



Systematic list, geographic distribution and ecological significance of lady beetles (Coleoptera: Coccinellidae) from the West Bank (Central Palestine)

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Abstract

We surveyed and identified species of lady beetles from the West Bank to document their geographic distribution and understand their ecological significance. This study documents the presence of 35 species of Coccinellidae in 19 genera belonging to 10 tribes and 6 subfamilies. Seven species (mostly very rare), out of the 35 documented, are recorded for the first time in the area studied. These are *Nephus (Bipunctatus) bipunctatus*, *N. crucifer*, *Scymnus (Scymnus) interruptus*, *S. (Parapullus) abietis*, *S. (Neopullus) limbatus*, *S. nigropictus*, and *S. (Pullus) suturalis*. *Nephus peyerimhoffi*, introduced to Palestine in 1986 and later considered extirpated, is recorded from three localities in this study. The distribution of many species generally correlates with local biogeographical zones. All species recorded during the study feed on agricultural pests such as aphids and scale insects. Previously published accounts have been very limited, and while more remains to be done, this study is currently the most comprehensive in the West Bank.

Keywords: biodiversity, lady bugs, faunistics, biological control, natural enemy, biogeography

Introduction

Agricultural pesticide use has increased dramatically in response to global demands to increase food production by decreasing losses due to pests and diseases. Unfortunately, excessive use of pesticides has led to increased cancer and other illnesses, along with detrimental consequences to the environment (Aktar *et al.* 2009). Hence, there is a need to develop and apply biological methods of control (Huffaker 2012), and modern studies have shown the importance of using local species in biological pest control to minimize the ecological disruption often associated with the introduction and use of imported (alien) species (Hajek *et al.* 2016; Kumschick *et al.* 2016).

Coleoptera of the family Coccinellidae Latreille, 1807, commonly known as lady beetles, are considered of significant importance as natural predators of many plant pests. The family includes approximately 6000 described species in some 360 genera and 42 tribes (Hodek *et al.* 2015), and the vast majority are predators. Many of these beetles feed on plant-sucking insects in the suborder Sternorrhyncha Amyot & Serville, 1843 (aphids, coccids, aleyrodids and psyllids) which are among the most devastating of crop pests (Giorgi *et al.* 2009). Under suitable conditions, populations of these pest insects can increase exponentially, especially when parthenogenesis and viviparity occur, causing significant agricultural economic damage (Fisher *et al.* 1999).

Modern aspects of biological control, involving conservation and augmentation of natural enemies, can become part of an integrated pest management program. However, for the success of these methods, it is important to have knowledge of existing native species, their geographic distribution, and ecology. Generally, coccinellids as pest control agents have been poorly studied in western Asia (Abdolahi Mesbah *et al.* 2015; Fürsch 1979; Halperin *et al.* 1995). The most relevant coccinellid study in Palestine is that of Halperin *et al.* (1995) who records about 70 species in historic Palestine and nearby areas. Unfortunately, the aforementioned work provides descriptive morphological data with little or outdated ecological information. We surveyed the lady beetles from the West Bank (Occupied

Palestinian Territories) to provide a baseline for monitoring coccinellid populations and for future biological control projects.

Materials and Methods

Collection localities representing various habitats within the four biogeographical regions of the West Bank of Palestine were surveyed for lady beetles between March and May 2018 (Table 1). The dates were chosen to cover the breeding season in spring and early summer. Sampling localities were concentrated in the southern parts of the West Bank and in the Jordan Valley. A variety of different habitats were investigated, from natural reserves and protected areas to agricultural lands. Sites were photographed and coordinates recorded to construct distribution maps. Field trips were conducted daily from 8:00 AM to 7:00 PM over the study period. First, sampling sites were examined carefully for the presence of active coccinellids (adults, pupae and larvae) on plants at a height of 0–2.5 m. Thereafter, sites were examined for the presence of aphids and scale insects, as they represent potential food to which the coccinellids' presence may be related. Five different sampling methods were applied to study and collect coccinellids at each site. These were 1) field observations for large species, 2) observations to determine the most abundant indicator species like aphids and scale insects, 3) line transects over the length of farms, 4) random sampling in natural areas, natural reserves, and protected areas using beating sheets and 5) sampling in each area was done in a way such that the existing vegetation cover was examined and the plants that corresponded to the previously studied similar vegetation areas were selected to be studied.

Adult beetles were held in sample containers for further study. Larvae were preserved in Eppendorf tubes with 70% alcohol. Each sample was marked with the name of the locality, date, plant level and type, and field notes taken *in situ*. All samples of adult lady beetles were kept alive for a maximum of 36 hours with aphids as a food source before killing by freezing. Each sample was given a field number and all related information was recorded in a corresponding catalogue file.

Species identifications were made using a dissecting microscope (16–100×) and an optical microscope (40–100×). Determinations were based on published keys (Ali *et al.* 2015; Ashfaque *et al.* 2015; Biranvand *et al.* 2017; Canepari 2009; Chapin 1965; Chapin 1974; Corrêa & Almeida 2010; Halperin *et al.* 1995; Hodek & Honêk 1996; Hodek *et al.* 2015; Khalil 2006; Khormizi *et al.* 2016; Ková 2005; Larson 2013; Li *et al.* 2016; Raimundo & van Harten 2000; Raimundo *et al.* 2006; Tomaszewska *et al.* 2017). 25 specimens previously deposited in the Palestine Museum of Natural History (PMNH) prior to the study period were also identified and included herein. After identification, all specimens were refrozen, larvae were preserved in alcohol, and all samples (including genitalia slides) were accessioned in the PMNH.

