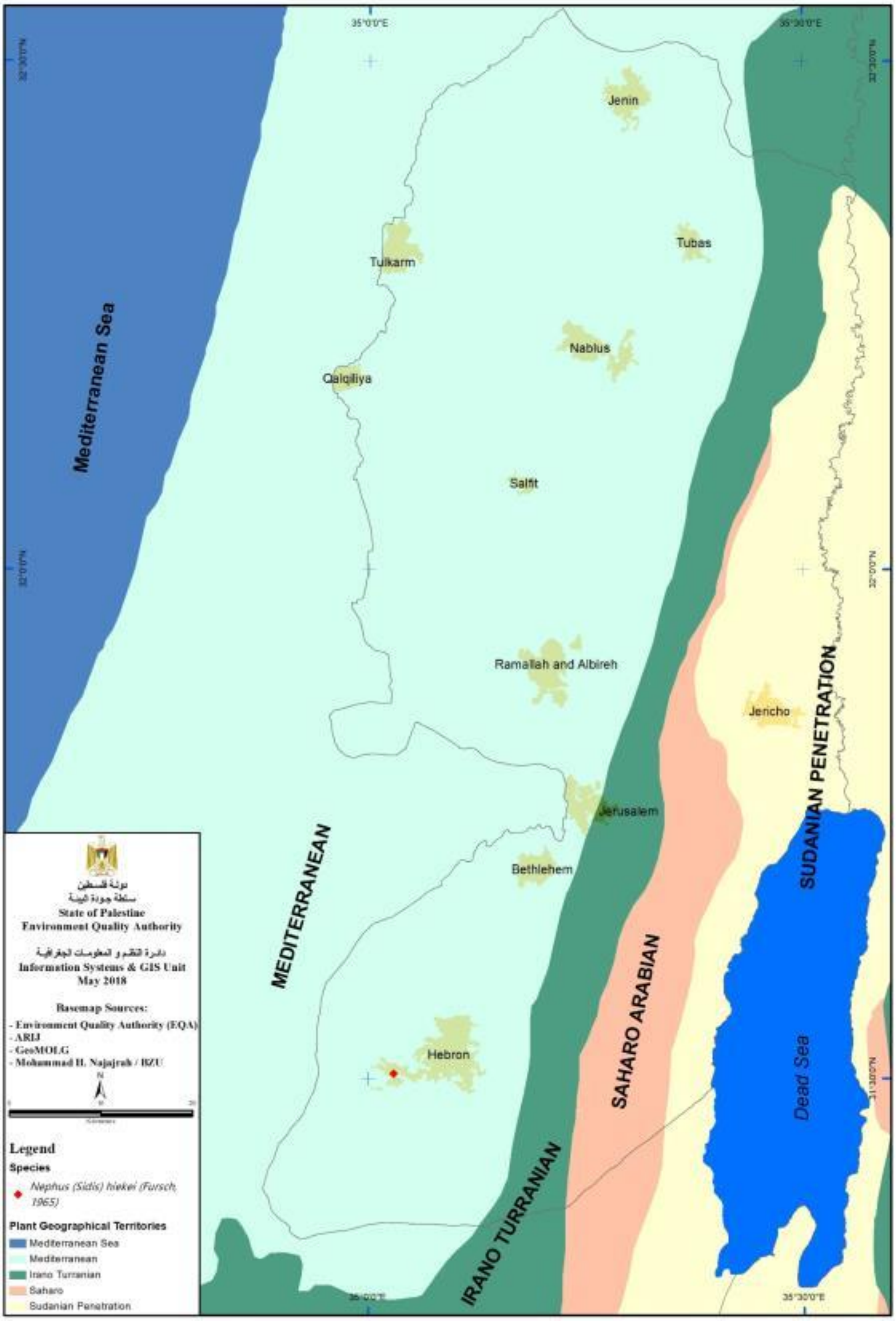

Figure 40. Collection site of *Nephus (Sidis) hiekei* in the south of the West Bank.

Nephus (Nephus) peyerimhoffi (Sicard, 1923), (Fig. 41)

Material: Bethlehem 1 (Field#267, 2, 1 April 2018). Al-Kum (Field#482, 1, 5 April 2018). Deir Krntl 1 (Field#826, 2, 23 April 2018).

Remarks: *Nephus peyerimhoffi* is reported from citrus trees in Europe (Saharaoui et al. 2015). In the region, it was introduced for avocado trees in 1986 (Swirski et al. 1995; Mendel et al. 2017). In the present study, it was collected from citrus and cypress trees in 3 localities in the West Bank (Fig. 42).

Figure 41. *Nephus (Nephus) peyerimhoffi* (Sicard, 1923).

Scale bar = 2mm.

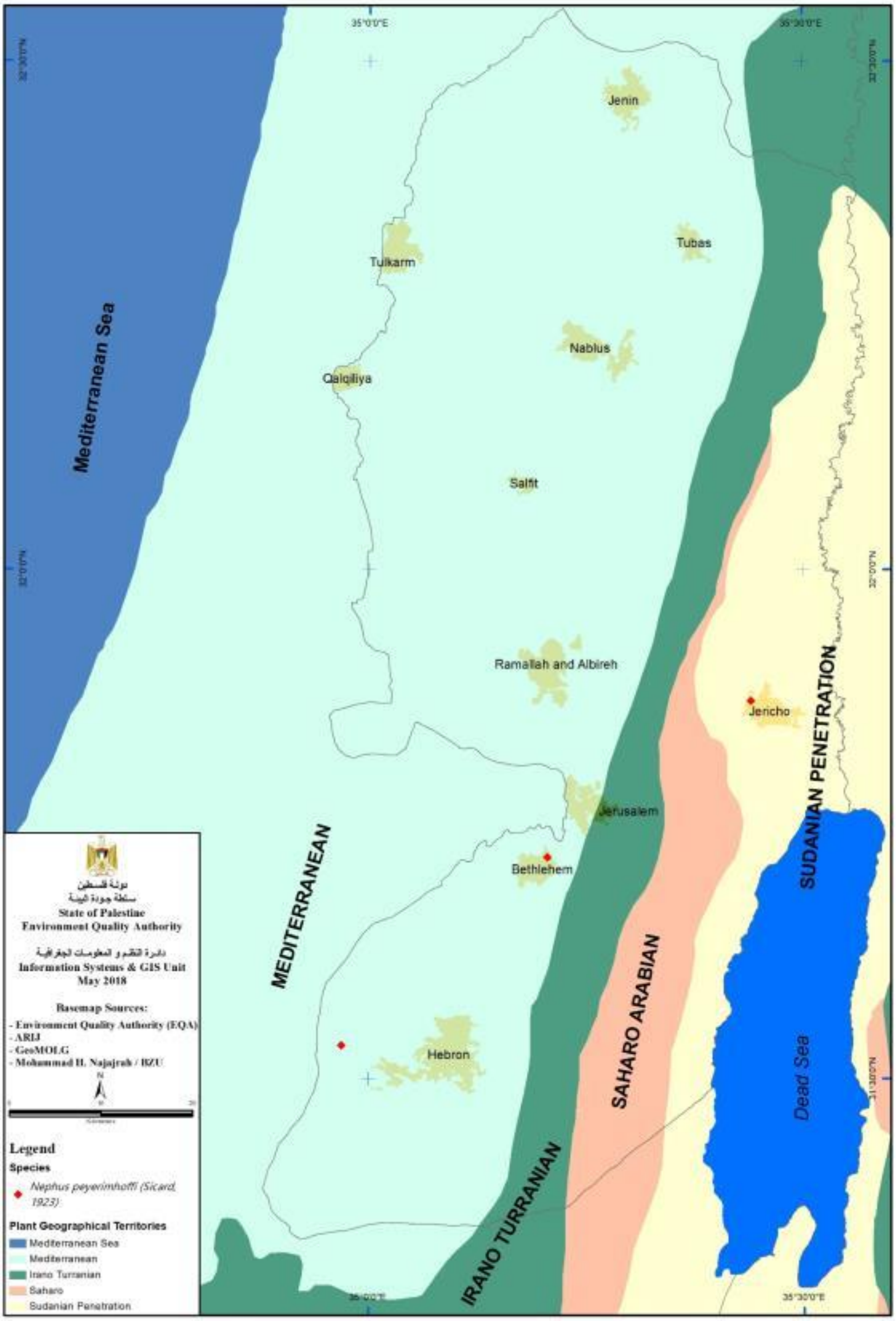

Figure 42. Geographical distribution map of *Nephus (Nephus) peyerimhoffi***.**

Nephus (Nephus) quadrimaculatus (Herbst, 1783), (Fig. 43)

Material: Bethlehem 1 (Field#23, 1, 23 November 2016). Ein Samiya (Field#93, 4, 4 March 2018). Bayt Jala 1 (Field#159, 2, 22 March 2018). Bayt Jala 1 (Field#163, 2, 22 March 2018). Battir 1 (Field#209, 2, 21 March 2018). Kisan (Field#242, 1, 27 March 2018). Asakra (Field#259, 3, 27 March 2018). Bethlehem 1 (Field#261, 4, 1 April 2018). Bethlehem 1 (Field#262, 2, 1 April 2018). Karme (Field#285, 1, 11March 2018). Irtas 1 (Field#291, 8, 25 March 2018). Irtas 2 (Field#300, 1, 25March 2018). Dayr Kremzan 1 (Field#323, 2, 31 March 2018). Bayt Sahur 1 (Field#327, 2, 1 April 2018). Ad-Dhahiriya 2 (Field#354, 1, 5 April 2018). Bethlehem 1 (Field#403, 1, 1 April 2018). Bayt Fajar 1 (Field#412, 2, 2 April 2018). Bethlehem 2 (Field#436, 3, 2 April 2018). Bayt Jala 2 (Field#454, 1, 31 March 2018). Al-Ramadin (Field#469, 1, 5 April 2018). Bayt Sahur 2 (Field#473, 1, 2 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 1 (Field#498, 4, 4 April 2018). Bayt Ula1 (Field#503, 1, 4 April 2018). Al Aroub (Field#528, 3, 3 April 2018). Bani Na'im 3 (Field#652, 2, 9 April 2018). Al Baqa'a 1 (Field#661, 1, 9 April 2018). Zif 2 (Field#690, 1, 12 April 2018). Al Carmel 2 (Field#698, 3, 12 April 2018). Tapuah (Field#808, 1, 21 April 2018). Nu'eima Altahta 1 (Field#845, 1, 23 April 2018). Idhna 1 (Field#858, 1, 5 April 2018). Wadi Al Joz (Field#895, 1, 21 April 2018).

Remarks: *Nephus quadrimaculatus* is a common species that was collected from cypresses, pine, oak, carob and olive trees in many localities of the studied area (Fig. 44). It is a coccidophagous species that feeds on leaf curl aphids (Almatni & Khalil, 2008).

Figure 43. *Nephus (Nephus) quadrimaculatus* (Herbst, 1783).

Scale bar = 2mm.

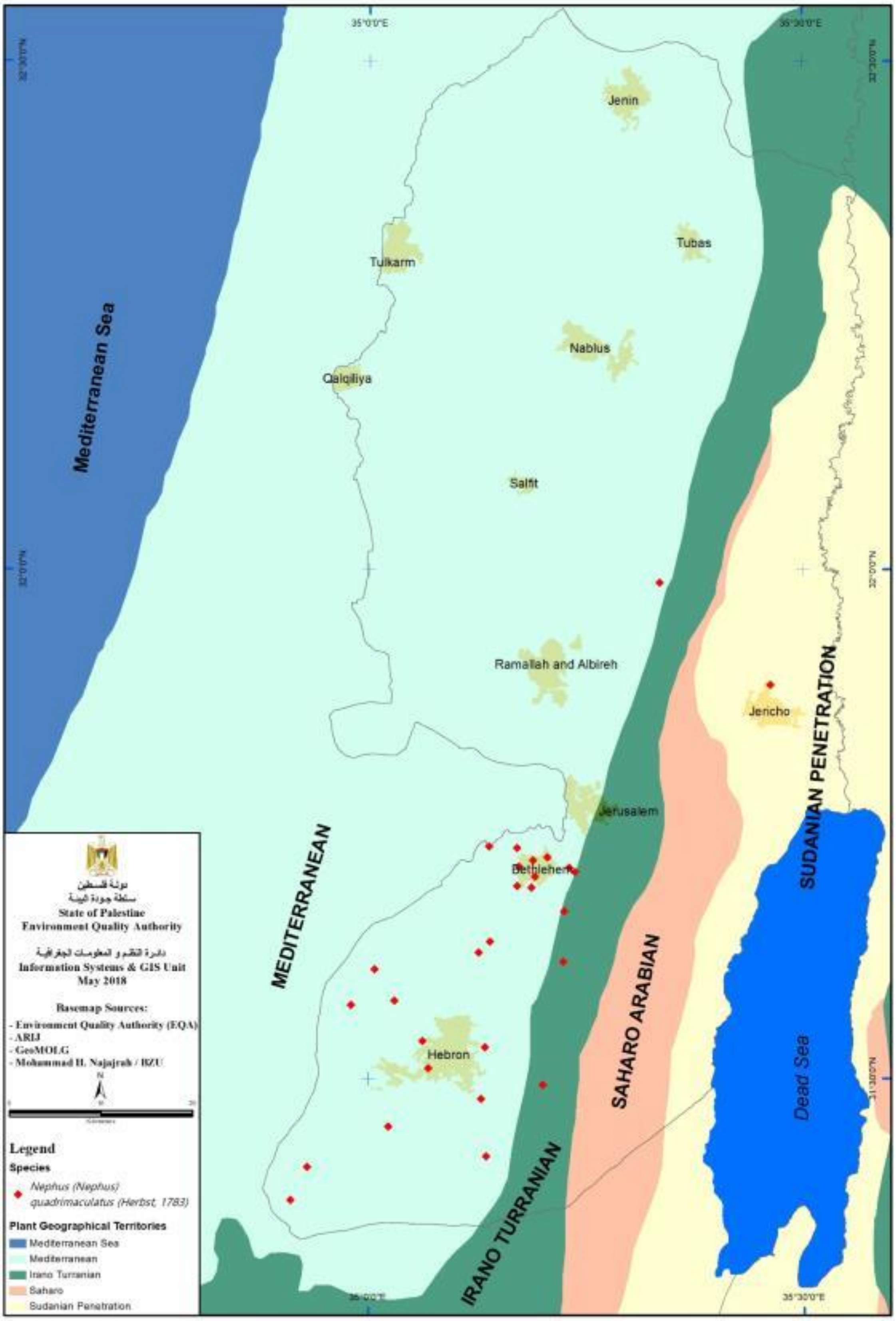

Figure 44. Geographical distribution map of *Nephus (Nephus) quadrimaculatus.*

Scymnus (Scymnus) flavicollis (Redtenbacher, 1843), (Fig. 45)

Material: Wadi Kelt (Field#581, 5, 16 April 2018). Deir Krntl 1 (Field#828, 1, 23 April 2018). Bethlehem 1 (Field#24, 1, 30 May 2016). Bethlehem 1 (Field#72, 1, 28 February 2018).

Remarks: *Scymnus flavicollis* can be found on cultivated pistachio feeding on common pistachio psylla (Salehi, 2011). The species is an enemy of white flies (Alemansoor & Ahmadi 1994) and banana aphids (Biale et al., 2017). It was reported from Palestine before (Halperin et al. 1995). In the present study, it was collected from ziziphus and citrus trees of 4 localities in the study area (Fig. 46).

Figure 45. *Scymnus (Scymnus) flavicollis (Redtenbacher, 1843).*

*S*cale bar = 2mm.

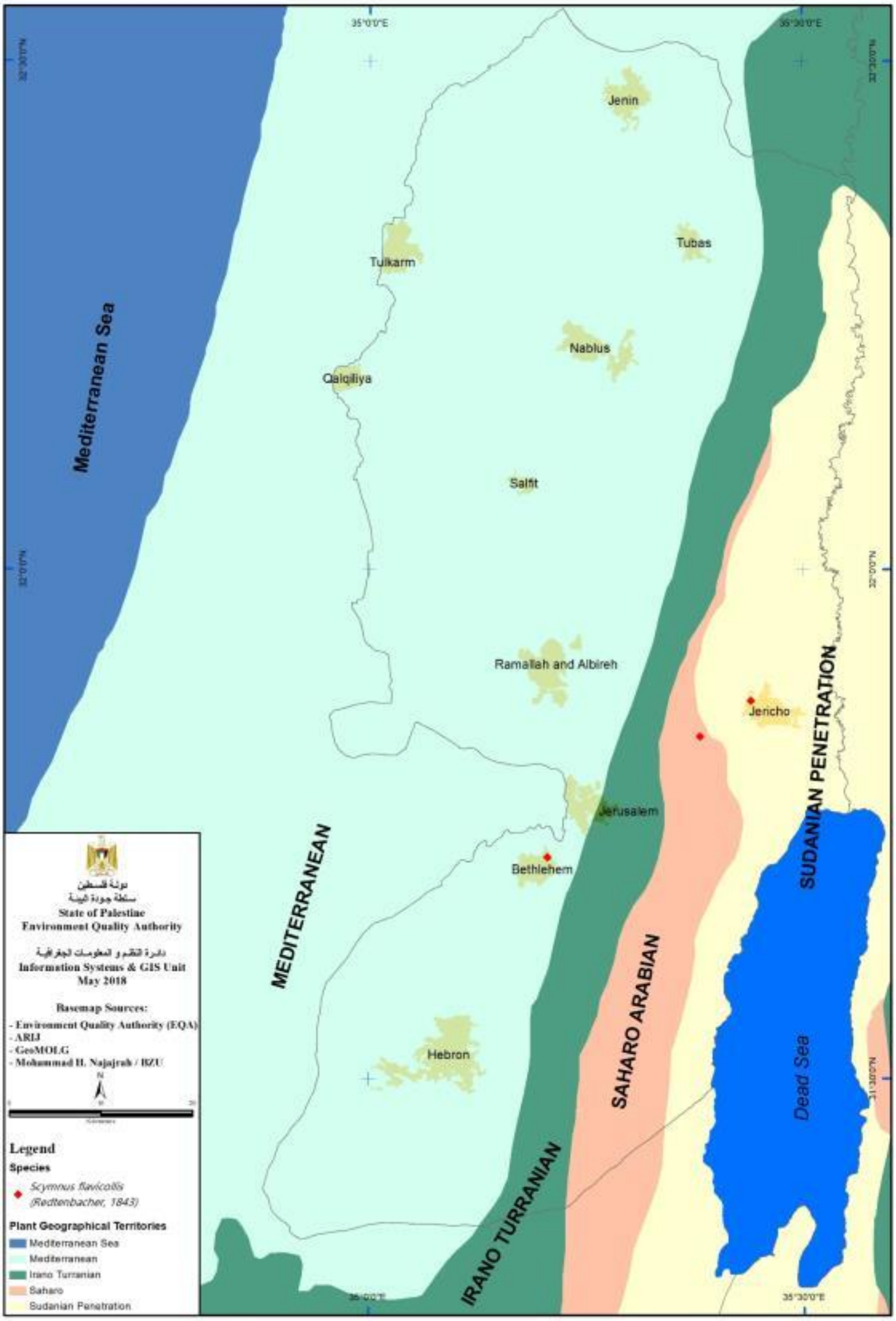

Figure 46. Geographical distribution map of *Scymnus (Scymnus) flavicollis.*

Scymnus (Parapullus) abietis (Paykull, 1798), (Fig. 47)

Material: Bethlehem 1 (Field#21, 2, 11 September 2017). Ein Samiya (Field#85, 1, 4 March 2018). Bethlehem 1 (Field#402, 1, 1 April 2018). Bayt Ula1 (Field#506, 1, 4 April 2018). Hadab Al'Alaqa (Field#720, 2, 15 April 2018).