Laboratory preparation of the lady beetle genitalia for slide mounting is based on Khalil (2006) and Dreisbach (1952) with some modifications as follows: Samples were removed from the deep freezer for 10 minutes to thaw, and then placed in a water bath (50°C). The internal genitalia under a dissecting microscope were extracted manually by teasing them out using needles without causing any damage to the external shape of the specimen. 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. Thereafter, genitalia were removed from the KOH, transferred to a clean petri dish, and washed using 3 ml of distilled water for 1 minute as above. Then, the distilled water was removed and the genitalia were washed with different concentrations of alcohol 70%, 95% and 100%, sequentially. After washing was completed, the genitalia were moved using a needle to a pre-labelled 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, placed on the slide again with a drop of Canada Media and a cover slip for microscopic examination. The remaining adult specimens, without genitalia, were refrozen.

Results

A total of 1490 lady beetle specimens were collected from 166 localities investigated in the West Bank (Fig. 1, Table 1). Our results document the presence of 35 species of Coccinellidae in 19 genera belonging to 10 tribes and 6 sub-families, following the higher classification presented in Hodek *et al.* (2016). Seven species (mostly very rare), out of the 35 documented, were recorded for the first time in Palestine.

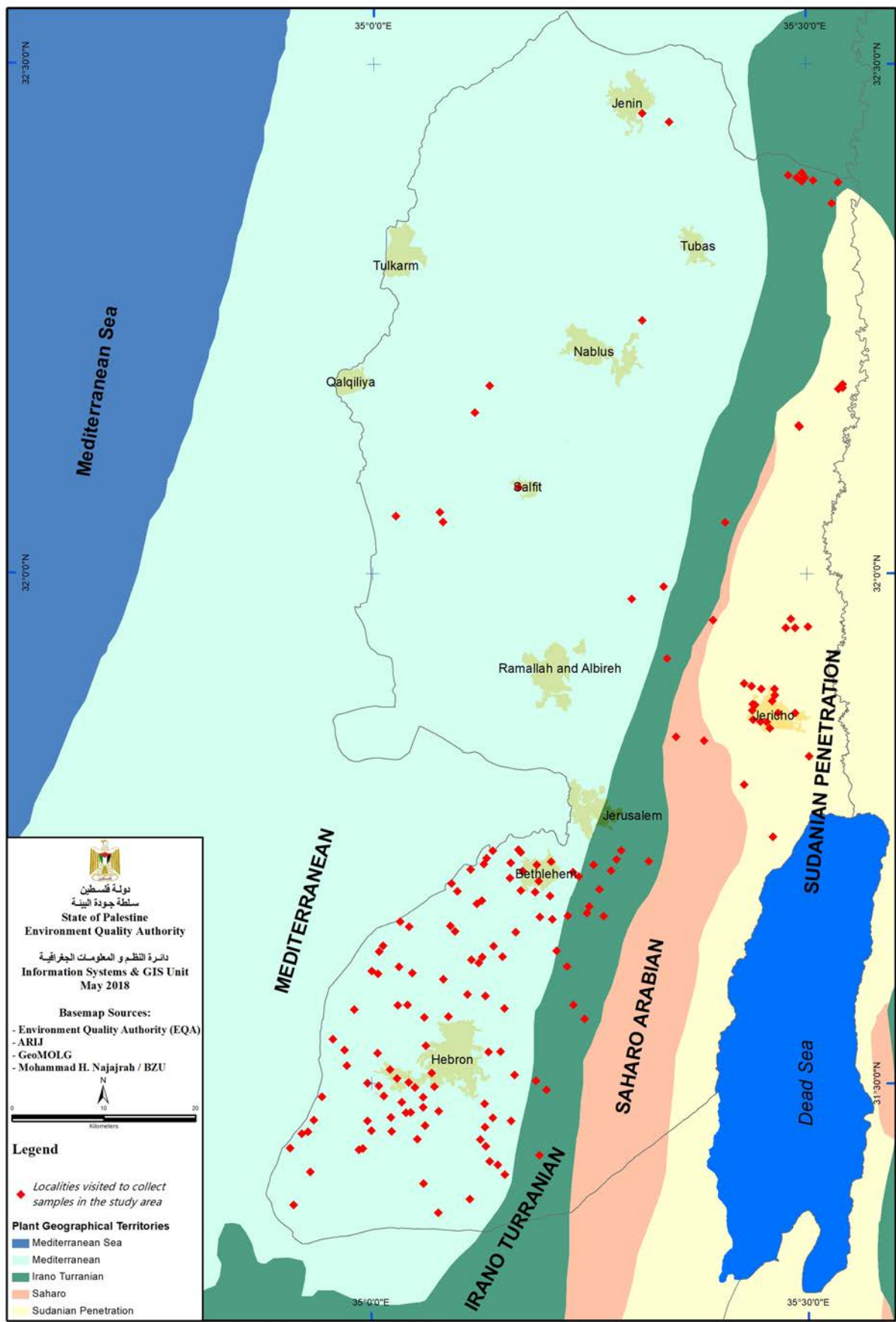


FIGURE 1. Map of the study area showing 166 localities visited to collect lady beetle samples from the West Bank, Palestine during March–May 2018.

TABLE 1. List for the lady beetles sampling localities visited during this study (March–May 2018) in the West Bank of Palestine.

Number	Name	Locality		
		Latitude	Longitude	Elevation (m)
1	Abda	31°27'59.9"N	035°01'19.6"E	727
2	Abu Nujaym 1	31°39'47.9"N	035°11'32.8"E	805
3	Abu Nujaym 2	31°39'40.2"N	035°12'24.2"E	704
4	Ad Deir	32°23'01.3"N	035°32'13.0"E	-237
5	Ad-Dhahiriya 1	31°26'10.1"N	034°59'24.7"E	671
6	Ad-Dhahiriya 2	31°24'46.5"N	034°55'48.5"E	641
7	Al Aroub	31°37'27.0"N	035°07'36.1"E	867
8	Al Aroub (Al Qarn)	31°37'06.3"N	035°07'21.1"E	928
9	Al Baqa'a 1	31°31'51.3"N	035°08'01.1"E	982
10	Al Baqa'a 2	31°31'52.9"N	035°08'51.1"E	900
11	Al Buweib	31°27'48.0"N	035°09'34.9"E	807
12	Al Carmel 1	31°25'12.3"N	035°08'40.8"E	746
13	Al Carmel 2	31°25'25.1"N	035°08'07.3"E	806
14	Al Dayr	31°39'32.0"N	035°01'55.8"E	445
15	Al Hijra	31°29'11.7"N	035°03'32.8"E	763
16	Al Rushayda	31°34'37.3"N	035°13'50.8"E	660
17	Al-Auja 1	31°56'48.5"N	035°29'09.7"E	-290
18	Al-Auja 2	31°56'48.2"N	035°28'32.0"E	-253
19	Al-Auja 3	31°57'20.2"N	035°28'52.5"E	-270
20	Al-Auja 4	31°56'52.1"N	035°30'03.5"E	-290
21	Al-Khader	31°42'06.4"N	035°09'29.1"E	852
22	Alkhas	31°42'53.1"N	035°15'14.6"E	561
23	Al-Kum	31°31'57.4"N	034°58'07.6"E	457
24	Al-Ramadin	31°22'50.5"N	034°54'40.1"E	596
25	Al-Rayhiyya	31°28'22.9"N	035°04'36.3"E	744
26	Al-Shawawra	31°41'26.3"N	035°15'39.5"E	555
27	AlShuyukh	31°34'26.1"N	035°09'07.7"E	911
28	Alsira	31°27'47.7"N	034°59'43.1"E	763
29	AlTabqa 1	31°29'51.8"N	035°00'30.1"E	858
30	AlTabqa 2	31°30'01.3"N	034°59'42.4"E	790
31	An-Nabi Musa	31°47'35.8"N	035°25'38.2"E	-112
32	Asakra	31°39'52.3"N	035°13'28.2"E	560
33	As-Samu	31°24'07.1"N	035°03'34.9"E	668
34	As-Samu (Amnyzl)	31°22'24.3"N	035°04'34.9"E	717
35	At-Tuwani	31°24'38.4"N	035°09'09.6"E	762
36	Bani Na'im 1	31°30'30.6"N	035°09'48.9"E	952
37	Bani Na'im 2	31°30'10.1"N	035°11'16.7"E	663
38	Bani Na'im 3	31°29'38.7"N	035°12'00.4"E	550
39	Bardala 1	32°23'19.3"N	035°29'21.8"E	-107
40	Bardala 2	32°23'26.5"N	035°28'46.0"E	-76
41	Bardala 3	32°23'35.4"N	035°29'42.7"E	-139
42	Battir 1	31°43'42.3"N	035°08'19.3"E	642
43	Battir 2	31°43'16.6"N	035°07'52.3"E	608
44	Bayt al-Rush	31°27'08.9"N	034°55'38.0"E	512
45	Bayt Amra	31°26'43.6"N	035°03'08.8"E	711

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TABLE 1. (Continued)