Remarks: *Scymnus abietis* lives on pine trees and feeds on the aphids (Khalil, 2006). It was found on the pine and cupressus in this study and was noted to be attracted to the yellow insect traps on olive trees in the Mediterranean area (Fig. 48). This is the first record of this species in our region. Chen et al. (2015) reviewed and updated this subgenus *Scymnus (Parapullus)* and described 8 new species.

Figure 47. *Scymnus (Parapullus) abietis* (Paykull, 1798).

Scale bar = 3mm.

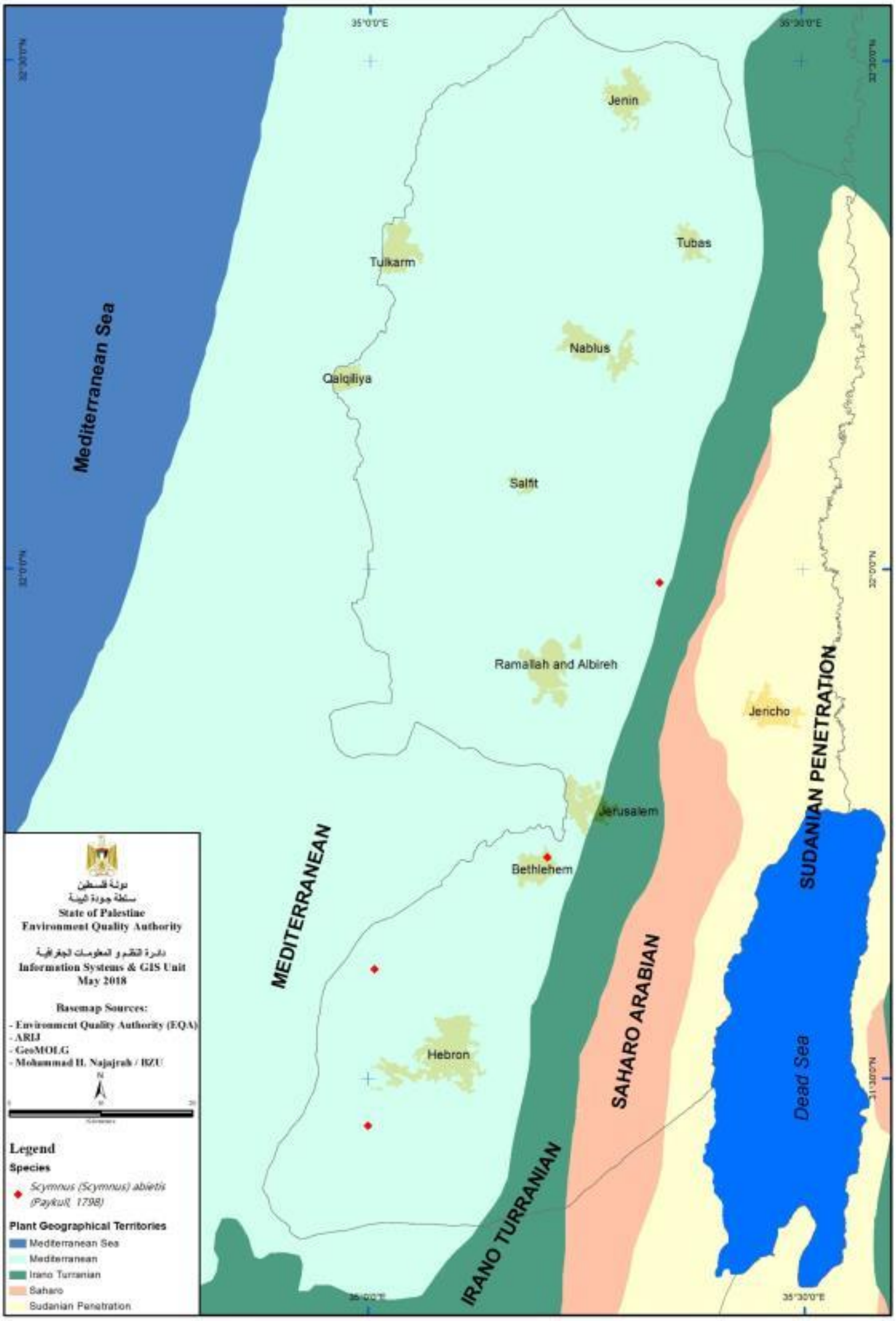

Figure 48. Geographical distribution map of *Scymnus (Parapullus) abietis.*

Scymnus (Scymnus) interruptus (Goeze, 1777), (Fig. 49)

Material: Ein Al 'Auja (Field#586, 1, 16 April 2018). Ein Fasa'll (Field#715, 1, 16 April 2018). Jericho 1 (Field#854, 1, 23 April 2018).

Remarks: *Scymnus interruptus* was collected from *Vitex agnus-castus* and citrus trees around the Jordan Valley region (Fig. 50). It was collected in south of Syria feeding maily on aphids on a wide range of plants and on pollen grains when food is scarce (Khalil, 2006). This is the first record of this species in our region.

Figure 49. *Scymnus (Scymnus) interruptus* (Goeze, 1777).

Scale bar = 3mm.

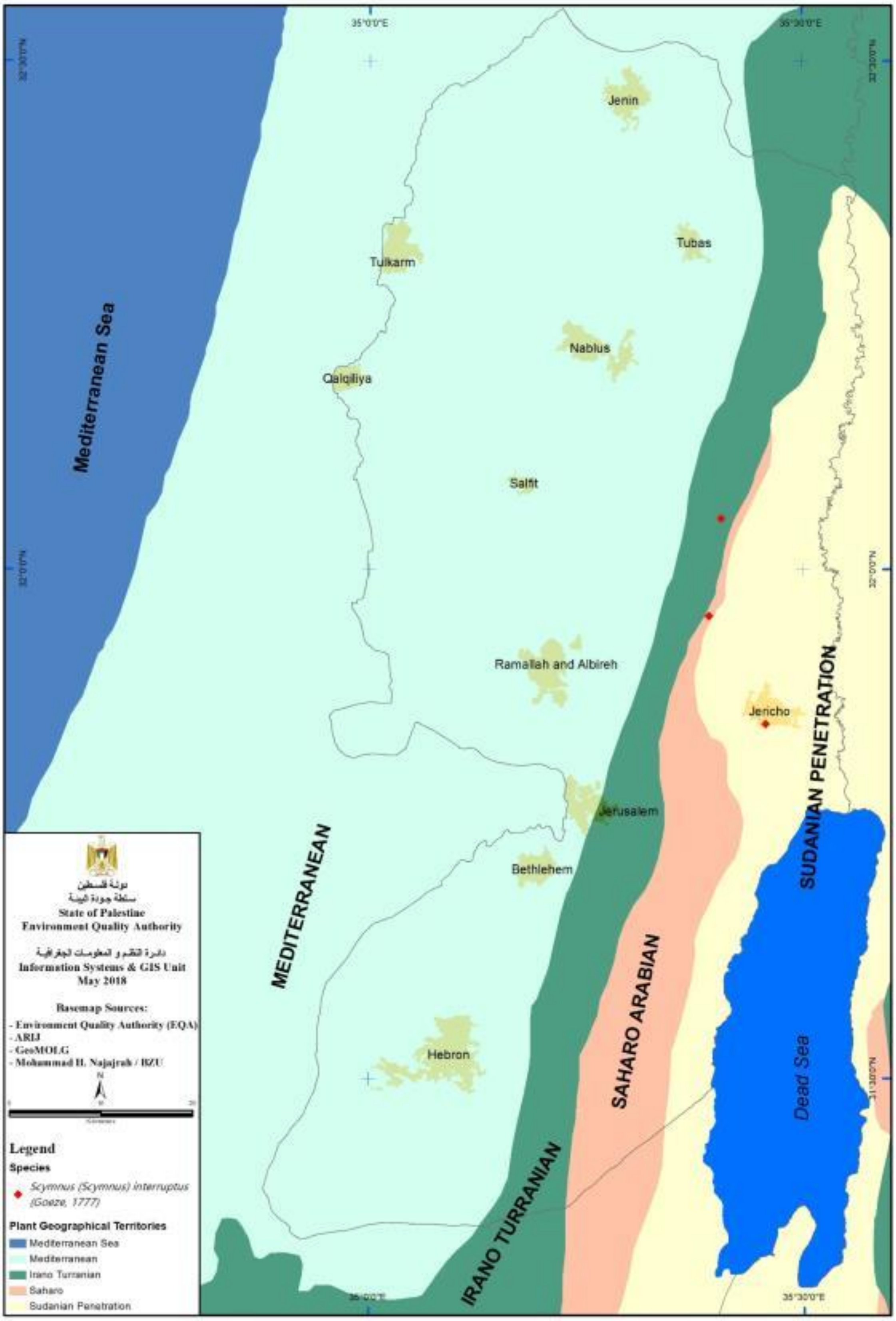

Figure 50. Geographical distribution map of *Scymnus (Scymnus) interruptus*.

Scymnus (Neopullus) limbatus (Stephens, 1831), (Fig. 51)

Material: Nahalin 1 (Field#180, 1, 20 March 2018). Al-Ramadin (Field#468, 1, 5 April 2018).

Remarks: *Scymnus limbatus* was found on *Cupressus* trees in the study area only in two localities (Fig. 52). This is the first record of this species in our region.

Figure 51. *Scymnus (Neopullus) limbatus (Stephens, 1831).*

Scale bar = 2mm.

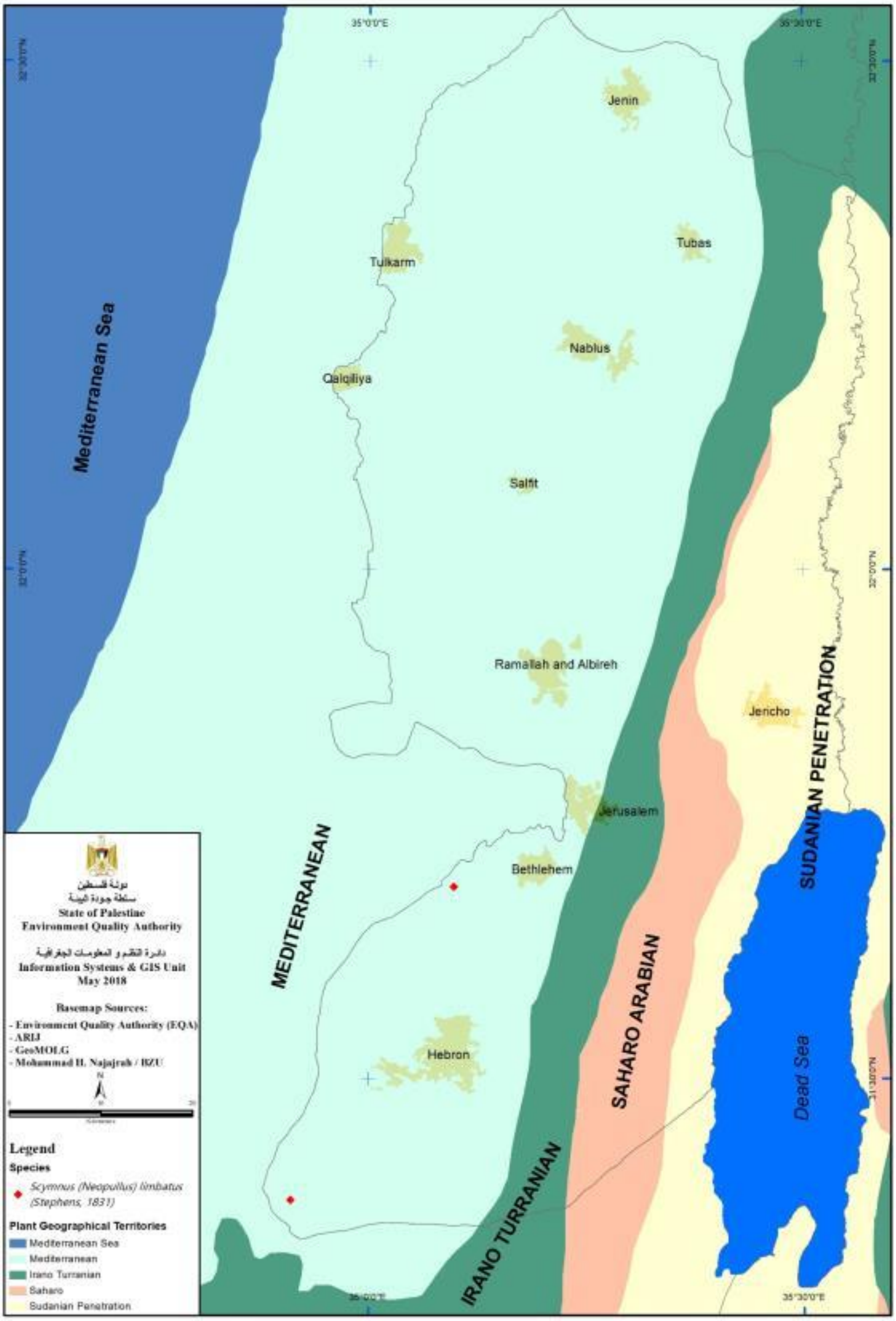

Figure 52. Geographical distribution map of *Scymnus (Neopullus) limbatus*.

Scymnus nigropictus (Wollaston, 1867), (Fig. 53)

Material: Ein Al 'Auja (Field#582, 1, 16 April 2018). Jericho 1 (Field#853, 7, 23 April 2018).

Remarks: *Scymnus nigropictus* is found only in the Middle East "Egypt, Saudi Arabia and Yemen" (Raimundo & van Harten 2000). It was collected from cane plants in the study area (Fig. 54). This is the first record of this species in our region.

Figure 53. *Scymnus nigropictus (Wollaston, 1867).*

Scale bar = 2mm.

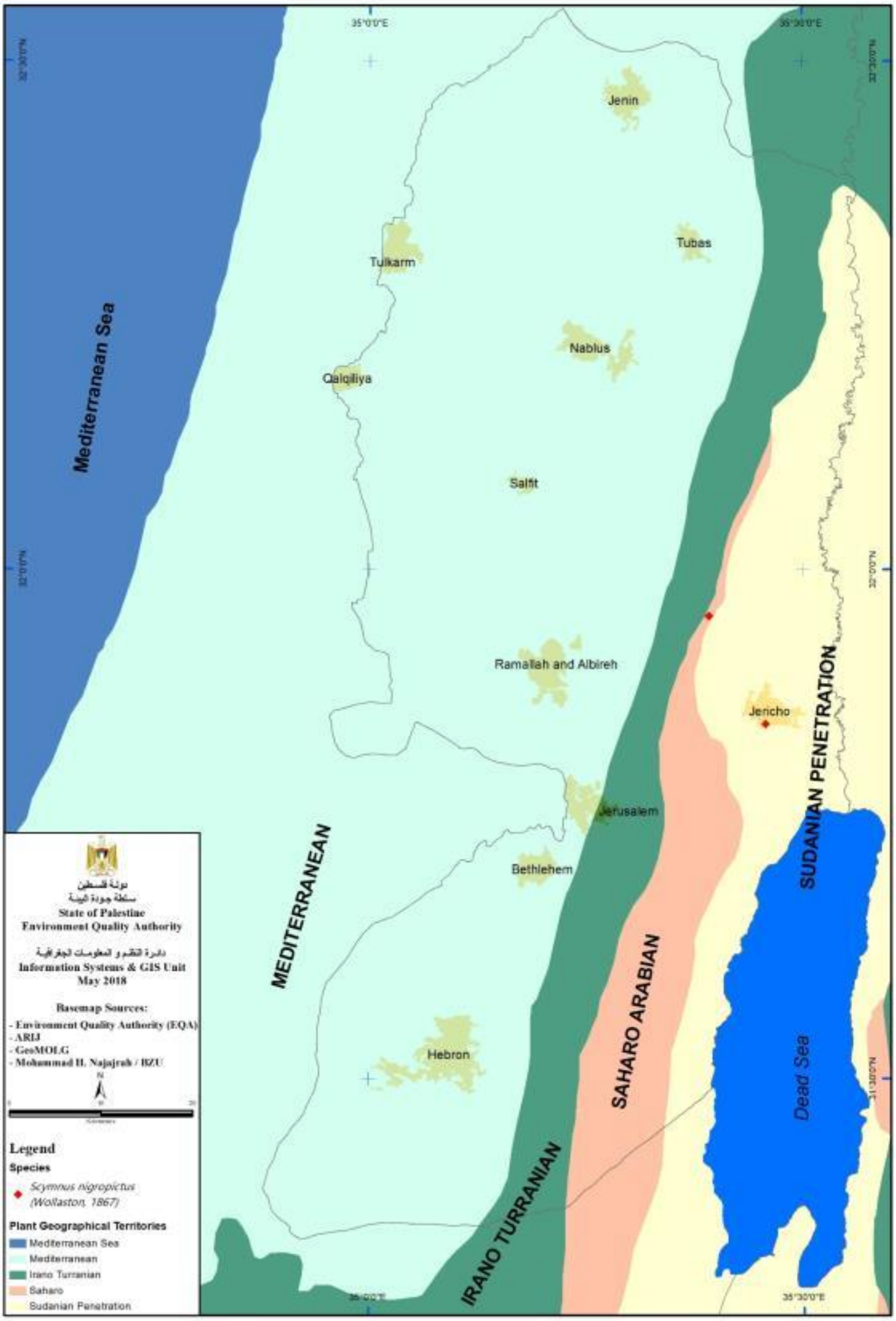

Figure 54. Geographical distribution map of *Scymnus nigropictus*.