Number	Locality			
	Name	Latitude	Longitude	Elevation (m)
46	Bayt Fajar 1	31°38'04.7"N	035°08'22.3"E	938
47	Bayt Fajar 2	31°37'27.7"N	035°08'58.6"E	928
48	Bayt Jala 1	31°42'31.1"N	035°10'21.9"E	880
49	Bayt Jala 2	31°42'52.4"N	035°11'20.7"E	787
50	Bayt Kahil	31°33'53.6"N	035°03'36.1"E	806
51	Bayt Mirsim	31°27'02.4"N	034°55'11.9"E	516
52	Bayt Sahur 1	31°42'12.0"N	035°14'14.5"E	635
53	Bayt Sahur 2	31°42'26.1"N	035°13'49.3"E	625
54	Bayt Ta'mar	31°40'26.0"N	035°14'57.5"E	611
55	Bayt Ula 2	31°36'37.2"N	034°59'59.8"E	423
56	Bayt Ula 1	31°36'27.5"N	035°00'25.6"E	467
57	Bayt Ummar	31°37'17.0"N	035°06'50.0"E	933
58	Bethlehem 1	31°43'03.4"N	035°12'19.4"E	716
59	Bethlehem 2	31°41'54.5"N	035°11'27.8"E	789
60	Bi'r Al Qaws	31°37'46.1"N	035°00'29.5"E	378
61	Burj	31°26'11.2"N	034°54'24.7"E	488
62	Dayr Al'Asal	31°27'50.2"N	034°56'01.6"E	431
63	Dayr Balut	32° 03'23.8"N	035°01'36.1"E	152
64	Dayr Kremzan 1	31°43'36.6"N	035°10'14.6"E	833
65	Dayr Kremzan 2	31°43'46.6"N	035°10'04.4"E	870
66	Dayr Samet	31°31'02.3"N	034°58'17.4"E	437
67	Deir Hajla	31°49'14.3"N	035°30'06.8"E	-324
68	Deir Krntl 1	31°52'17.3"N	035°26'23.2"E	-190
69	Deir Krntl 2	31°52'19.8"N	035°26'14.6"E	-145
70	Deir Razih	31°28'16.3"N	035°02'21.7"E	836
71	Deir Razih 2	31°28'18.7"N	035°02'41.7"E	811
72	Duma	31°26'05.3"N	034°59'07.4"E	661
73	Dura 1	31°30'17.4"N	035°01'44.5"E	846
74	Dura 2	31°29'46.5"N	035°02'58.9"E	788
75	Dura 3	31°30'49.6"N	035°01'15.9"E	821
76	Ein Al 'Auja	31°57'16.8"N	035°23'31.1"E	-17
77	Ein Al Fawwar	31°50'24.4"N	035°20'56.7"E	76
78	Ein AlBeida 1	32°23'18.7"N	035°29'55.8"E	-139
79	Ein AlBeida 2	32°23'09.2"N	035°30'29.2"E	-170
80	Ein Al-Duok Al foqa	31°53'32.5"N	035°25'39.2"E	-137
81	Ein Al-Sakout 1	32°21'48.2"N	035°31'47.9"E	-212
82	Ein Fasa'll	32°03'02.0"N	035°24'21.3"E	-81
83	Ein Hasaka	31°33'56.6"N	035°05'16.7"E	877
84	Ein Samiya	31°59'15.4"N	035°20'06.0"E	438
85	Far'a El-Giftlik 1	32°08'39.7"N	035°29'31.0"E	-239
86	Far'a El-Giftlik 2	32°08'43.0"N	035°29'27.0"E	-245
87	Hadab Al Fawar	31°28'36.4"N	035°03'32.9"E	754
88	Hadab Al'Alaqa	31°27'12.8"N	034°59'59.8"E	735
89	Halhul 1	31°35'15.4"N	035°06'34.6"E	963
90	Halhul 2	31°36'08.4"N	035°04'54.8"E	904

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TABLE 1. (Continued)

Number	Locality			
	Name	Latitude	Longitude	Elevation (m)
91	HaRasa	31°29'15.1"N	035°00'50.6"E	772
92	Hebron	31°29'49.4"N	035°04'18.2"E	870
93	Hindaza Bredhaa	31°41'03.0"N	035°12'14.7"E	634
94	Husan	31°42'55.2"N	035°07'41.5"E	677
95	Idhna 1	31°34'20.3"N	034°58'48.4"E	417
96	Idhna 2	31°32'36.1"N	034°57'18.9"E	375
97	Irtas 1	31°41'21.9"N	035°10'15.2"E	800
98	Irtas 2	31°41'15.8"N	035°11'13.2"E	684
99	Jinsafut	32°11'03.9"N	035°08'04.2"E	416
100	Jenin	32°27'06.1"N	035°18'39.4"E	263
101	Jericho 1	31°50'53.6"N	035°27'25.4"E	-250
102	Jericho 2	31°51'16.6"N	035°27'12.4"E	-252
103	Jericho 3	31°51'47.7"N	035°27'58.8"E	-263
104	Jericho 4	31°51'48.2"N	035°29'09.2"E	-285
105	Jubbet ad-Dhib	31°40'02.0"N	035°14'48.0"E	637
106	Kardala	32°23'04.6"N	035°29'43.2"E	-127
107	Karme	31°27'10.8"N	035°01'23.2"E	660
108	Khallet Al-Mia	31°26'18.7"N	035°07'50.1"E	793
109	Khallet Hamad	31°33'48.0"N	035°14'38.2"E	574
110	Kharas 1	31°38'06.2"N	035°00'45.8"E	388
111	Kharas 2	31°36'30.1"N	035°02'45.9"E	545
112	kharisa	31°26'41.9"N	035°07'27.7"E	773
113	Khirbat Safa 1	31°38'56.9"N	035°05'42.5"E	815
114	Khirbat Safa 2	31°39'17.3"N	035°05'23.7"E	781
115	Kisan	31°36'54.6"N	035°13'26.0"E	770
116	Kreisa	31°31'47.0"N	035°00'24.7"E	678
117	Kufr al-Dik	32°03'37.3"N	035°04'38.7"E	234
118	Mar Saba	31°43'05.0"N	035°19'03.7"E	445
119	Marj Na'je 1	32°10'55.8"N	035°32'30.1"E	-272
120	Marj Na'je 2	32°11'08.6"N	035°32'29.8"E	-273
121	Marj Na'je 3	32°10'52.6"N	035°32'12.8"E	-265
122	Mu'arrajat	31°55'00.8"N	035°20'20.0"E	645
123	Nablus	32°14'55.8"N	035°18'38.8"E	228
124	Nahalin 1	31°41'19.3"N	035°05'53.1"E	565
125	Nahalin 2	31°40'45.9"N	035°07'33.5"E	691
126	Nahalin 3	31°40'35.3"N	035°07'12.3"E	781
127	Nuba	31°36'52.1"N	035°01'51.7"E	510
128	Nu'eima 1	31°53'23.3"N	035°26'09.1"E	-144
129	Nu'eima 2	31°52'50.8"N	035°27'45.6"E	-175
130	Nu'eima 3	31°53'13.4"N	035°26'49.5"E	-188
131	Nu'eima altahta 1	31°53'12.8"N	035°27'44.0"E	-232
132	Nu'eima altahta 2	31°52'29.8"N	035°27'35.4"E	-245
133	Qumran	31°44'30.5"N	035°27'37.4"E	-345
134	Ruq'a	31°27'26.4"N	035°07'47.9"E	812
135	Salfit	32°05'05.6"N	035°10'03.8"E	455