Scymnus (Scymnus) pallipediformis (Gunther, 1958), (Fig. 55)

Material: Nahalin 1 (Field#5, 1, 20 August 2017). Irtas 1 (Field#290, 2, 25 March 2018). Al Carmel 2 (Field#699, 2, 12 April 2018). Ein Al Fawwar (Field#710, 2, 16 April 2018). Ein Fasa'll (Field#714, 1, 16.4.2018). Tel Alsamrat (Field#813, 1, 23 April 2018). Kufr Al-Dik (Field#894, 1, 16 August 2017).

Remarks: *Scymnus pallipediformis* was recorded as one of the important natural enemies of *Monosteira sp*. in almond orchards of Turkey (Bolu, 2007) and of *Ceroplastes floridensis* on grapefruits and citrus (Eserkaya & Karaca, 2016). It was reported from Palestine before (Halperin et al. 1995). In the present study, it was recorded near springs and dich water areas (Fig. 56).

Figure 55. *Scymnus (Scymnus) pallipediformis* (Gunther, 1958).

Scale bar = 2mm.

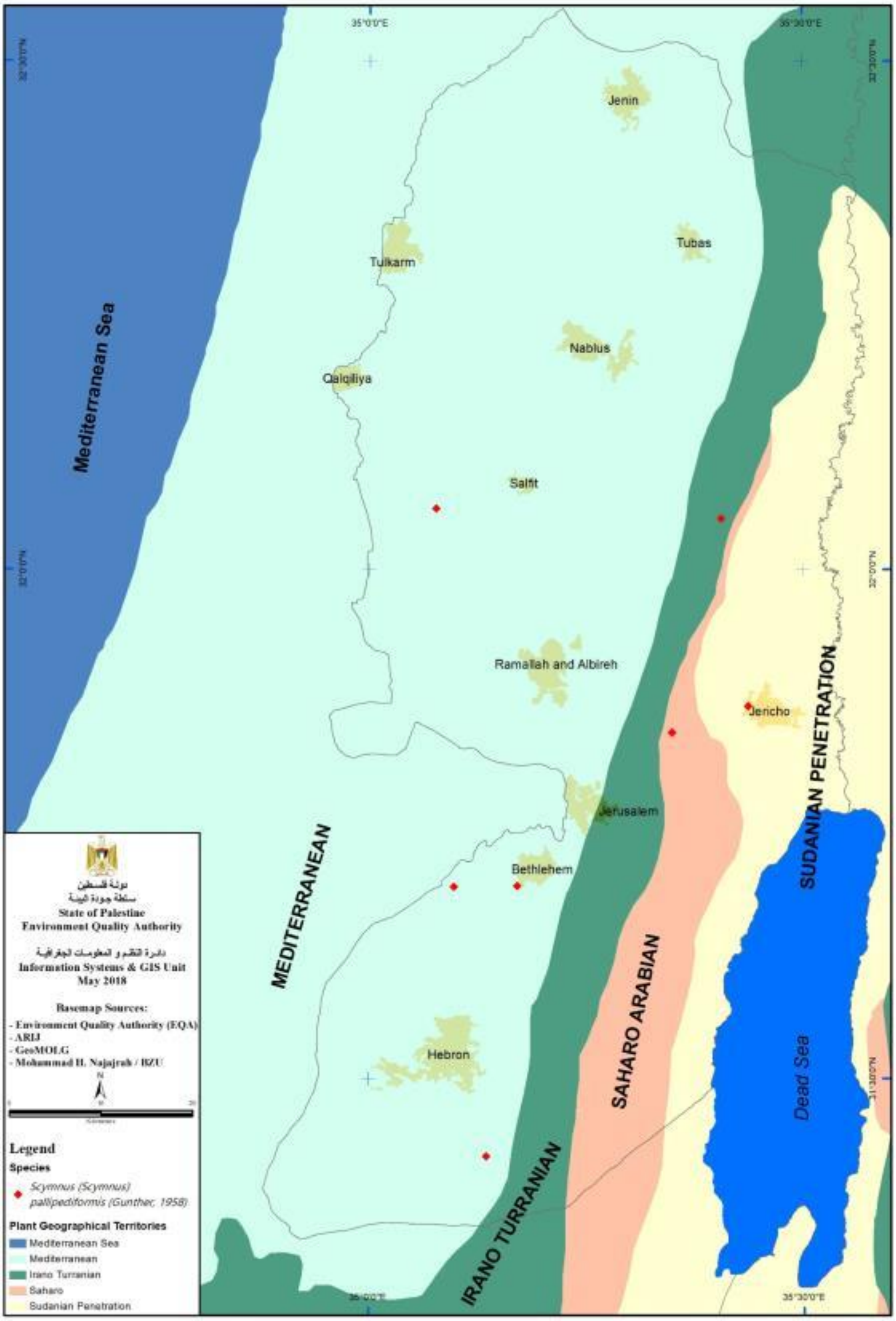

Figure 56. Geographical distribution map of *Scymnus (Scymnus) pallipediformis*.

Scymnus (Pullus) subvillosus (Goeze, 1777), (Fig. 57)

Material: Al-Auja 3 (Field#140, 1, 6 March 2018). Nahalin 1 (Field#172, 1, 20 March 2018). Idhna 1 (Field#386, 1, 4 April 2018). Bayt Fajar 1 (Field#408, 1, 2 April 2018). Surif (Field#510, 2, 3 April 2018). Bani Na'im 1 (Field#633, 2, 9 April 2018). Ein Al Fawwar (Field#707, 1, 16 April 2018). Dura 3 (Field#797, 1, 21 April 2018).

Remarks: *Scymnus subvillosus* is a common species in the Middle East and in the Mediterranean region specifically (Raimundo & van Harten, 2000). It’s an aphidophagous species that is widely distributed on citrus groves and more frequent in the warmer parts (Kehat & Greenberg, 1970). It was reported from Palestine before (Halperin et al. 1995). Most of the samples were collected from barley fields and almond trees in the study area (Fig. 58).

Figure 57. *Scymnus (Pullus) subvillosus* (Goeze, 1777).

Scale bar = 3mm.

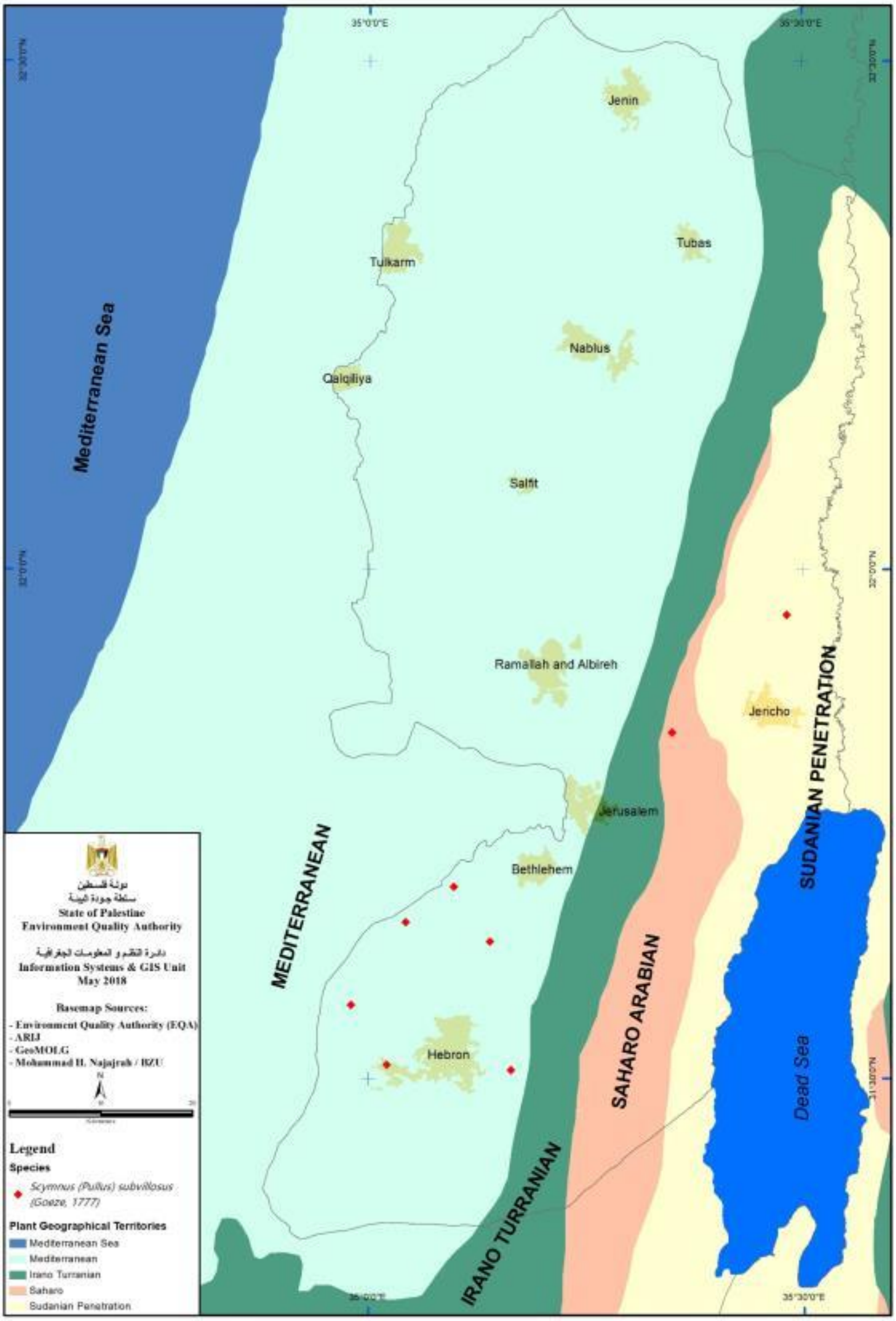

Figure 58. Geographical distribution map of *Scymnus (Pullus) subvillosus*.

Scymnus (Pullus) suturalis (Thunberg, 1795) (Fig. 59)

Material: Ein Samiya (Field#84, 2, 4 March 2018). Ein Samiya (Field#92, 1, 4 March 2018). Ein Al 'Auja (Field#587, 1, 16 April 2018). Bayt Jala 1 (Field#145, 3, 22 March 2018). Bayt Sahur 1 (Field#325, 4, 1 April 2018). Ad-Dhahiriya 2 (Field#359, 1, 5 April 2018). Dura 1 (Field#753, 1, 15 April 2018). Irtas 1 (Field#288, 4, 25 March 2018). Wadi Kelt (Field#580, 1, 16 April 2018). Bethlehem 1 (Field#903, 1, 31 May 2018).

Remarks: *Scymnus (Pullus) suturalis* is a Palearctic aphidophagous species that occurs on conifers (Lyon & Montgomery, 1995). It was collected from *Cupressus* trees of different localities visited during this study and noted feeding on scale insects of these trees (Fig 60). This is the first documentation of such a feeding habit for this species and this is the first record of this species in our region.

Figure 59. *Scymnus (Pullus) suturalis* (Thunberg, 1795*).*

*S*cale bar = 2mm.

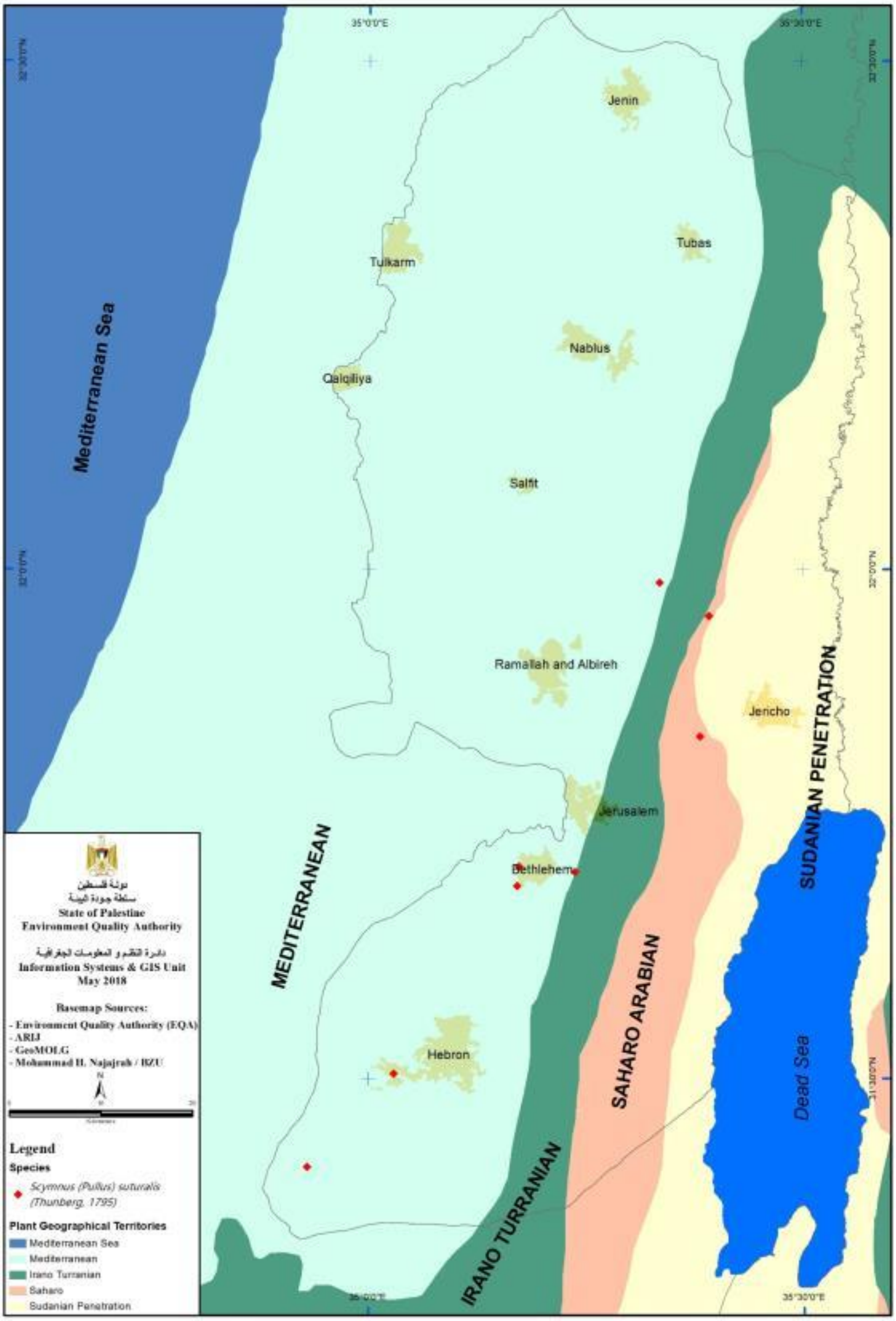

Figure 60. Geographical distribution map of *Scymnus (Pullus) suturalis.*

Scymnus (Pullus) syriacus (Marseul, 1868), (Fig. 61)

Materials: Nu'eima 1 (Field#35, 1, 5 March 2018). Ein AlBeida 1 (Field#39, 1, 8 March 2018). Ein Samiya (Field#87, 1, 4 March 2018). An-Nabi Musa (Field#611, 2, 16 April 2018). Ein Fasa'll (Field#719, 3, 16 April 2018). Jericho 2 (Field#818, 1, 23 April 2018). Deir Krntl 1 (Field#830, 1, 23 April 2018). Jericho 1 (Field#852, 2, 23 April 2018).

Remarks: *Scymnus syriacus* is an aphidophagous species feeding on a wide range of aphids on different vegetables, fruits and wild plants (Khalil, 2006). It is a common species in Palestine (Helprin et al. 1995). Most of the samples were collected from Sudanian penetration zone on atriplex, cane, citrus, prosopis and jujube plants (Fig. 62).

Figure 61. *Scymnus (Pullus) syriacus* (Marseul, 1868).

*S*cale bar = 2mm.

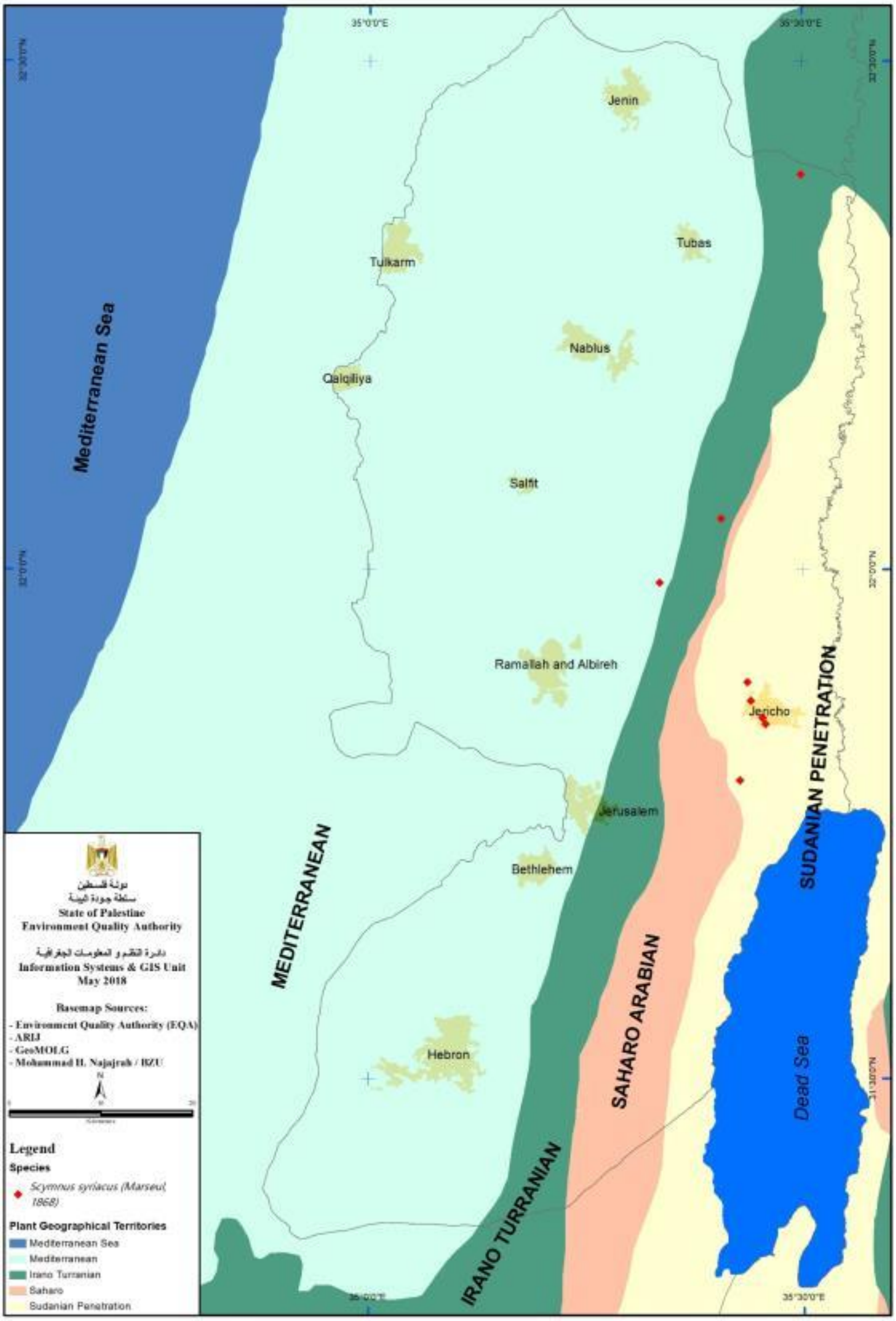

Figure 62. Geographical distribution map of *Scymnus (Pullus) syriacus.*

Diomus anemicus (Fursch, 1960), (Fig. 63)

Material: Asakra (Field#260, 1, 27 March 2018). Bethlehem 1 (Field#548, 1, 1 April 2018).