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TABLE 1. (Continued)

Number	Locality			
	Name	Latitude	Longitude	Elevation (m)
136	Si'ir	31°35'09.2"N	035°07'48.0"E	929
137	Sika	31°29'12.3"N	034°56'34.6"E	412
138	Surif	31°39'14.4"N	035°02'34.0"E	487
139	Susiya	31°23'12.3"N	035°06'45.4"E	781
140	Taibe	31°58'31.5"N	035°17'53.2"E	924
141	Tapuah	31°32'13.7"N	035°03'43.5"E	816
142	Tarama	31°28'54.4"N	035°02'03.8"E	805
143	Tarqumiyah (Wadi Al Quff Reserve) 1	31°34'36.1"N	035°01'47.3"E	627
144	Tarqumiyah (Wadi Al Quff Reserve) 2	31°34'37.4"N	035°02'27.7"E	600
145	Tel Alsamrat	31°51'57.3"N	035°26'12.6"E	-202
146	Tulul Abu Al-Ala'iq 1	31°51'18.3"N	035°26'46.2"E	-234
147	Tulul Abu Al-Ala'iq 2	31°51'24.3"N	035°26'15.7"E	-208
148	Tuqu'	31°37'49.3"N	035°12'42.2"E	768
149	Ubeidiya	31°43'12.5"N	035°16'50.2"E	598
150	Umm Al-Kear	31°25'47.8"N	035°11'31.4"E	711
151	Umm al-Tut	32°26'36.2"N	035°20'31.0"E	268
152	Umm Salmuna	31°38'55.3"N	035°09'53.2"E	927
153	Wadi Abu Al-Qamarah	31°30'03.7"N	035°02'33.6"E	819
154	Wadi Al Joz	31°30'36.6"N	035°04'06.9"E	786
155	Wadi Al'Ara'is	31°42'32.0"N	035°16'28.2"E	530
156	Wadi Al-Makhrur	31°43'00.0"N	035°09'33.1"E	793
157	Wadi AlNaar	31°43'43.6"N	035°17'10.1"E	390
158	Wadi AlZurqa AlEulwii	32°03'03.2"N	035°04'51.1"E	240
159	Wadi Fukin 1	31°42'36.2"N	035°06'47.0"E	712
160	Wadi Fukin 2	31°41'46.2"N	035°05'28.1"E	571
161	Wadi Kelt	31°50'10.7"N	035°22'53.0"E	-31
162	Wadi Qana	32°09'29.5"N	035°07'03.2"E	240
163	Yata	31°27'31.9"N	035°03'40.4"E	685
164	Za'tara	31°39'51.0"N	035°15'57.1"E	550
165	Zif 1	31°27'58.8"N	035°08'18.8"E	840
166	Zif 2	31°28'48.6"N	035°07'45.0"E	844

Subfamily Coccinellinae Latreille, 1807

Seven species belonging to the tribe Coccinellini are recorded. Among these, four are categorized as common species and two as very rare ones.