Remarks: *Diomus anemicus* known only from Egypt, Palestine and Yemen (Raimundo & van Harten, 2000). It feeds on mealybugs and scale insects (Gerson et al., 1975; Canovai et al., 2014). The very limited distribution in this study (two localities near Bethlehem) is an interesting finding (Fig. 64). It was reported from Palestine before (Halperin et al. 1995).

Figure 63. *Diomus anemicus* (Fursch, 1960).

Scale bar = 2mm.

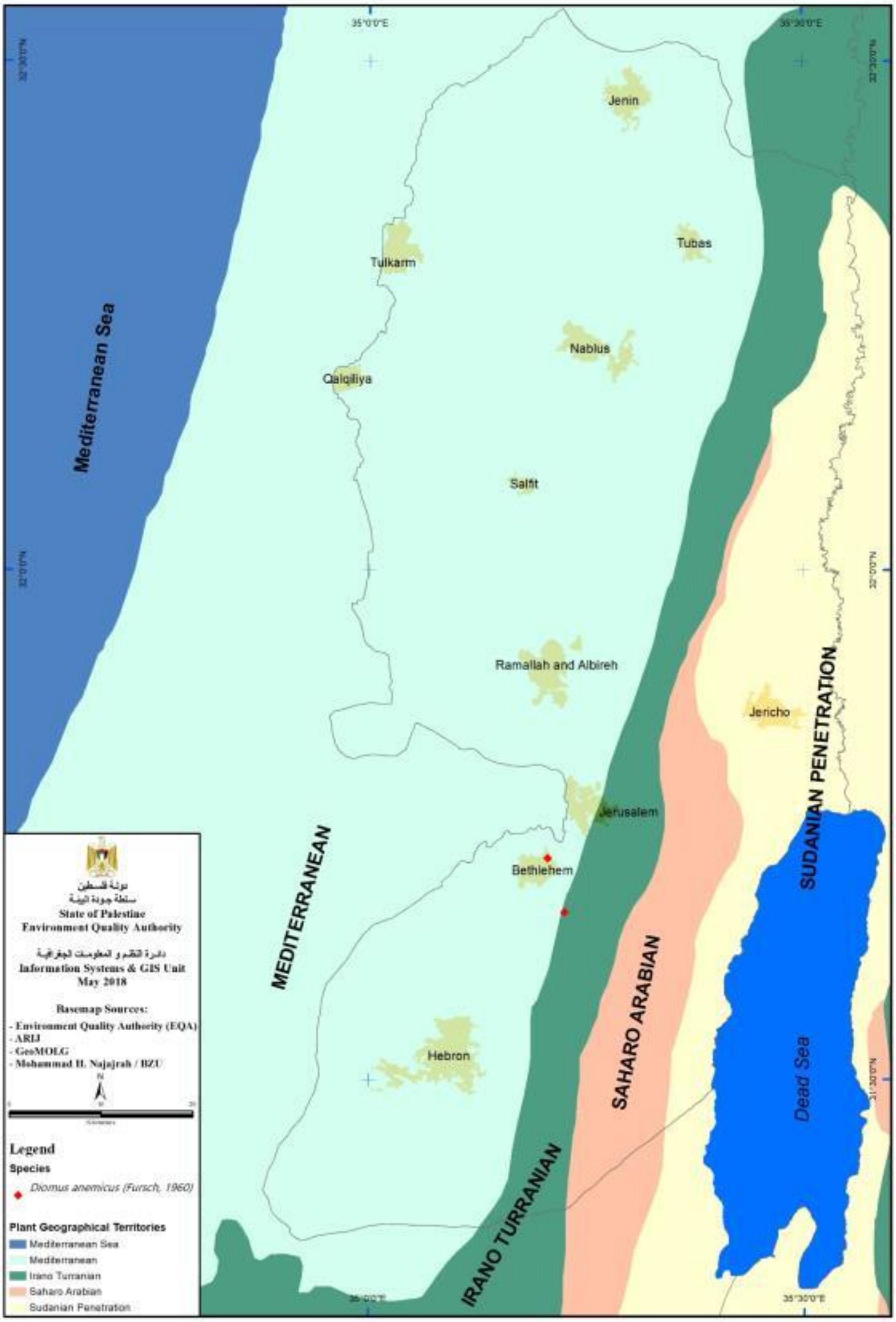

Figure 64. Geographical distribution map of *Diomus anemicus*.

Tribe Stethorini

Stethorus gilvifrons (Mulsant, 1850), (Fig. 65)

Material: Ein AlBeida 2 (Field#47, 7, 8 March 2018). Bardala 1 (Field#56, 5, 8 March 2018). Ein Al-Sakout 1 (Field#64, 1, 7 March 2018). Far'a El-Giftlik 1 (Field#69, 14, 8 March 2018). Marj Na'je 2 (Field#75, 8, 6 March 2018). Ein Al-Duok Al Foqa (Field#107, 1, 4 March 2018). Al-Auja 1 (Field#126, 2, 6 March 2018). Ad-Dhahiriya 2 (Field#355, 8, 5 April 2018). Halhul 1 (Field#381, 1, 4 April 2018). Bayt Jala 2 (Field#455, 3, 31 March 2018). Kharas 1 (Field#459, 15, 3 April 2018). Al-Kum (Field#481, 19, 5 April 2018). Ein Al 'Auja (Field#585, 1, 16 April 2018). Ein Fasa'll (Field#718, 3, 16 April 2018). Abda (Field#741, 1, 15 April 2018). Tel Alsamrat (Field#814, 1, 23 April 2018). Nu'eima Altahta 2 (Field#821, 4, 23 April 2018). Deir Krntl 1 (Field#823, 5, 23 April 2018). Jericho 4 (Field#833, 1, 23 April 2018). Tulul Abu Al-Ala'iq 2 (Field#839, 13, 23 April 2018). Nu'eima altahta 1 (Field#841, 4, 23 April 2018). Jericho 1 (Field#849, 37, 23 April 2018). Bethlehem 1 (Field#907, 1, 13 June 2018).

Remarks: *Stethorus gilvifrons* is an acarophagous Mediterranean species according to Khalil (2006). During this study, it was noted in many regions including the Jordan Valley (Fig. 66). It was collected from farms on eggplant, citrus, squash, corn, tomato, peppers, watermelon, and on wild plants like jujube and atriplex (plants infested with spider mites on which this species feeds). This species was reported from Palestine before (Halperin et al. 1995).

Figure 65. *Stethorus gilvifrons* (Mulsant, 1850).

Scale bar = 2mm.

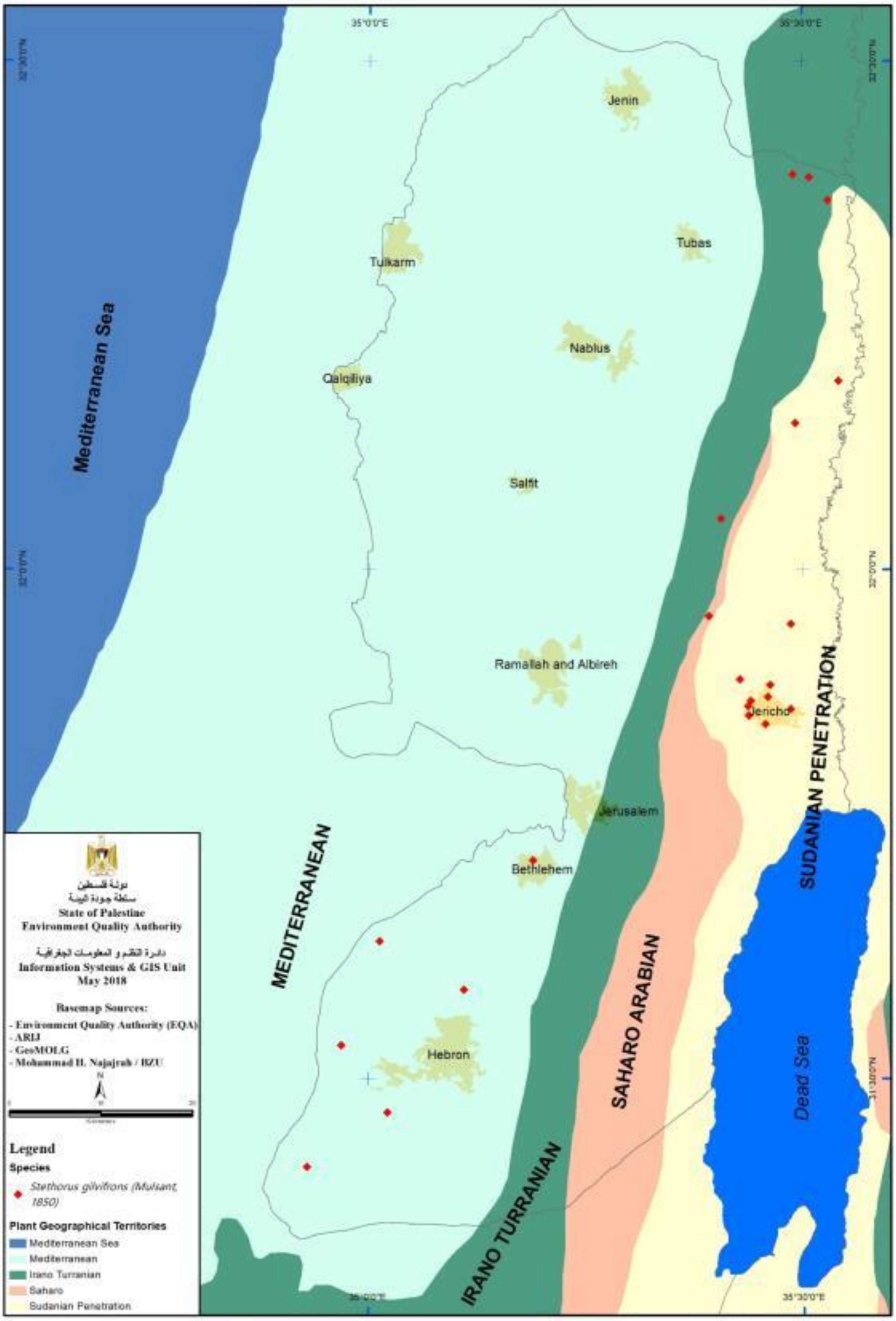

Figure 66. Geographical distribution map of *Stethorus gilvifrons*.

Subfamily Sticholotidinae

Sticholotidinae are represented by two species belonging to two tribes, one of them is from the most common species in the study area (*Pharoscymnus fleischeri*) and one from the very rare ones (*Serangium parcesetosum*).

Tribe Sticholotidini

Pharoscymnus fleischeri (Weise, 1883) (Fig. 67)

Material: Ein AlBeida 2 (Field#44, 5, 8 March 2018). As-Samu (Amnyzl) (Field#52, 1, 11 March 2018). Karme (Field#53, 2, 11 March 2018). Ein Samiya (Field#83, 7, 4 March 2018). Ein Samiya (Field#91, 4, 4 March 2018). Ein Al-Duok Al Foqa (Field#119, 1, 4 March 2018). Bayt Jala 1 (Field#148, 12, 22 March 2018). Al-Khader (Field#156, 2, 22 March 2018). Bayt Jala 1 (Field#161, 10, 22 March 2018). Nahalin 3 (Field#168, 3, 20 March 2018). Nahalin 2 (Field#177, 2, 20 March 2018). Wadi Fukin 1 (Field#188, 8, 21 March 2018). Battir 2 (Field#201, 11, 21 March 2018). Battir 1 (Field#205, 6, 21 March 2018). Battir 1 (Field#207, 3, 21 March 2018). Alkhas (Field#225, 1, 18 March 2018). Umm Salmuna (Field#232, 7, 27 March 2018). Kisan (Field#239, 2, 27 March 2018). Abu Nujaym 2 (Field#246, 8, 27 March 2018). Hindaza Bredhaa (Field#254, 2, 25 March 2018). Asakra (Field#258, 1, 27 March 2018). Bethlehem 1 (Field#266, 10, 1 April 2018). Khallet Hamad (Field#284, 11, 27 March 2018). Irtas 1 (Field#292, 7, 25 March 2018). Irtas 2 (Field#299, 5, 25 March 2018). Bayt al-Rush (Field#313, 6, 5 April 2018). Dayr Kremzan 1 (Field#319, 9, 31 March 2018). Bayt Sahur 1 (Field#330, 1, 1 April 2018). Dayr Kremzan 2 (Field#334, 3, 31 March 2018). Ad-Dhahiriya 2 (Field#351, 10, 5 April 2018). Khirbat Safa 2 (Field#363, 2, 3 April 2018). Bayt Mirsim (Field#377, 3, 5 April 2018). Halhul 1 (Field#380, 1, 4 April 2018). Idhna 1 (Field#387, 1, 4 April 2018). Burj (Field#395, 1, 5 April 2018). Bayt Fajar 1 (Field#409, 8, 2 April 2018). Sika (Field#424, 2, 5 April 2018). Sika (Field#425, 1, 5 April 2018). Bethlehem 2 (Field#432, 6, 2 April 2018). Bayt Jala 2 (Field#458, 6, 31 March 2018). Bayt Sahur 2 (Field#476, 5, 2 April 2018). Halhul 2 (Field#490, 3, 4 April 2018). Halhul 2 (Field#491, 1, 4 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 2 (Field#495, 4, 4 April 2018). Nuba (Field#521, 2, 4 April 2018). Al Aroub (Field#526, 1, 3 April 2018). Al Aroub (Field#534, 6, 3 April 2018). Bayt Ummar (Field#538, 2, 3 April 2018). Bethlehem 1 (Field#546, 3, 1 April 2018). Deir Razih 2 (Field#564, 4, 15 April 2018). Al Hijra (Field#571, 2, 12 April 2018). As-Samu (Field#592, 2, 12 April 2018). Zif 1 (Field#596, 1, 9 April 2018). Bayt Amra (Field#601, 1, 12 April 2018). Al-Rayhiyya (Field#617, 2, 12 April 2018). Hadab Al Fawar (Field#624, 12, 12 April 2018). Bani Na'im 1 (Field#632, 1, 9 April 2018). At-Tuwani (Field#646, 1, 12 April 2018). Bani Na'im 3 (Field#654, 2, 9 April 2018). Al Baqa'a 2 (Field#667, 1, 9 April 2018). Si'ir (Field#672, 1, 9 April 2018). Si'ir (Field#672, 1, 9 April 2018). Duma (Field#731, 13, 15 April 2018). Duma (Field#733, 1, 15 April 2018). Abda (Field#739, 1, 15 April 2018). HaRasa (Field#745, 2, 15 April 2018). Dura 1 (Field#755, 1, 15 April 2018). Tarama (Field#763, 4, 15 April 2018). Kreisa (Field#779, 5, 21 April 2018). Surif (Field#785, 3, 3 April 2018). Dura 3 (Field#796, 1, 21 April 2018).

Remarks: *Pharoscymnus fleischeri* is a common species in Palestine (Helprin et al., 1995). During this study, it was noted mostly in the Mediterranean zone on cupressus, pine and oak trees (Fig 68).

Figure 67. *Pharoscymnus fleischeri (Weise, 1883).*

Scale bar = 2mm.

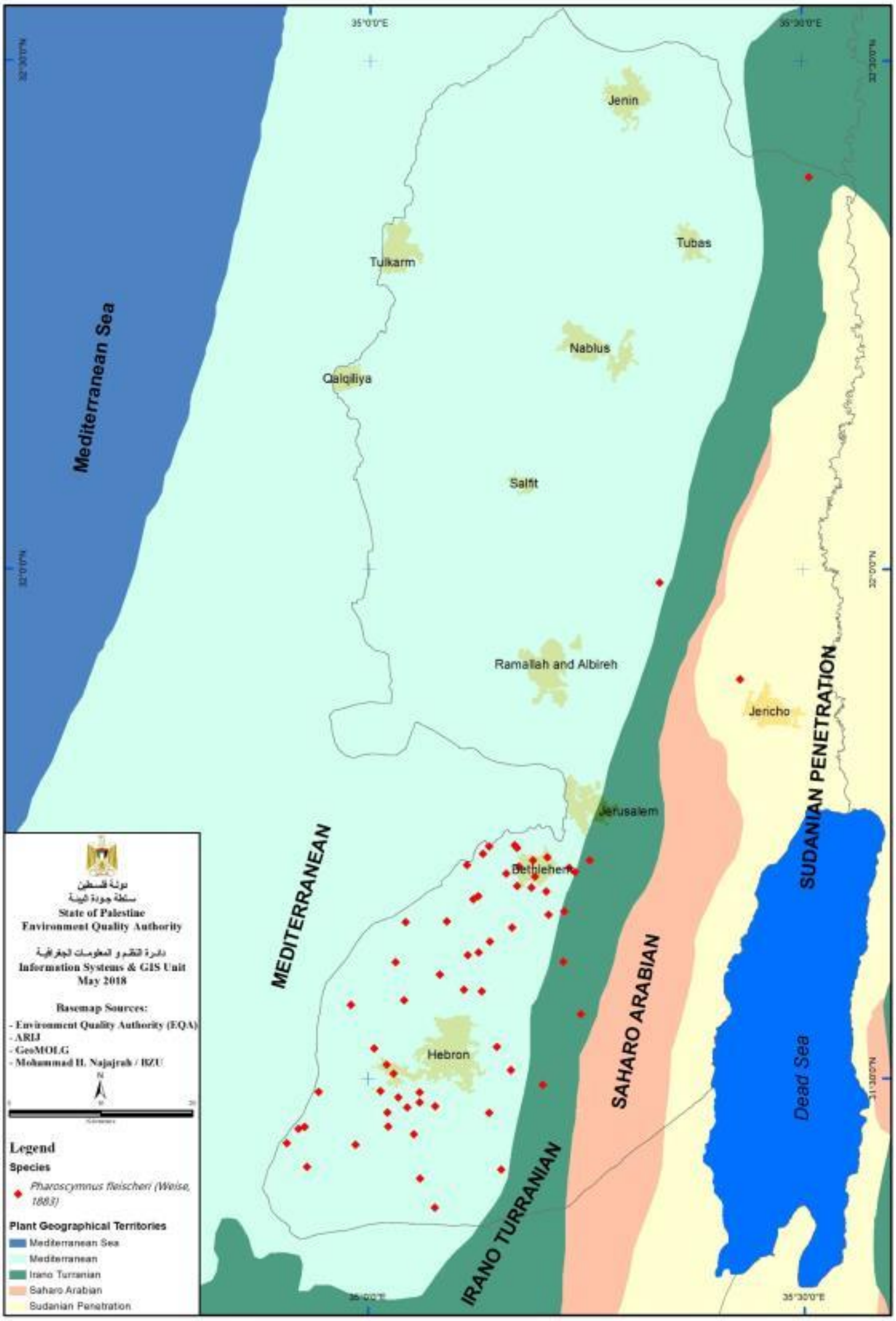

Figure 68. Geographical distribution map of *Pharoscymnus fleischeri*.

Serangium parcesetosum (Sicard, 1929), (Fig. 69)

Material: Ein Al-Duok Al foqa (Field#105, 41, 4 March 2018).

Remarks: Previously *Serangium parcesetosum,* was introduced in our region in 1989 (Agrov 1994; Mendel et al., 2017). Our specimens seemed closer to *montazerii* in morphology, but the preparation for reproductive organs confirmed that the sample is *Serangium parcesetosum*. During this study, it was found in one site in a high density on *Ligustrum* plant infested with scale insects (Fig 70). *Serangium* species (unidentified by the authors) was also noted feeding on *Bemisia tabaci* (Asiimwe et al. 2007).

Figure 69. *Serangium parcesetosum* (Sicard 1929).

Scale bar = 2mm.

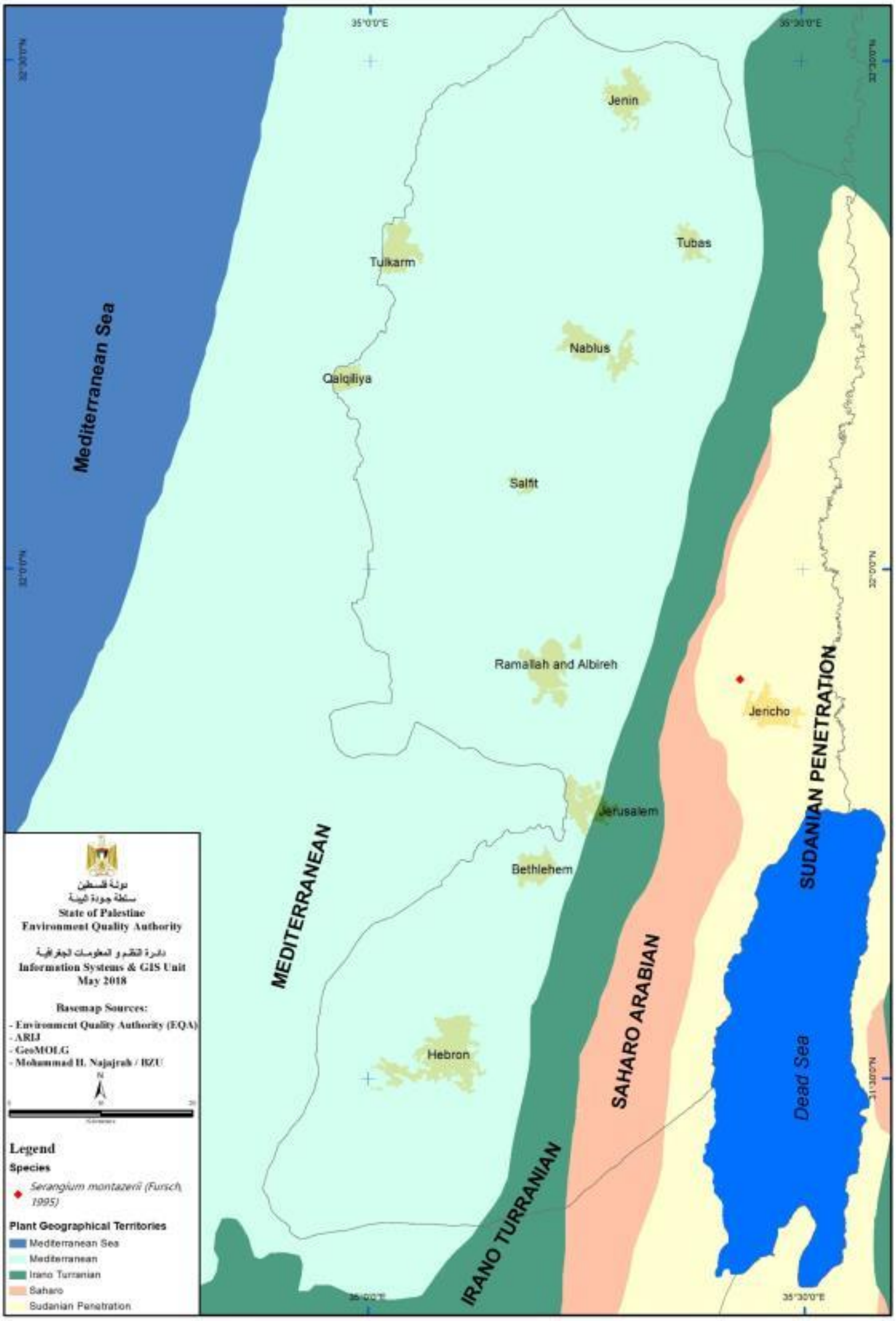

Figure 70. Collection site of *Serangium parcesetosum* in the Jordan Valley

Subfamily Coccidulinae

Coccidulinae represented by one coccidophagous species from the tribe coccidulini.

Tribe Coccidulini

Rhyzobius (Lindorus) lophanthae (Blaisdell, 1892), (Fig. 71)

Material: Bayt Jala 1 (Field#160, 1, 22 March 2018). Khallet Hamad (Field#281, 10, 27 March 2018). Bethlehem 2 (Field#433, 2, 2 April 2018). Al-Kum (Field#483, 4, 5 April 2018). Bethlehem 1 (Field#553, 1, 1 April 2018). Hadab al Fawar (Field#627, 32, 12 April 2018). Al Buweib (Field#684, 2, 9 April 2018).

Remarks: *Rhyzobius lophanthae* is one of the most important predators of scale insects on date palm trees in Palestine (Kehat, 1967). It's a highly predatory species for *Chrysomphalus dictyospermi* (Branco et al., 2017). It was reported from Palestine before (Halperin et al. 1995). During this study, it was recorded from seven localities in the south of the West Bank (Fig. 72).

Figure 71. *Rhyzobius (Lindorus) lophanthae* (Blaisdell, 1892).

Scale bar = 3mm.

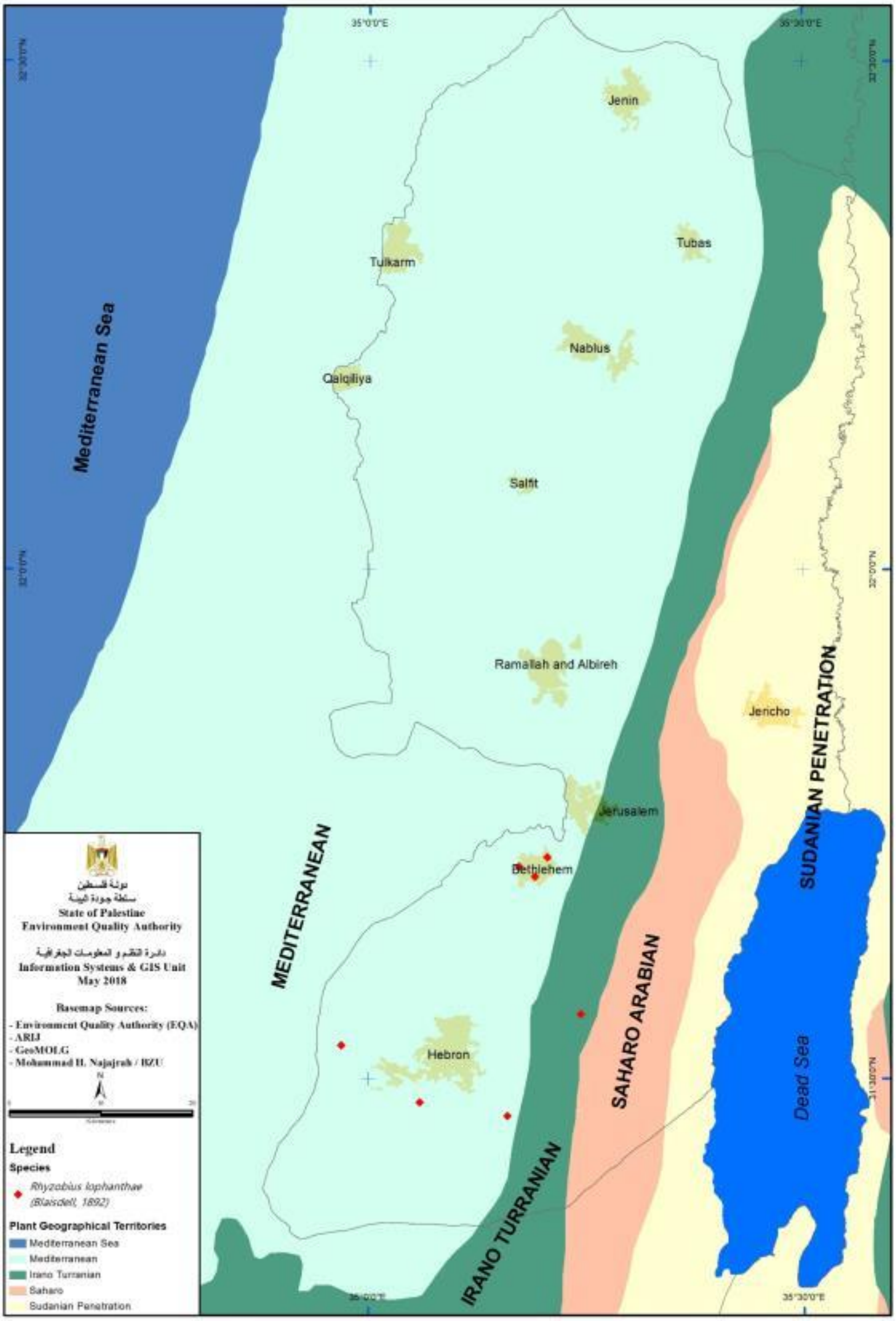

Figure 72. Geographical distribution map of *Rhyzobius (Lindorus) lophanthae*.

Subfamily Ortaliinae

Ortaliinae is represented by one introduced species from the tribe Noviini

Tribe Noviini

Rodolia cardinalis (Mulsant, 1850), (Fig. 73)

Material: Kufr al-Dik (Field#14, 2, 1 October 2017). Ad-Dhahiriya 2 (Field#350, 1, 5 April 2018). Bethlehem 1 (Field#401, 1, 1 April 2018). Wadi Kelt (Field#575, 1, 16 April 2018).

Remarks: This is one of three species from our collection of 35 species of Coccinellids that was introduced and it was one of the earliest to be introduced in 1912 (Mendel, 2017). It was reported from Palestine before as an introduced species (Halperin et al., 1995). It was observed In Kufr al-Dik and Ad-Dhahiriya 2 it was oserved feedingfeeding on *Icerya purchase* (Fig. 74).

Figure 73. *Rodolia cardinalis* (Mulsant, 1850).

Scale bar = 3mm.

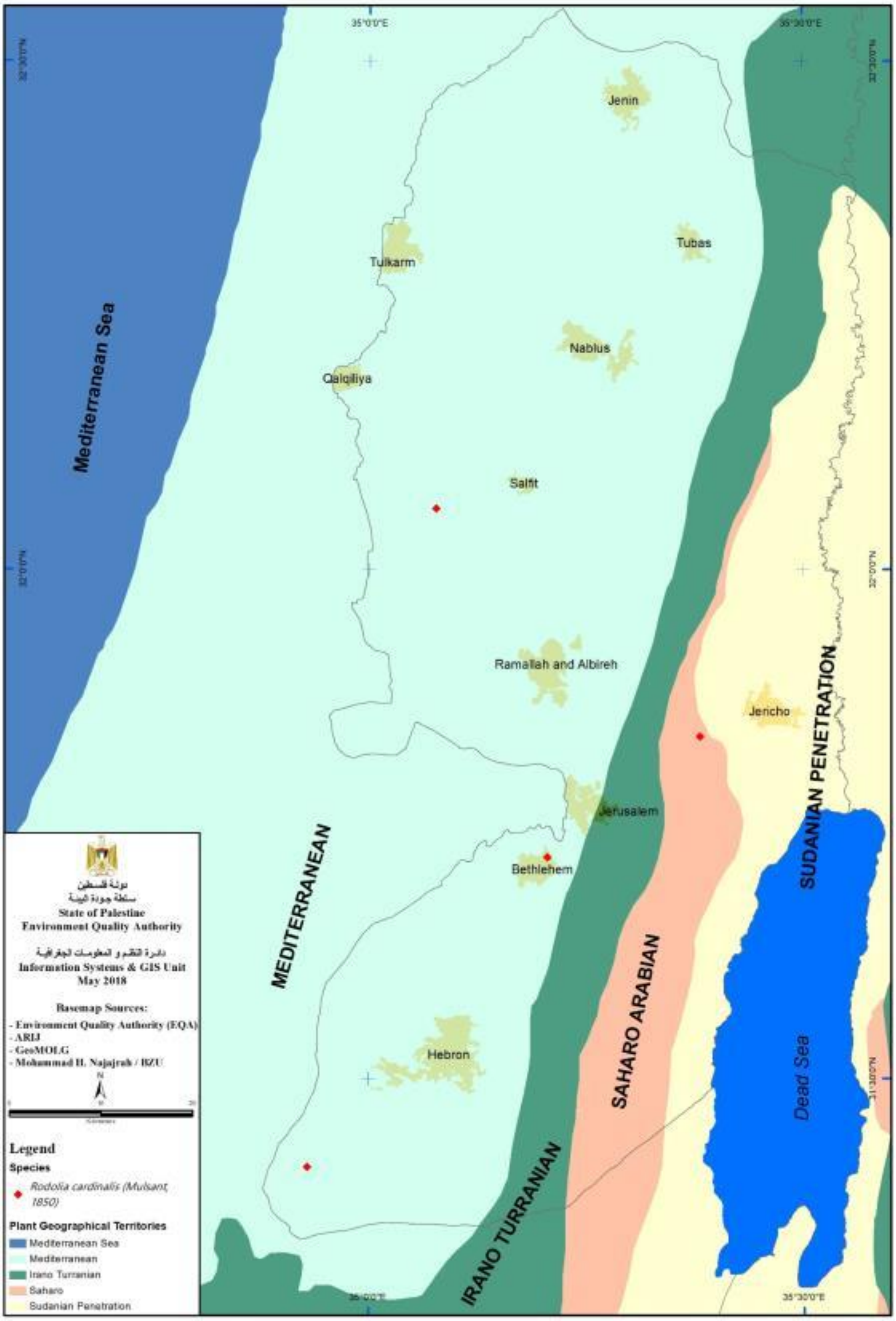

Figure 74. Geographical distribution map of *Rodolia cardinalis*.

4.2. Summary of Results

In total, 35 species in 19 genera belonging to 10 tribes representing 6 Subfamilies of lady beetles were identified from the the West Bank of Palestine. Specimens were categorized according to rarity (Table 5). Six species were found in 26 or more localities (one, *Coccinella (Coccinella) septempunctata,* was found in the highest number of localities, 99). Ten species were noted in 6 to 25 localities and nineteen species were noted in five or less localities (Table 5).

Table 5. List of the lady beetles that have been collected from the West Bank during the present study. c: common (26-99 records), r: rare (6-25 records), rr: very rare (1-5 records).

Subfamily	Tribe	Species	Rarity
Coccinellinae	Coccinellini	*Adalia (Adalia) decempunctata (Linnaeus, 1758)*	*c*
		Cheilomenes propinqua nilotica (Mulsant, 1850)	*rr*
		Coccinella (Coccinella) septempunctata (Linnaeus, 1758)	*c*
		Coccinella (Neococcinella) undecimpunctata (Linnaeus, 1758)	*r*
		Harmonia quadripunctata (Pontoppidan, 1763)	*rr*
		Hippodamia (Adonia) variegata (Goeze, 1777)	*c*
		Oenopia conglobata (Linnaeus, 1758)	*c*
Chilocorinae	Chilocorini	*Chilocorus bipustulatus (Linnaeus, 1758)*	*r*
		Exochomus nigromaculatus (Goeze, 1777)	*rr*
		Exochomus pubescens (Kuster, 1848)	*r*
		Exochomus quadripustulatus (Linnaeus, 1758)	*r*
	Platynaspini	*Platynaspis luteorubra (Goeze, 1777)*	*rr*
Scymninae	Hyperaspidini	*Hyperaspis polita (Weise, 1885)*	*rr*
		Hyperaspis syriaca (Weise, 1885)	*rr*
	Scyminini	*Cryptolaemus montrouzieri (Mulsant, 1853)*	*rr*
		Nephus (Bipunctatus) bipunctatus (Kugelann, 1794)	*rr*
		Nephus crucifer (Fleischer, 1900)	*rr*
		Nephus (Sidis) hiekei (Fursch, 1965)	*rr*
		Nephus peyerimhoffi (Sicard, 1923)	*rr*
		Nephus (Nephus) quadrimaculatus (Herbst, 1783)	*c*
		Scymnus flavicollis (Redtenbacher, 1843)	*rr*
		Scymnus (Parapullus) abietis (Paykull, 1798)	*rr*
		Scymnus (Scymnus) interruptus (Goeze, 1777)	*rr*
		Scymnus (Neopullus) limbatus (Stephens, 1831)	*rr*
		Scymnus nigropictus (Wollaston, 1867)	*rr*
		Scymnus (Scymnus) pallipediformis (Gunther, 1958)	*r*
		Scymnus (Pullus) subvillosus (Goeze, 1777)	*r*
		Scymnus (Pullus) suturalis (Thunberg, 1795)	*r*
		Scymnus syriacus (Marseul, 1868)	*r*
		Diomus anemicus (Fursch, 1960)	*rr*

Sticholotidinae	Stethorini	*Stethorus gilvifrons (Mulsant, 1850)*	*r*
	Sticholotidini	*Pharoscymnus fleischeri (Weise, 1883)*	*c*
	Serangiini	*Serangium parcesetosum (Sicard, 1929)*	*rr*
Coccidulinae	Coccidulini	*Rhyzobius lophanthae (Blaisdell, 1892)*	*r*
Ortaliinae	Noviini	*Rodolia cardinalis (Mulsant, 1850)*	*rr*

5. Discussion

5.1. Overview of Findings

This study documented the presence of 35 species of Coccinellidae in 19 genera belonging to 10 tribes and 6 subfamilies from the the West Bank (mainly south) and the Jordan Valley. Seven species (mostly very rare) out of the 35 were recorded for the first time in this area (Table 6). One species that was introduced to Palestine in 1986 (*Nephus peyerimhoffi*) was not able to acclimatize decleared as disappeared was recorded from 3 localities during this study.