Tribe Coccinellini Latreille, 1807

Adalia (Adalia) decempunctata (Linnaeus, 1758)

(Fig. 2A–C; Fig. 3)

Material: Nu'eima (PMNH# E12250, 1, 5 March 2018). Marj Na'je 1 (PMNH# E12265, 1, 6 March 2018). Ein Samiya (PMNH# E12267, 1, 4 March 2018). Al-Auja 2 (PMNH# E12279, 1, 5 March 2018). Bayt al-Rush (PMNH#

E12251, 8, 5 April 2018). Bayt Sahur 1 (PMNH# E12252, 3, 1 April 2018). Dayr Kremzan 2 (PMNH# E12253, 3, 31 March 2018). Ad-Dhahiriya 2 (PMNH# E12267, 2, 5 April 2018). Halhul 1 (PMNH# E12268, 1, 4 April 2018). Burj (PMNH# E12280, 1, 5 April 2018). Bayt Fajar 1 (PMNH# E12257, 2, 2 April 2018). Bayt Ula 2 (PMNH# E12269, 1, 4 April 2018). Halhul 2 (PMNH# E12270, 1, 4 April 2018). Surif (PMNH# E12254, 3, 3 April 2018). Deir Razih 2 (PMNH# E12271, 3, 15 April 2018). AlTabqa 2 (PMNH# E12272, 1, 15 April 2018). Si'ir (PMNH# E12255, 1, 9 April 2018). Ruq'a (PMNH# E12278, 3, 12 April 2018). HaRasa (PMNH# E12256, 2, 15.4.2018). Tarama (PMNH# E12273, 2, 15 April 2018). Hebron (PMNH# E12258, 2, 21 April 2018). Tapuah (PMNH# E12274, 2, 21 April 2018). Deir Krntl 1 (PMNH# E12275, 1, 23 April 2018). Kharas 1 (PMNH# E12259, 3, 3 April 2018). Bayt Kahil (PMNH# E12260, 4, 4 April 2018). Bethlehem 1 (PMNH# E12261, 1, 1 April 2018). Duma (PMNH# E12262, 1, 15 April 2018). Bayt Jala 2 (PMNH# E12264, 3, 31 March 2018). Bayt Sahur 2 (PMNH# E12276, 6, 2 April 2018). Al-Rayhiyya (PMNH# E12277, 1, 12 April 2018).

Remarks: *Adalia* (*Adalia*) *decempunctata* is a common species that feeds on many types of pests and is mostly found in the Mediterranean region on trees and shrubs (Rana *et al.* 2002). This species was noted preying on *Moneilia* aphids on Pecan trees in Palestine (Wysocki & 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.