Table 6. List of species recorded for the first time in historic Palestine during this study. Commonness symbols as in Table 5.

Species	Commonness
Nephus (Bipunctatus) bipunctatus (Kugelann, 1794)	rr
Nephus crucifer (Fleischer, 1900)	rr
Scymnus (Parapullus) abietis (Paykull, 1798)	rr
Scymnus (Scymnus) interruptus (Goeze, 1777)	rr
Scymnus (Neopullus) limbatus (Stephens, 1831)	rr
Scymnus nigropictus (Wollaston, 1867)	rr
Scymnus (Pullus) suturalis (Thunberg, 1795)	r

Six species were recorded as common species in the study area: *Adalia (Adalia) decempunctata, Coccinella (Coccinella) septempunctata, Hippodamia (Adonia) variegata, Oenopia conglobata, Nephus (Nephus) quadrimaculatus,* and *Pharoscymnus fleischeri.*

Nineteen species were recorded as very rare species recorded from five or less localities: *Cheilomenes propinqua nilotica, Exochomus nigromaculatus, Harmonia quadripunctata,* *Platynaspis luteorubra, Hyperaspis polita, Hyperaspis syriaca, Cryptolaemus montrouzieri, Nephus (Bipunctatus) bipunctatus, Nephus crucifer, Nephus (Sidis) hiekei, Nephus peyerimhoffi, Scymnus flavicollis, Scymnus (Neopullus) limbatus, Scymnus nigropictus, Scymnus (Parapullus) abietis, Scymnus (Scymnus) interruptus, Diomus anemicus, Serangium parcesetosum*, and *Rodolia cardinalis.*

While more remains to be done on ladybeetles, this study is the most comprehensive in the West Bank. It illustrates the very rich biodiversity due to diverse habitats representing different climatic zones and four biogeographical regions.

5.2. Diversity and Distribution of Coccinellidae in the Targeted Area

Most species of the Coccinellids are considered as predators, which has attracted the attention of many researchers and scientists to study and use them in the biological control strategies (Salehi et al., 2011). Where the prey is abundant, Coccinellids will lay more eggs, increase in numbers and increase their efficiency in biological control (Evans, 2003). Resource limitation, environmental conditions and competition are the causal factors in the reduction of their numbers (Sloggett & Majerus, 2000). Palestine is characterized by a great variation in topography and climate. It belongs to the sub-tropical zone and the climate is mostly of Mediterranean type with a long hot and dry summer, short cool and rainy winter. This appropriate environment provides an opportunity for the existence of much appropriate prey. This helps to increase the diversity and the spread of the lady beetles in Palestine. Because the existence of the coccinellide species is determined by the presence of their prey and the suitable environment, coccinellids show a great increase in the environment once these conditions are fulfilled. Among the common species, *Coccinella septempunctata* is the most widely distributed and common species in the study area and found mostly feeding on the aphids on both wild plants and agricultural crops in the Mediterranean and semi-arid regions.

Adalia (Adalia) decempunctata was observed on almond and pine trees in the agricultural lands and *Oenopia conglobate* mostly feeding on the aphids of almond trees in agricultural and residential areas. *Pharoscymnus fleischeri* was noted in coniferous woods especially *Cupressus* trees. Some species occupied many types of habitat such as *Coccinella (Coccinella) septempunctata* while others were more restricted in their habitat such as *Hyperaspis syriaca.*

Mediterranean Zone Species

Twenty-nine species of Coccinellide were found to inhabit various habitats within the Mediterranean zone (Table 7), comprising about 83% of the total recorded species in the study area, this may be due to the fact that the rainfall rate in this region is high and the temperature is moderate (Isaac, 2002) which helped increase the vegetation cover and agricultural practices, thes is reflected in provide suitable conditions and food richense for the lady beetles. Among these 29 species, ten were restricted to the Mediterranean zone. Only one species were shared between the Mediterranean and the Irano-Turanian zone (*Rhyzobius lophanthae*), two with Saharo Arabian zone (*Rodolia cardinalis and Scymnus (Pullus) suturalis)* and five with Sudanian zone (*Adalia (Adalia) decempunctata, Coccinella (Neococcinella) undecimpunctata, Exochomus pubescens, Nephus crucifer* and *Nephus peyerimhoffi).* Five species were recorded from all zones (*Coccinella (Coccinella) septempunctata, Hippodamia (Adonia) variegate, Oenopia conglobate, Scymnus (Scymnus) pallipediformis* and *Stethorus gilvifrons* which are aphidophagous species and have wide range of preys. Coccidulinae and Ortaliinae subfamilies were represented by a single species for each subfamily in our area, while subfamily Sticholotidinae were exemplified by two species (Table 7). With annual rainfall of 400-800 mm the Mediterranean zone has a rich vegetation cover with plants like quercus and pistachio and a diversity of the shrubs and grasses. The existence of sufficient water in the northern and western water aquifers and abundance of springs gives resources for rich agriculture and plant production resulting in a large diversity of Coccinellidae. Many of the species recorded from the West Bank of Palestine are found in Turkey and southern Europe (which share similar climate and vegetation).

Irano-Turanian Zone Species

The Coccinellide fauna of the Irano-Turanian zone consisted of 10 species, with one shared with the Mediterranean (*Rhyzobius lophanthae*), two species shared with the Mediterranean and the Saharo Arabian (*Nephus quadrimaculatus* and *Pharoscymnus fleischeri*) and one shared with Saharo Arabian and Sudanian Penetration zones (*Scymnus interruptus)*. The other six species were shared with the Mediterranean, Saharo-Arabian, and Sudanian Penetration zones (Table 7). *Nephus (Bipunctatus) bipunctatus* was the only distinctive species for this zone. Coccinellids can move from the humid Mediterranean to the edges of the semi-arid Irano-Turanian zone.

Saharo-Arabian Zone Species

Fourteen species were found to inhabit this semi-arid to arid zone (Table 7). This zone was represented by xeric species such as *Coccinella (Coccinella) septempunctata* and *Oenopia conglobata*. Other desert dwelling species associated with this zone include *Cryptolaemus montrouzieri*, *Scymnus (Scymnus) interruptus, Scymnus flavicollis and Scymnus syriacus. Hyperaspis syriaca* was the only distinctive species for this zone. *Coccinella (Coccinella) septempunctata*, *Hippodamia (Adonia) variegata* and *Oenopia conglobata* were the most common species and were found in high densities distributed in deserts with 200 mm annual rainfall in the southeastern areas of the Palestinian Territories.

Sudanian Penetration Zone Species

Nineteen species were recorded from this zone (Table 7). The southern part of the Sudanian zone around the Dead Sea basin harbored species such as *Coccinella (Coccinella)* *septempunctata*, *Hippodamia (Adonia) variegate* and *Stethorus gilvifrons* as the dominant species.

Table 7. Lady beetles in South of the west Bank and the Jordan Valley of Palestine according to their biogeographic zones.

Subfamily	Species	M	IT	SA	S
Coccinellinae	*Adalia (Adalia) decempunctata*	•			•
	Cheilomenes propinqua nilotica	•			
	Coccinella (Coccinella) septempunctata	•	•	•	•
	Coccinella (Neococcinella) undecimpunctata	•			•
	Harmonia quadripunctata	•			
	Hippodamia (Adonia) variegata	•	•	•	•
	Oenopia conglobata	•	•	•	•
Chilocorinae	*Chilocorus bipustulatus*	•			
	Exochomus nigromaculatus	•			
	Exochomus pubescens	•			•
	Exochomus quadripustulatus	•			
	Platynaspis luteorubra	•			
Scymninae	*Hyperaspis polita*	•			
	Hyperaspis syriaca			•	
	Cryptolaemus montrouzieri			•	•
	Nephus (Bipunctatus) bipunctatus		•		
	Nephus crucifer	•			•
	Nephus (Sidis) hiekei	•			
	Nephus peyerimhoffi	•			•
	Nephus (Nephus) quadrimaculatus	•	•		•
	Scymnus flavicollis	•		•	•
	Scymnus (Parapullus) abietis	•			
	Scymnus (Scymnus) interruptus		•	•	•
	Scymnus (Neopullus) limbatus	•			
	Scymnus nigropictus			•	•
	Scymnus (Scymnus) pallipediformis	•	•	•	•
	Scymnus (Pullus) subvillosus	•		•	•
	Scymnus (Pullus) suturalis	•		•	
	Scymnus syriacus	•		•	•
	Diomus anemicus	•			
	Stethorus gilvifrons	•	•	•	•
Sticholotidinae	*Pharoscymnus fleischeri*	•	•		•
	Serangium parcesetosum				•
Coccidulinae	*Rhyzobius lophanthae*	•	•		
Ortaliinae	*Rodolia cardinalis*	•		•	

Note: M = Mediterranean, IT = Irano-Turanian, SA = Saharo Arabian, S = Sudanian.

Soto-Berelov et al. (2015) did a detailed modeling study that revised the margins and maps of the phytogeographical zones in Palestine and nearby Jordan based on detailed studies of plants adding one biogeographical zone (see Fig. 75 and compare with Fig. 1). According to Soto-Berelov et al. (2015), the "Coastal Mediterranean" zone is found in southern Palestine and has increased its size significantly in the past 5000 years. The nuances of this map may actually reflect better the distribution of coccinellids than the simplified maps based on Zohary's work. Further Soto-Berelov et al. (2015) modeled changes in 200 year intervals in boundaries of the zones and noted that the Saharo Arabian and Irano-Turanian zones expanded on the expense of the Mediterranean zones with two major episodes (likely climatic related) happening at 4200 BP and 3000 BP. This again may explain distribution of certain Coccinellids and other fauna in our region. For example, the current distribution of *Scymnus (Pullus) suturalis* (Fig. 60) likely follows an Irano-Turanian distribution that has now invaded two other biogeographical zones (Mediterranean and Saharo Arabian). However, many species of Coccinellids in our study were noted to feed on a diversity of aphids of planted crops and so, showed distribution related to availability of these plants for aphids. Future studies may be needed to assess aphid species distributions and correlate that with Coccinellid presence.

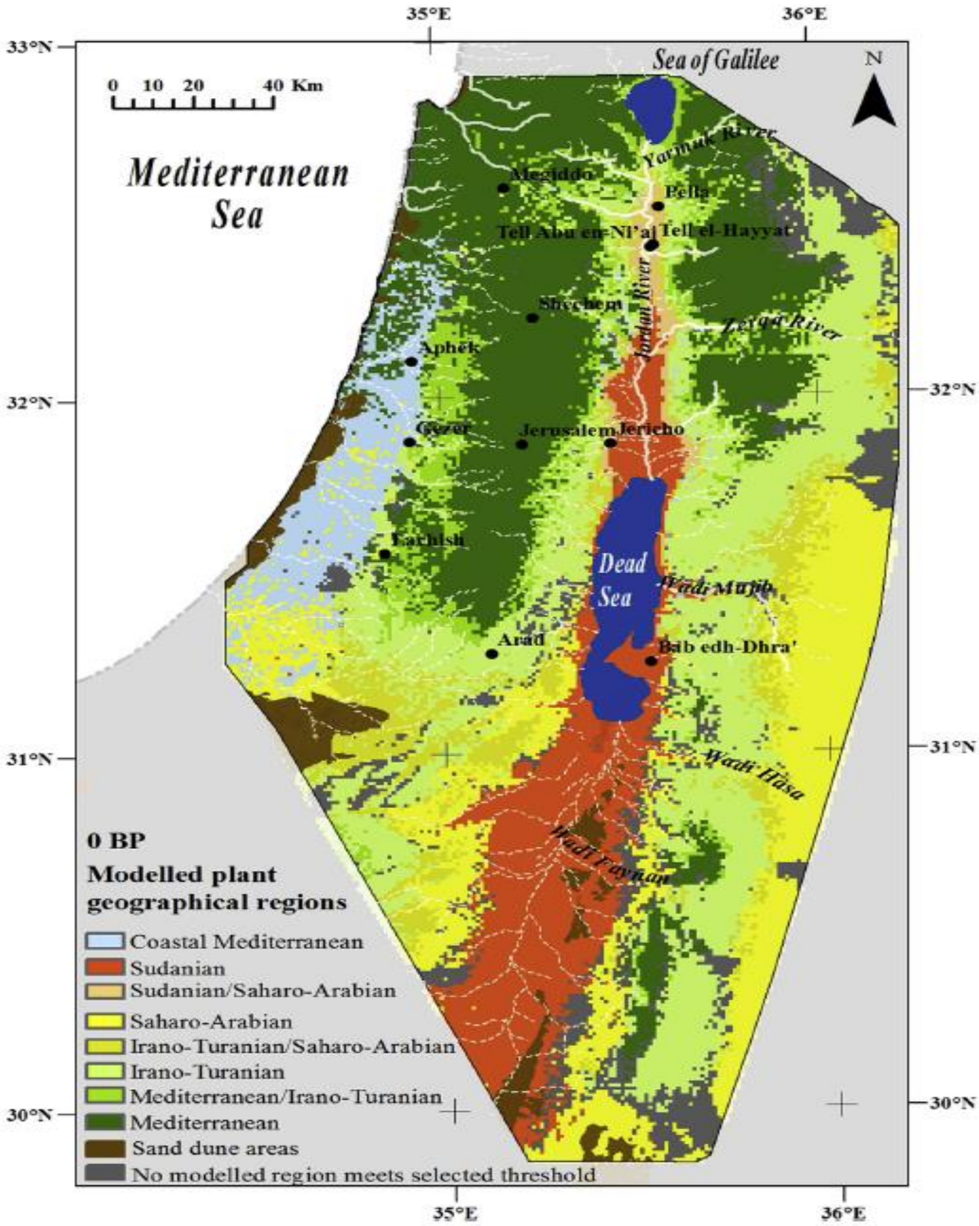

Figure 75. Revised biogeographical zones of Palestine and Jordan (Soto-Berelov et al. 2015)

Another peculiarity of the distributions is the presence of remarkably high number of coccinellid species in certain localities. For example, the locality labelled “Bethlehem 1” were found to contain 15 species of coccinellids comprising 42.8 % of the total species recorded in the present study (Table 8). One of the explanations we have for this richness is that it was isolated for decades from the surrounding communities and there was no use of pesticides/insecticides in the area noting that this area contains olive trees, almond, lemon, cypress, pine, apple, pear, grapes, carob, willow and rosemary as well as many wild plants that were planted during the past two years, such as hawthorn, oak and wild pear in addition to planting some vegetable crops without using pestesids. The other potential reason for richness of the Bethlehem 1 locality is the presence of the botanical garden of the Palestine Institute of Biodiversity and Sustainability (Palestine Museum of Natural History, palestinenature.org). So here, we may have paid closer attention to the local fauna and flora and maybe some specimens were accidentally introduced during collection trips or on plants brought into the facility. The next richest localities (Ein Samiya and Dahriya 1) also had little use of pesticides/insecticides

Table 8. The richest regions of Coccinellids in the study area

Locality	Species	Commonness	Nots
Bethlehem 1	*Adalia (Adalia) decempunctata*	C	
	Coccinella (Coccinella) septempunctata	C	
	Oenopia conglobate	C	
	Harmonia quadripunctata	rr	
	Exochomus nigromaculatus	rr	
	Nephus peyerimhoffi	rr	Introduced species
	Nephus (Nephus) quadrimaculatus	C	
	Scymnus flavicollis	rr	
	Scymnus (Parapullus) abietis	rr	First record
	Scymnus (Pullus) suturalis	r	First record
	Platynaspis luteorubra	rr	
	Diomus anemicus	rr	
	Pharoscymnus fleischeri	C	
	Rhizobius lophanthae	r	
	Rodolia cardinalis	rr	Introduced species
Ein Samiya	*Adalia (Adalia) decempunctata*	C	
	Coccinella (Coccinella) septempunctata	C	
	Oenopia conglobate	C	
	Chilocorus bipustulatus	r	
	Nephus (Nephus) quadrimaculatus	C	
	Scymnus (Parapullus) abietis	rr	First record
	Scymnus (Pullus) suturalis	r	First record
	Scymnus syriacus	r	
	Pharoscymnus fleischeri	C	
Ad-Dhahiriya 2	*Adalia (Adalia) decempunctata*	C	
	Coccinella (Coccinella) septempunctata	C	
	Oenopia conglobate	C	

	Nephus (Nephus) quadrimaculatus	C	
	Scymnus (Pullus) suturalis	r	First record
	Stethorus gilvifrons	r	
	Pharoscymnus fleischeri	C	
	Rodolia cardinalis	rr	Introduced species
Bayt Jala 2	*Adalia (Adalia) decempunctata*	C	
	Coccinella (Coccinella) septempunctata	C	
	Hippodamia (Adonia) variegata	C	
	Oenopia conglobate	C	
	Nephus (Nephus) quadrimaculatus	C	
	Stethorus gilvifrons	r	
	Pharoscymnus fleischeri	C	
Bethlehem 2	*Coccinella (Coccinella) septempunctata*	C	
	Oenopia conglobate	C	
	Chilocorus bipustulatus	r	
	Exochomus quadripustulatus	r	
	Nephus (Nephus) quadrimaculatus	C	
	Pharoscymnus fleischeri	C	
	Rhizobius lophanthae	r	
Deir Krntl 1	*Adalia (Adalia) decempunctata*	C	
	Coccinella (Coccinella) septempunctata	C	
	Exochomus pubescens	r	
	Nephus peyerimhoffi	rr	Introduced species
	Scymnus flavicollis	rr	
	Scymnus syriacus	r	
	Stethorus gilvifrons	r	
Irtas 1	*Coccinella (Coccinella) septempunctata*	C	
	Chilocorus bipustulatus	r	
	Hyperaspis polita	rr	
	Nephus (Nephus) quadrimaculatus	C	
	Scymnus (Scymnus) pallipediformis	r	
	Scymnus (Pullus) suturalis	r	First record
	Pharoscymnus fleischeri	C	
Jericho 1	*Coccinella (Coccinella) septempunctata*	C	
	Oenopia conglobate	C	
	Nephus crucifer	rr	First record
	Scymnus (Scymnus) interruptus	rr	First record
	Scymnus nigropictus	rr	First record
	Scymnus syriacus	r	
	Stethorus gilvifrons	r	

Of the 35 species of coccinellids recordedfrom the West Bank during this study, four were introduced species (*Rodolia cardinalis*, *Nephus peyerimhoffi*, *Serangium parcesetosum* and

Cryptolaemus montrouzieri). All four were very rare species (found in 5 or less localities). Perhaps this is related to their low adaptability to local climate and habitats and competition with native ones. In Palestinian areas behind the 1948 greenline, 24 species out of 90 were introduced species but many did not get well-established (Mendel et al. 2017). The discrepancy in percentage of introduced species (11.4% versus 26.6%) may have to do with the simple fact that the introductions were done by the Israelis in the 1948 areas and many of those did not or could not spread to the parts of the West Bank that we studied.