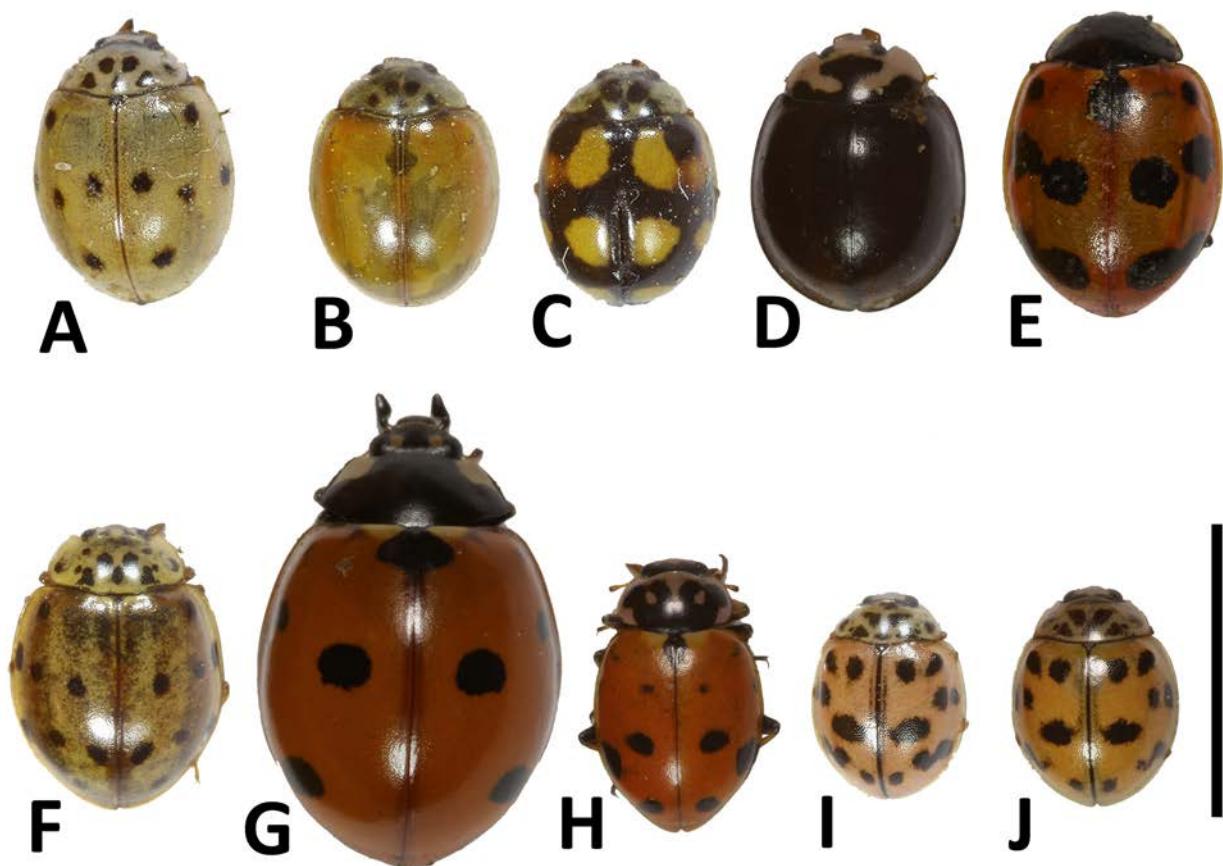


FIGURE 2. Dorsal habitus images of the Coccinellidae of the West Bank: A–C. *Adalia* (*Adalia*) *decempunctata*, D. *Cheilomenes propinqua nilotica*, E. *Coccinella* (*Neococcinella*) *undecimpunctata*, F. *Harmonia quadripunctata*, G. *Coccinella* (*Coccinella*) *septempunctata*, H. *Hippodamia* (*Adonia*) *variegata*, I & J *Oenopia conglobata* (Scale bar = 5 mm).

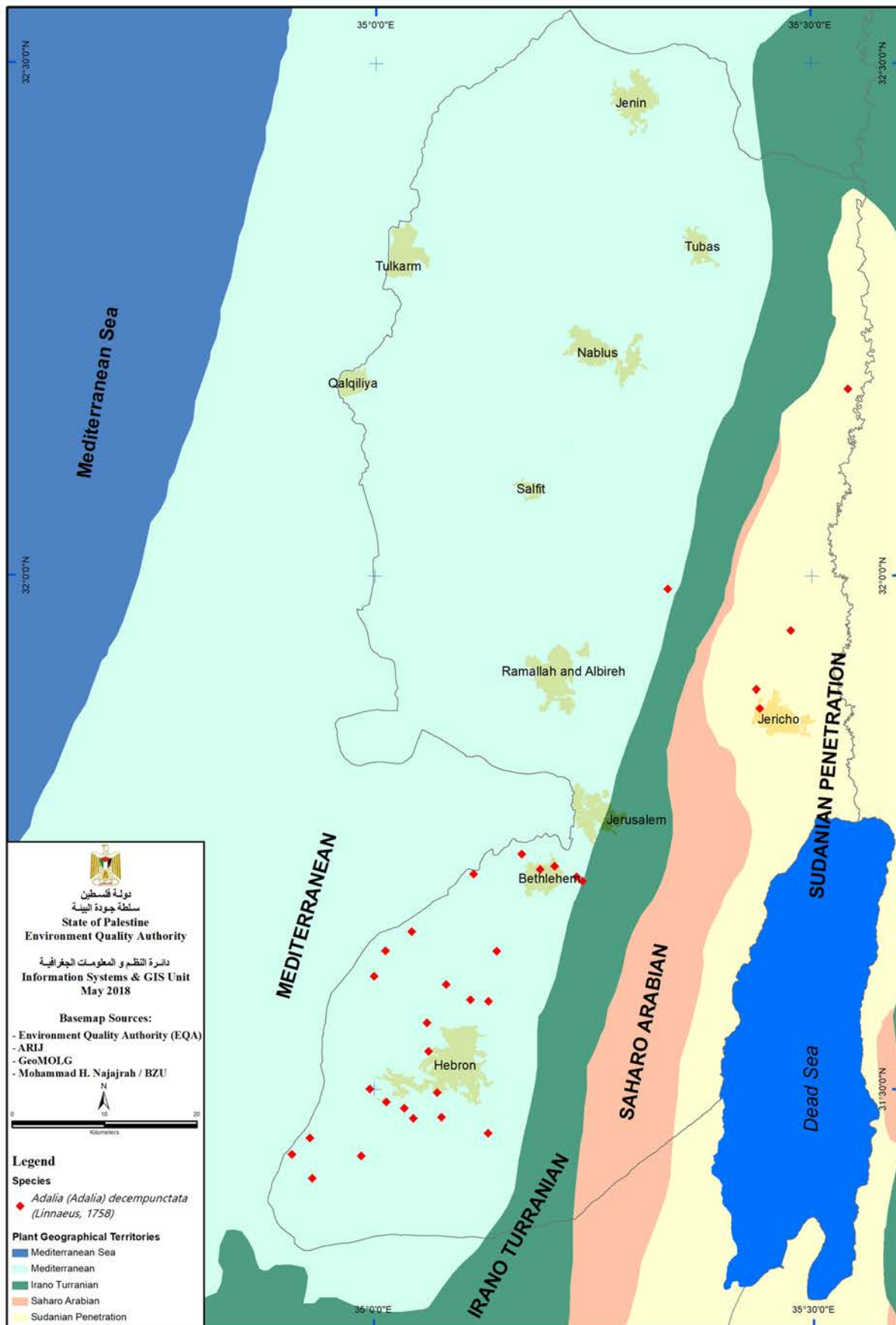


FIGURE 3. Localities where *Adalia (Adalia) decempunctata* was collected during the course of this study.

***Cheilomenes propinqua nilotica* (Mulsant, 1850)**

(Fig. 2D)

Material: Bayt Ula 2 (PMNH# E12282, 1, 4 April 2018).

Remarks: Halperin *et al.* (1995) records this species as very common in more than 100 localities in the region. However, in the present study, it is recorded only in one site in the south of the West Bank, preying on aphids on almond trees.