Globally Coccinellid introductions were common but percentage of establishment varied. For example, of 179 species introduced in Canada and the USA, only 27 got established (Honek, 2015). However, established introduced species are known to occasionally displace native species of coccinellidae (Honek, 2015).

5.3. Ecological Observations

All species recorded during the study are useful species that feed on agricultural pests such as aphids and scale insects. The large diversity of Coccinellids in the study area is particularly important in reducing the spread of agricultural pests while maintaining ecological balance and biodiversity. The following are some observations that were recorded in the farms where pesticides are used:

- The heavy use of pesticides in farms has resulted in the elimination of many of the natural enemies in these farms and increased the operations of infected pests that have developed resistance to these pesticides.
- Lady beetles were mostly found on weeds surrounding the farms not on plants inside the farm. This shows that the use of pesticides in farms causes ladybeetles to escape to farm edges where vegetation should not be sprayed.

- The presence of some trees such as *Ligustrum*, *Cupressus* and almond trees in some of the farms has been noted and the presence of ladybeetles on these trees was recorded during the use of pesticides in the farms.
- *Coccinella (Coccinella) septempunctata and Hippodamia (Adonia) variegata* two species found in the state of mating and development on barley in the farms or located on the borders of farms, which shows the possibility of planting these plants in the farm as a factor attractive to these species to mating and development.
- The farms that used a polyculture system have more diversity of lady beetles than the farms that have monoculture systems.

Honek (2015) showed impact of climatic changes on habitats and distributions of Coccinellids. Considering the significant climatic changes in our region in the past 5000 years (Soto-Berelov et al. 2015) and the acceleration of the changes due to human induced climatic changes here (e.g. Sowers et al., 2011), we anticipate there may indeed have been past and will be future changes in distribution and abundance of Coccinellids in Palestine. Our data may work as a baseline date to compare with new studies in the future to assess such changes.

6. Conclusions

1. In total, 35 species in 19 genera belonging to 10 tribes representing 6 Subfamilies of ladybeetles were identified from the south of the West Bank and the Jordan Valley of Palestine.
2. Seven species identified represent **new records** of lady beetles from the West Bank.
3. One species that was introduced to Palestine in 1986 (*Nephus peyerimhoffi*) and declared as disappeared because it did not acclimatize was recorded in this study from 3 localities.
4. Of the 35 species of coccinellids identified, four were introduced species (*Rodolia cardinalis, Nephus peyerimhoffi, Serangium parcesetosum and Cryptolaemus montrouzieri*); the remaining 31 were local.
5. Six species collected during this study were recorded as **common species** (found in twenty-six localities or more). These were *Adalia (Adalia) decempunctata, Coccinella (Coccinella) septempunctata, Hippodamia (Adonia) variegata, Oenopia conglobata, Nephus (Nephus) quadrimaculatus and Pharoscymnus fleischeri.*
6. Ten species recorded during this study were considered **rare** (found in 6-25 localities). These were *Coccinella (Neococcinella) undecimpunctata, Rhyzobius lophanthae, Stethorus gilvifrons, Scymnus syriacus, Scymnus (Pullus) suturalis, Scymnus (Pullus) subvillosus, Scymnus (Scymnus), Exochomus quadripustulatus pallipediformis, Chilocorus bipustulatus, Exochomus pubescens*
7. The remaining nineteen species collected during this study were recorded as **very rare species** (found in less than five localities). These were *Cheilomenes propinqua nilotica, Exochomus nigromaculatus, Harmonia quadripunctata, Platynaspis luteorubra, Hyperaspis polita, Hyperaspis syriaca, Cryptolaemus montrouzieri, Nephus (Bipunctatus) bipunctatus, Nephus crucifer, Nephus (Sidis) hiekei, Nephus*

peyerimhoffi, Scymnus flavicollis, Scymnus (Neopullus) limbatus, Scymnus nigropictus, Scymnus (Parapullus) abietis, Scymnus (Scymnus) interruptus, Diomus anemicus, Serangium parcesetosum and *Rodolia cardinalis.*

8. Distributions of coccinellids roughly follow the biogeographical zones of the West Bank as initially established by Zohary and modified by Soto-Berelov et al. (2015).
9. Twenty-nine species (83%) were recorded from the Mediterranean zone with 10 of them restricted to this zone.
10. Ten species were recorded in the Irano-Turranean zone with *Nephus (Bipunctatus) bipunctatus as the* distinctive species for this zone.
11. The Saharo-Arabian zone was inhabited by 14 species with *Hyperaspis syriaca* as the distinctive species for this zone.
12. The Sudanian Penetration zone was inhabited by 9 species with *Serangium parcesetosum* as the distinctive species.
13. Five species of lady beetles were recorded in the four phytogeographical zones (*Stethorus gilvifrons, Scymnus (Scymnus) pallipediformis, Oenopia conglobate, Hippodamia (Adonia) variegate, Coccinella (Coccinella) septempunctata*).
14. The most common species of lady beetles from the West Bank was *Coccinella (Coccinella) septempunctata* (Recorded from 39% of localities visited).
15. All species recorded during the study are useful species that feed on agricultural pests such as aphids and scale insects.
16. The large diversity of Coccinellids in the study area is particularly important in reducing the spread of agricultural pests.

7. Recommendations

1. Further studies covering the middle and northern parts of the West Bank are needed to cover the whole area and record all species of lady beetles present.
2. The rich biodiversity of Coccinellids in Palestine indicates the possibility of successful application of biological pest control straegies.
3. Ministry of Agriculture and the environmental institutions should excute awareness campaigns that target farmers in order to reduce the use of pesticides and allow ladybeetles to spread and reproduce. Farmers showed great acceptance of biological control.
4. More studies are recommended to investigate other biological and ecological aspects of lady beetles that are not covred by this study and important for using lady beetles in biological control (e.g. diet specificity and rearing of potential of useful local species for integrated pest management).

8. References

Abu Nasr, A. (1956). Coccinelles du Liban. Minster de I'agiculture. Liban.

Abusarhan, M. A., Handal, E. N., Ghattas, M. M., Amr, Z. S., & Qumsiyeh, M. B. (2016). Some records of butterflies (Lepidoptera) from the Palestinian Territories. *Jordan Journal of Biological Sciences*, *9*(1), 11-23.

Abusarhan, M., Amr, Z. S., Ghattas, M., Handal, E. N., & Qumsiyeh, M. B. (2017). Grasshoppers and locusts (Orthoptera: Caelifera) from the Palestinian territories at the Palestine Museum of Natural History. *Zoology and Ecology*, *27*(2), 143-155.

Adawi, S. H., Qasem[1], K. R., Zawahra, M. M., & Handal, E. N. (2017). On some Records of Dragonflies (Insecta: Odonata: Anisoptera) from the West Bank (Palestine). *Jordan Journal of Biological Sciences (JJBS)*, 151.

Adedipe, F., & Park, Y. L. (2010). Visual and olfactory preference of Harmonia axyridis (Coleoptera: Coccinellidae) adults to various companion plants. *Journal of Asia-Pacific Entomology*, *13*(4), 319-323.

Adriaens, T., San Martin y Gomez, G., Bogaert, J., Crevecoeur, L., Beuckx, J. P., & Maes, D. (2015). Testing the applicability of regional IUCN Red List criteria on ladybirds (Coleoptera, Coccinellidae) in Flanders (north Belgium): opportunities for conservation. *Insect Conservation and Diversity*, *8*(5), 404-417.

Agarwala, B. K., Singh, T. K., Lokeshwari, R. K., & Sharmila, M. (2009). Functional response and reproductive attributes of the aphidophagous ladybird beetle, *Harmonia dimidiata* (Fabricius) in oak trees of sericultural importance. *Journal of Asia-Pacific Entomology*, *12*(3), 179-182.

Agarwala, B. K., Yasuda, H., & Sato, S. (2008). Life history response of a predatory ladybird, *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae), to food stress. *Applied Entomology and Zoology*, *43*(2), 183-189.

Aktar, W., Sengupta, D., & Chowdhury, A. (2009). Impact of pesticides use in agriculture: their benefits and hazards. *Interdisciplinary toxicology*, *2*(1), 1-12.

Alemansoor, H., & Ahmadi, A. (1994). Natural enemies of cotton whitefly *Bemisia tabaci* (Gennadius) (Homoptera: aleyrodidae) in Fars province of Iran. *Iran Agricultural Research*, *13*(1), 67-76.

Alfieri, A. (1976). The Coleoptera of Egypt. Memoires de la Societe Entomologique d'Egypte, 5.

Ali, H. A., Abdul-Rassoul, M. S., & Swail, M. A. (1990). Systematic list of Coccinellidae recorded for Iraq. *Bulletin of the Iraq Natural History Museum*, *8*(3), 45-51.

Ali, M., Perveen, R., Naqvi, A. U. N., Ahmed, K., Raza, G., & Hussain, I. (2015). The Tribe Scymnini (Coccinellidae: Coleoptera) From Sindh Province, Pakistan. *Journal of Insect Science*, *15*(1).

Allawi, T. F. (1989). A list of predaceous Coccinellids collected in Jordan [record of the different Coccinellid species found in Jordan: immature stage; emergence in the adult stage]. *Dirasat*.

Almatni, W., & Khalil, N. (2008). A primary survey of aphid species on almond and peach, and natural enemies of *Brachycaudus amygdalinus* in As-Sweida, Southern Syria. In *Ecofruit-13th International Conference on Cultivation Technique and Phytopathological Problems in Organic Fruit-Growing: Proceedings to the Conference from 18thFebruary to 20th February 2008 at Weinsberg/Germany* (pp. 109-115).

Amr, Z. S., Handal, E. N., Bibi, F., Najajrah, M. H., & Qumsiyeh, M. B. (2016). Change in diet of the Eurasian eagle owl (*Bubo bubo*) suggests decline in biodiversity in Wadi Al Makhrour, Bethlehem Governorate, Palestinian Territories. *Slovak Raptor Journal*, *10*(1), 75-79.

Apak, F. K., & Aksit, T. (2016). Natural Enemies and Population Dynamics of the Blackmargined Aphid (*Monellia caryella* (Fitch) Aphididae, Hemiptera) on Pecan Trees in Aydin, Turkey. *Journal of the Entomological Research Society*, *18*(3), 49.

Argov, Y. (1994). The woolly whitefly, a new pest in Israel. *Alon Hanotea*, *48*(6), 290-292.

Ashfaque, M., Ullah, F., Rafi, M. A., & Naz, F. (2015). Taxonomic study of subfamily Scymninae (Coleoptera: Coccinellidae) with one new record from Gilgit-Baltistan, Pakistan. *Turkish Journal of Zoology*, *39*(6), 1034-1040.

Asiimwe, P., Ecaat, J. S., Guershon, M., Kyamanywa, S., Gerling, D., & Legg, J. P. (2007). Evaluation of *Serangium* n. sp. (Col., Coccinellidae), a predator of *Bemisia tabaci* (Hom., Aleyrodidae) on cassava. *Journal of Applied Entomology*, *131*(2), 76-80.

Belyakova, N. A., Pazyuk, I. M., Ovchinnikov, A. N., & Reznik, S. Y. (2016). The influence of temperature, photoperiod, and diet on development and reproduction in the four-spot lady beetle *Harmonia quadripunctata* (Pontoppidan) (Coleoptera, Coccinellidae). *Entomological Review*, *96*(1), 1-11.

Biale, H., Mendel, Z., & Soroker, V. (2017). Insects associated with the banana aphid *Pentalonia nigronervosa* Coquerel (Hemiptera: Aphididae) in banana plantations with special emphasis on the ant community. *Phytoparasitica*, *45*(3), 361-372.

Biranvand, A., Tomaszewska, W., Li, W., Nicolas, V., Shakarami, J., Fekrat, L., & Hesami, S. (2017). Review of the tribe Chilocorini Mulsant from Iran (Coleoptera, Coccinellidae). *ZooKeys*, (712), 43.

Bodenheimer, F.S. (1937). Prodromus Faunae Palaestinae. *Mem. Inst. Egypte* 33:1-286.

Bolu, H. (2007). Population Dynamics of Lacebugs (Heteroptera: Tingidae) and its Natural Enemies in Almond Orchards of Turkey. *Journal of the Entomological Research Society*, *9*(1).

Branco, B., Dalmau, L., Borges, I., & Soares, A. O. (2017). Life-history traits of the predator *Rhyzobius lophanthae* reared on the scale *Chrysomphalus dictyospermi*. *Bulletin of Insectology*, *70*(2), 231-235.

Brooks, T. M., Mittermeier, R. A., da Fonseca, G. A., Gerlach, J., Hoffmann, M., Lamoreux, J. F. & Rodrigues, A. S. (2006). Global biodiversity conservation priorities. *Science*, 313 (5783), 58-61.

Cabral, S., Soares, A. O., & Garcia, P. (2011). Voracity of *Coccinella undecimpunctata*: effects of insecticides when foraging in a prey/plant system. *Journal of Pest Science*, *84*(3), 373.

Canepari C. (2009). New data on some Coccinellidae (Coleoptera) from the Mediterranean Region. *Zootaxa*, *2318*(1), 394-399.

Canovai, R., Loni, A., Gandini, L., & Lucchi, A. (2014). Ladybirds in Tuscan vineyards (Coleoptera: Coccinellidae). *Integrated protection and production in Viticulture. IOBCWPRS Bulletin*, *15*, 241-244.

Chapin, E. A. (1965). Insects of Micronesia. *Coleoptera Coccinellidae. Insects of Micronesia*, *16*, 189-254.

Chapin, J. B. (1971). The Coccinellidae of Louisiana (Insecta: Coleoptera). *Louisiana Experiment Station Bulletin*. 682, 87.

Chen, X., Ren, S., & Wang, X. (2015). Contribution to the knowledge of the subgenus *Scymnus* (Parapullus) Yang, 1978 (Coleoptera, Coccinellidae), with description of eight new species. *Deutsche Entomologische Zeitschrift*, *62*, 211.

Conrad A. 2005. *Adalia bipunctata* als Beute von Gomphus flavipes (Coleoptera: Coccinellidae; Odonata: Gomphidae). *Libellula*. 24 (3), 237 – 239.

Corrêa, G. H., & Almeida, L. M. (2010). Revision of the genus *Harpasus* Mulsant (Coleoptera, Coccinellidae, Chilocorini). *Revista Brasileira de Entomologia*, *54*(3), 350-360.

Costamagna, A. C., & Landis, D. A. (2007). Quantifying predation on soybean aphid through direct field observations. *Biological Control*, *42*(1), 16-24.

Dreisbach, R. R. (1952). Preparing and photographing slides of insect genitalia. *Systematic Zoology*, *1*(3), 134-136.

Egerer, M. H., Bichier, P., & Philpott, S. M. (2017). Landscape and local habitat correlates of lady beetle abundance and species richness in urban agriculture. *Annals of the Entomological Society of America*, *110*(1), 97-103.

Eilenberg, J., Hajek, A., & Lomer, C. (2001). Suggestions for unifying the terminology in biological control. *BioControl*, *46*(4), 387-400.

EQA, (2015). State of Palestine Fifth National Report to the Convention on Biological Diversity. CBD

Escalona, H. E., Zwick, A., Li, H. S., Li, J., Wang, X., Pang, H., ... & Niehuis, O. (2017). Molecular phylogeny reveals food plasticity in the evolution of true ladybird beetles (Coleoptera: Coccinellidae: Coccinellini). *BMC Evolutionary Biology*, *17*(1), 151.

Eserkaya, E., & Karaca, İ. (2016). Population Development of *Ceroplastes floridensis* on Grapefruit and Oranges. *Asian Journal of Agriculture and Food Sciences (ISSN: 2321-1571)*, *4*(02).

Evans, E. W. (2003). Searching and reproductive behaviour of female aphidophagous ladybirds (Coleoptera: Coccinellidae): a review. *European Journal of Entomology*, *100*(1), 1-10.

Fallahzadeh, M., Japoshvili, G., & Saghaei, N. (2016). A contribution to the knowledge of the encyrtid wasps (Hymenoptera: Chalcidoidea, Encyrtidae) from southern Iran, with four new records. *Journal of Insect Biodiversity and Systematics*, *2*(3), 309-319.

Félix, S., & Soares, A. O. (2004). Intraguild predation between the aphidophagous ladybird beetles *Harmonia axyridis* and *Coccinella undecimpunctata* (Coleoptera: Coccinellidae): the role of body weight. *European Journal of Entomology*, *101*, 237-242.

Finlayson, C. J., Landry, K. M., & Alyokhin, A. V. (2008). Abundance of native and non-native lady beetles (Coleoptera: Coccinellidae) in different habitats in Maine. *Annals of the Entomological Society of America*, *101*(6), 1078-1087.

Fisher, T. W., Bellows, T. S., Caltagirone, L. E., Dahlsten, D. L., Huffaker, C. B., & Gordh, G. (Eds.). (1999). *Handbook of biological control: principles and applications of biological control*. Elsevier.

Fréchette, B., Dixon, A. F., Alauzet, C., Boughenou, N., & Hemptinne, J. L. (2006). Should aphidophagous ladybirds be reluctant to lay eggs in the presence of unsuitable prey? *Entomologia experimentalis et applicata*, *118*(2), 121-127.

Fursch, H. (1979). Insects of Saudi Arabia. Coleoptera: Fam. Coccinellidae. *Fauna Saudi Arabia*, *1*, 235-248.

Gambino, P. (1992). Yellowjacket (*Vespula pensylvanica*) predation at Hawaii Volcanoes and Haleakala National Parks: identity of prey items. *Hawaiian Entomological Society*, 31, 157-164.

Garzón, A., Medina, P., Amor, F., Viñuela, E., & Budia, F. (2015). Toxicity and sublethal effects of six insecticides to last instar larvae and adults of the biocontrol agents *Chrysoperla carnea* (Stephens)(Neuroptera: Chrysopidae) and *Adalia bipunctata* (L.)(Coleoptera: Coccinellidae). *Chemosphere*, *132*, 87-93.

Gerson, U., Mescheloff, E., & Dubitzki, E. (1975). The introduction of *Neodusmetia sangwani* (Rao)(Hymenoptera: Encyrtidae) into Israel for the control of the Rhodesgrass scale, *Antonina graminis* (Maskell)(Homoptera: Pseudococcidae). *Journal of Applied Ecology*, 767-779.

Ghahari, H., Jedryczkowsky, W. B., Aslan, M., & Ostovan, H. (2009). Lady beetles (Coleoptera: Coccinellidae) of Iranian cotton fields and surrounding grasslands. *Journal of Biological Control*, *23*(3), 265-269.

Ghahari, H., Lehr, P. A., Lavigne, R. J., Hayat, R., & Ostovan, H. (2007). New records of robber flies (Diptera, Asilidae) for the Iranian fauna with their prey records. *Far Eastern Entomologist*, *179*(1.9).

Giorgi, J. A., Vandenberg, N. J., McHugh, J. V., Forrester, J. A., Ślipiński, S. A., Miller, K. B., ... & Whiting, M. F. (2009). The evolution of food preferences in Coccinellidae. *Biological Control*, *51*(2), 215-231.

Girling, R. D., & Hassall, M. (2008). Behavioural responses of the seven-spot ladybird *Coccinella septempunctata* to plant headspace chemicals collected from four crop Brassicas and *Arabidopsis thaliana*, infested with *Myzus persicae*. *Agricultural and forest entomology*, *10*(4), 297-306.

Grez, A. A., Zaviezo, T., Díaz, S., Camousseigt, B., & Cortés, G. (2008). Effects of habitat loss and fragmentation on the abundance and species richness of aphidophagous beetles and aphids in experimental alfalfa landscapes. *European Journal of Entomology*, *105*(3), 411.

Hajek, A. E., Hurley, B. P., Kenis, M., Garnas, J. R., Bush, S. J., Wingfield, M. J., … & Cock, M. J. (2016). Exotic biological control agents: A solution or contribution to arthropod invasions? *Biological invasions*, *18*(4), 953-969.

Halperin, J., Merkl, O., & Kehat, M. (1995). An annotated list of the Coccinellidae (Coleoptera) of Israel and adjacent areas. *Phytoparasitica*, *23*(2), 127-137.

Hammad, K. and M.B. Qumsiyeh. (2013). Genotoxic Effects of Israeli Industrial Settlement Pollutants on Palestinian Residents of Bruqeen Village (Salfit). *International Journal of Environmental Studies*. 70(4), 655-622.

Handal, E. N., Amr, Z. S., & Qumsiyeh, M. B. (2016). Some records of reptiles from the Palestinian Territories. *Russian Journal of Herpetology*, *23*(4).

Handal, E. N., Amr, Z., & Qumsiyeh, M. B. (2015). Some records of freshwater snail from the Occupied Palestinian Territories. *Jordan Journal of Natural History, 2,* 23-29.

Harmon, J. P., Stephens, E., & Losey, J. (2006). The decline of native coccinellids (Coleoptera: Coccinellidae) in the United States and Canada. In *Beetle conservation* (pp. 85-94). Springer, Dordrecht.

Harrison, D. L., & Bates, P. J. J. (1991). The Mammals of Arabia. Harrison Zoological Museum. *Lakeside Printing, London*.

Hatano, E., Kunert, G., Michaud, J. P., & Weisser, W. W. (2008). Chemical cues mediating aphid location by natural enemies. *European Journal of Entomology*, *105*(5), 797-806.

Hironori, Y., & Katsuhiro, S. (1997). Cannibalism and interspecific predation in two predatory ladybirds in relation to prey abundance in the field. *Entomophaga*, *42*(1-2), 153-163.

Hoddle, M. S. (2004). Restoring balance: using exotic species to control invasive exotic species. *Conservation Biology*, *18*(1), 38-49.

Hodek I. & Evans E. (2015). Food Relationships, pp. 141-274 in Hodek I., van Emden, H. F., & Honek, A. (Eds.). *Ecology and behaviour of the ladybird beetles (Coccinellidae)* edited book. John Wiley & Sons.

Hodek I. (1973). Biology of Coccinellidae. Dr. W. *Junk, The Hague*.

Hodek I. (2015). Diapause/dormancy, pp. 275- 342 in Hodek I., van Emden, H. F., & Honek, A. (Eds.). *Ecology and behaviour of the ladybird beetles (Coccinellidae)* edited book. John Wiley & Sons.

Hodek I., H.F. van Emden and A. Honk. (2015). Ecology and behaviour of the ladybird beetles (coccinellidae) edited book. Blackwell Publishing Ltd.

Hodek, I., & Honêk, A. (1996). *Ecology of coccinellidae*. Springer Science & Business Media.

Honek, A. (2015). *Distribution and Habitats*, pp. 110-140 in Hodek I., van Emden, H. F., & Honek, A. (Eds.). *Ecology and behaviour of the ladybird beetles (Coccinellidae)* edited book. John Wiley & Sons.

Huffaker, C. B. (Ed.). (2012). *Theory and practice of biological control*. Elsevier.

Isaac, J. (2002). *An atlas of Palestine: (the West Bank and Gaza)*. Applied Research Institute-Jerusalem (ARIJ)

Jafari, R., Fursch, H., & Zare, M. (2015). An annoted checklist of the ladybirds (Coleoptera: Coccinellidae) of Iran. *Journal of Entomological Research*, *7*(3), 31-54.

Kaplan, M., Özgen, İ., & Ayaz, T. (2016). Natural enemies of the olive psyllid [*Euphyllura straminea* Loginova (Hemiptera: Psyllidae)] and population trends of the most important species in olive orchards in Mardin province (Turkey). *Harran Tarım ve Gıda Bilimleri Dergisi/Harran Journal of Agricultural and Food Science*, *20*(3), 175-182.

Kehat, M. (1967). Survey and distribution of common lady beetles [Col. Coccinellidae] on data palm trees in Israel. *Entomophaga, 12*(2), 119-125.

Kehat, M., & Greenberg, S. (1970). Survey and distribution of lady beetles [Coccinellidae] in citrus groves in Israel. *Entomophaga*, *15*(3), 275-280.

Khalil N, (2006). Contribution to a Taxonomic and Environmental Study of the Coccinellidae in Southern Syria (PhD thesis). Damascus University (Unpublished Data)

Khlaif, N., & Qumsiyeh, M. B. (2017). Genotoxicity of recycling electronic waste in Idhna, Hebron District, Palestine. *International Journal of Environmental Studies*, *74*(1), 66-74.

Khormizi, M. Z., Ostovan, H., Fallahzadeh, M., & Saied, M. (2016). Variation of elytral colour polymorphism in six species of ladybird beetles in central Iran (Coleoptera, Coccinellidae). *Entomofauna Zeitschrift Für Entomologie*, 13, 225-240.

Ková, I. (2005). Revision of the Palaearctic species of the *Coccinella transversoguttata* species group with notes on some other species of the genus (Coleoptera: Coccinellidae). *Acta entomologica musei nationalis pragae*, *45*, 129-164.

Kovar I. (1996). Morphology and Anatomy, pp. 1-18 in Hodek I., & Honêk A. (Eds.). *Ecology of coccinellidae*. Springer Science & Business Media.

Kumschick, S., Devenish, A., Kenis, M., Rabitsch, W., Richardson, D. M., & Wilson, J. R. (2016). Intentionally introduced terrestrial invertebrates: patterns, risks, and options for management. *Biological invasions*, *18*(4), 1077-1088.

Larson, D. J. (2013). Key to Lady Beetles (Coleoptera: Coccinellidae) of Saskatchewan. *Entomological Society of Saskatchewan*.

Li, W., Huo, L., Wang, X., Chen, X., & Ren, S. (2016). The genera *Exochomus* Redtenbacher, 1843 and Parexochomus Barovsky, 1922 (Coleoptera: Coccinellidae: Chilocorini) from China, with descriptions of two new species. *The Pan-Pacific Entomologist*, *91*(4), 291-304.

Lotfalizade, H., & Ahmadi, A. (2000). Natural enemies of cypress tree mealybug *planococcus vovae* (nasonov) and their parasitoids in Shiraz Iran. *Iran Agricultural Research*, *19*(2), 145-154.

Lucas E., Gagne E., & Coderre, L. (2002). Impact of the arrival of *Harmonia axyridis* on adults of *Coccinella septempunctata* and *Coleomegilla maculata* (Coleoptera: Coccinellidae). *European Journal of Entomology*, *99*(4), 457-463.

Lumbierres, B., Madeira, F., & Pons, X. (2018). Prey Acceptability and Preference of Oenopia conglobata (Coleoptera: Coccinellidae), a Candidate for Biological Control in Urban Green Areas. *Insects*, *9*(1), 7.

Lyon, S. M., & Montgomery, M. E. (1995). *Scymnus (Pullus) suturalis* Thunberg (Coleoptera: Coccinellidae): New locality records and a report on feeding on hemlock woolly adelgid, *Adelges tsugae* Annand (Homoptera: Adelgidae). *The Coleopterists Bulletin. 49 (2): 118*, *49*(2), 118-118.

Majerus, M. E., Sloggett, J. J., Godeau, J. F., & Hemptinne, J. L. (2007). Interactions between ants and aphidophagous and coccidophagous ladybirds. *Population Ecology*, *49*(1), 15-27.

Majka, C. G., & McCorquodale, D. B. (2010). Ladybird beetles (Coleoptera: Coccinellidae) of the Atlantic Maritime Ecozone. *Assessment of Species Diversity in the Atlantic Maritime Ecozone. Edited by DF McAlpine, and IM Smith. NRC Research Press. Ottawa, Ontario*, 439-452.

Marin, J., Crouau-Roy, B., Hemptinne, J. L., Lecompte, E., & Magro, A. (2010). *Coccinella septempunctata* (Coleoptera, Coccinellidae): a species complex? *Zoologica scripta*, *39*(6), 591-602.

Mendel Z., Protasov A. & Rittner O. (2017). Lady beetles in Israel, their acclimatization and use as control agents of arthropod pests. Alon Hanotea. vol. 71. (In Hebrew with English abstract).

Mizer, A. V. (1970). On eating of beetles from Coccinellidae family by birds. *Vestnik Zoologii*, *6*, 21-24. (In Russian with English summary.)

Modarres Awal, M. (2002). List of agricultural pests and their natural enemies in Iran. 3rd. *Univ. Ferdowsi, Mashhad*. 759 pp.

Obrycki, J. J., & Kring, T. J. (1998). Predaceous Coccinellidae in biological control. *Annual review of entomology*, *43*(1), 295-321.

Ohgushi, T. (1986). Population dynamics of an herbivorous lady beetle, *Henosepilachna niponica*, in a seasonal environment. *The Journal of Animal Ecology*, 861-879.

Otsu, Y., Matsuda, Y., Shimizu, H., Ueki, H., Mori, H., Fujiwara, K. & Tosa, Y. (2003). Biological control of phytophagous ladybird beetles *Epilachna vigintioctopunctata* (Col., Coccinellidae) by chitinolytic phylloplane bacteria *Alcaligenes paradoxus* entrapped in alginate beads. *Journal of applied entomology*, *127*(8), 441-446.

Por, F. D. (1975). An Outline of the Zoogeography of the Levant 1. *Zoologica Scripta*, *4*(1), 5-20.

Qumsiyeh, M. B., Amr, Z. S., Srour, K. T. A., & Al-Fawaghra, N. (2014b). Karyotype for Nebo hierichonticus (Simon 1872) from the Palestinian Territories (Scorpiones: Scorpionidae). *Cytologia*, *79*(2), 277-280.

Qumsiyeh, M. B., Salman, I. N., Salsaa', M., & Amr, Z. S. (2013). Records of scorpions from the Palestinian Territories, with the first chromosomal data (Arachnida: Scorpiones). *Zoology in the Middle East*, *59*(1), 70-76.

Qumsiyeh, M., & Isaac, J. (2012). Research and development in the Occupied Palestinian Territories: challenges and opportunities. *Arab Studies Quarterly*, *34*(3), 158-172.

Qumsiyeh, MB (1985). The Bats of Egypt, Texas Tech Press.

Qumsiyeh, MB (1996). Mammals of the Holy Land, Texas Tech University Press.

Qumsiyeh, MB, S Zavala, and Zuhair Amr. (2014a). Decline in Vertebrate biodiversity in Bethlehem, Palestine. *Jordan Journal of Biological Sciences* 7(2):101-107.

Raimundo, A. A., & van Harten, A. (2000). An annotated checklist of the Coccinellidae (Insecta: Coleoptera) of Yemen. *Fauna of Arabia*, *18*, 211-244.

Raimundo, A. A., Fürsch, H., & van Harten, A. (2006). Notes on the ladybird beetles (Coleoptera: Coccinellidae) of Yemen, with the description of two new species. *Fauna of Arabia*, *21*, 217-245.

Rana, J. S., Dixon, A. F. G., & Jarošík, V. (2002). Costs and benefits of prey specialization in a generalist insect predator. *Journal of Animal Ecology*, *71*(1), 15-22.

Reid, W. V., Mooney, H. A., Cropper, A., Capistrano, D., Carpenter, S. R., Chopra, K., ... & Kasperson, R. (2005). Millennium Ecosystem Assessment. Ecosystems and human well-being: synthesis. *World Resources Institute, Washington, DC*. Mizer, A. V. 1970. On eating of beetles from Coccinellidae family by birds. *Vest. Zool.* 6: 1970, 21 – 24. (In Russian with English summary.)

Richardson, M. L., & Hanks, L. M. (2009). Partitioning of niches among four species of orb-weaving spiders in a grassland habitat. *Environmental entomology*, *38*(3), 651-656.

Saharaoui, L., Hemptinne, J.L. & Magro, A., (2015). Partage Des Ressources Trophiques Chez Les Coccinelles. *Bull. Soc. Zool. Fr*, *140*(1), 5-23.

Salehi, T., Pashaei Rad, S. H., Mehrnejad, M. R., & Shokri, M. R. (2011). Ladybirds associated with pistachio trees in part of Kerman province, Iran (Coleoptera: Coccinellidae). *Iranian Journal of Animal Biosystematics*, *7*(2).

Scheffers, B. R., Joppa, L. N., Pimm, S. L., & Laurance, W. F. (2012). What we know and don’t know about Earth's missing biodiversity. *Trends in ecology & evolution*, *27*(9), 501-510.

Seyfollahi, F., Esfandiari, M., Mossadegh, M. S., & Rasekh, A. (2016). Life table parameters of the coccinellid *Hyperaspis polita*, a native predator in Iran, feeding on the invasive mealybug *Phenacoccus solenopsis*. *Journal of Asia-Pacific Entomology*, *19*(3), 835-840.

Sloggett, j. j., & Majerus, m. e. (2000). Habitat preferences and diet in the predatory Coccinellidae (Coleoptera): an evolutionary perspective. *Biological Journal of the Linnean Society*, *70*(1), 63-88.

Soleimani, S., & Madadi, H. (2015). Seasonal dynamics of: the pea aphid, *Acyrthosiphon pisum* (Harris), its natural enemies the seven spotted lady beetle *Coccinella septempunctata* Linnaeus and variegated lady beetle *Hippodamia variegata* Goeze, and their parasitoid *Dinocampus coccinellae* (Schrank). *Journal of plant protection research*, *55*(4), 421-428.

Soto-Berelov, M., Fall, P. L., Falconer, S. E., & Ridder, E. (2015). Modeling vegetation dynamics in the Southern Levant through the Bronze Age. *Journal of Archaeological Science*, *53*, 94-109.

Sowers, J., Vengosh, A., & Weinthal, E. (2011). Climate change, water resources, and the politics of adaptation in the Middle East and North Africa. *Climatic Change*, *104*(3-4), 599-627.

Spodek, M., Ben-Dov, Y., Mondaca, L., Protasov, A., Erel, E., & Mendel, Z. (2018). The cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in Israel: pest status, host plants and natural enemies. *Phytoparasitica*, *46*(1), 45-55.

Stork, N. E. (2018). How many species of insects and other terrestrial arthropods are there on Earth? *Annual review of entomology*, *63*, 31-45.

Swirski, E., Wysoki, M., & Izhar, Y. (1995). Avocado pests in Israel. In *Proceedings of the World Avocado Congress III, Israel* (pp. 419-428).

Tomaszewska, W., Nedvěd, O., Canepari, C., Ca'Granda, A. O. N., & Fekrat, L. (2017). Article Review of the tribe *Hyperaspidini Mulsant* (Coleoptera: Coccinellidae) from Iran. *Zootaxa*, *4236*(2), 311-326.

Tristram, H.B. (1865). Report on the terrestrial and fluviatile Mollusca of Palestine. Proceedings of the Zoological Society of London, Blackwell Publishing Ltd, 33, 530–545.

Tristram, H.B., (1884). The survey of Western Palestine: the fauna and flora of Palestine. Adelphi, for the Committee of the Palestine Exploration Fund.

Ulgenturk, S., & Toros, S. (2016). Natural enemies of the oak scale insect, *Eulecanium ciliatum* (Douglas) (Hemiptera: Coccidae) in Turkey. *Entomologica*, *33*, 219-224.

Vandenberg, N. J. (1990). First North American records for *Harmonia quadripunctata* (Pontopiddian) (Coleoptera: Coccinellidae); a lady beetle native to the Palaearctic. *Proceedings of the Entomological Society of Washington*, *92*(3), 407-410.

Wallace, M. S., & Hain, F. P. (2000). Field surveys and evaluation of native and established predators of the hemlock woolly adelgid (Homoptera: Adelgidae) in the southeastern United States. *Environmental Entomology*, *29*(3), 638-644.

Wysoki, M., & Izhar, Y. (1978). A list of arthropod pests of avocado and pecan trees in Israel. *Phytoparasitica*, *6*(2), 89-93.

Xie, J., Wu, H., Pang, H., & De Clercq, P. (2017). An artificial diet containing plant pollen for the mealybug predator *Cryptolaemus montrouzieri*. *Pest management science*, *73*(3), 541-545.

Za'aqiq I. (2007). Field Studies on Biology, Ecology and Management of Grapevine Aphid, *Aphis illinoisensis* (Shimer) [Homoptera: Aphididae] on Some Grapevine Cultivars *Vitis vinifera* L. in Al-Arroub Agricultural Experimental Station, Palestine. (Master Thesis). Hebron University.

Zohary, M. (1947). A vegetation map of Western Palestine. *The Journal of Ecology*, 34, 1-19.