***Coccinella (Neococcinella) undecimpunctata* (Linnaeus, 1758)**

(Fig. 2E, Fig. 4)

Material: Marj Na'je 1 (PMNH# E12426, 2, 6 March 2018). Jericho 2 (PMNH# E12427, 1, 23 April 2018). Jericho 4 (PMNH# E12425, 1, 23 April 2018). Taibe (PMNH# E12429, 1, 12 April 2013). Nablus (PMNH# E12430, 1, March 2014). Dayr Balut (PMNH# E12431, 1, 25 March 2017). Al-Auja 1 (PMNH# E12428, 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. The use of this species in 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 species *Harmonia axyridis* (Félix & Soares 2004).

***Harmonia quadripunctata* (Pontoppidan, 1763)**

(Fig. 2F)

Material: Wadi Fukin 1 (PMNH# E12464, 1, 21 March 2018). Bethlehem 1 (PMNH# E12463, 1, 20 June 2018).

Remarks: *Harmonia quadripunctata* is native to the Palaearctic region (Vandenberg 1990), and was mostly found feeding on aphids of pine and cypress trees (Khalil 2006). Coccinellids are exotherms, depending on external temperature to determine population dynamics (Hodek *et al.* 2015); for example, climate change reduced the quantity and duration of oviposition of *H. quadripunctata* (Belyakova *et al.* 2016). Populations of this species may be reduced in the future or currently because of climate change. It was found in two areas in the Mediterranean zone.

***Coccinella (Coccinella) septempunctata* (Linnaeus, 1758)**

(Fig. 2G, Fig. 5)

Material: Jeansafot (PMNH# E12299, 7, 22 January 2018). Nu'eima 2 (PMNH# E12300, 3, 5 March 2018). Ein alBeida (PMNH# E12301, 1, 8 March 2018). Nahalin 2 (PMNH# E12302, 5, 10 March 2018). Bardala 1 (PMNH# E12304, 1, 8 March 2018). Ein Al-Sakout 1 (PMNH# E12305, 4, 7 March 2018). Marj Na'je 1 (PMNH# E12306, 10, 6 March 2018). Al-Auja 1 (PMNH# E12307, 1, 6 March 2018). Al-Auja 2 (PMNH# E12308, 2, 5 March 2018). Al-Khader (PMNH# E12309, 1, 22 March 2018). Nahalin 1 (PMNH# E12310, 2, 20 March 2018). Wadi Fukin 2 (PMNH# E12312, 6, 21 March 2018). Battir 2 (PMNH# E12313, 1, 21 March 2018). Battir 1 (PMNH# E12314, 2, 21 March 2018). Al-Shawawra (PMNH# E12315, 7, 18 March 2018). Za'tara (PMNH# E12317, 6, 18 March 2018). Wadi al'Ara'is (PMNH# E12320, 1, 18 March 2018). Abu Nujaym 1 (PMNH# E12321, 10, 27 March 2018). Bethlehem 1 (PMNH# E12325, 7, 1 April 2018). Al Rushayda (PMNH# E12327, 5, 27 March 2018). Khallet Hamad (PMNH# E12328, 2, 27 March 2018). Irtas 2 (PMNH# E12329, 5, 25 March 2018). Bayt al-Rush (PMNH# E12331, 1, 5 April 2018). Dayr Kremzan 1 (PMNH# E12332, 1, 31 March 2018). Bayt Sahur 1 (PMNH# E12333, 2, 1 April 2018). Dayr Al'Asal (PMNH# E12334, 4, 5 April 2018). Ad-Dhahiriya 2 (PMNH# E12335, 2, 5 April 2018). Khirbat Safa 2 (PMNH# E12336, 4, 3 April 2018). Idhna 2 (PMNH# E12337, 1, 5 April 2018). Bayt Mirsim (PMNH# E12338, 3, 5 April 2018). Halhul 1 (PMNH# E12339, 2, 4 April 2018). Burj (PMNH# E12340, 45, 5 April 2018). Bayt Fajar 1 (PMNH# E12345, 2, 2 April 2018). Al Dayr (PMNH# E12346, 3, 3 April 2018). Sika

(PMNH# E12347, 3, 5 April 2018). Bethlehem 2 (PMNH# E12348, 2, 2 April 2018). Bayt Jala 2 (PMNH# E12349, 6, 31 March 2018). Kharas 1 (PMNH# E12353, 10, 3 April 2018). Al-Ramadin (PMNH# E12355, 2, 5 April 2018). Al-Kum (PMNH# E12356, 1, 5 April 2018). Halhul 2 (PMNH# E12357, 2, 4 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 1 (PMNH# E12358, 2, 4 April 2018). Bayt Ula 1 (PMNH# E12359, 2, 4 April 2018). Surif (PMNH# E12360, 5, 3 April 2018). Nuba (PMNH# E12361, 2, 4 April 2018). Al Aroub (PMNH# E12362, 5, 3 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 2 (PMNH# E12363, 2, 2 April 2018). Bayt Ummar (PMNH# E12364, 1, 3 April 2018). Deir Razih 2 (PMNH# E12366, 2, 15 April 2018). Al Hijra (PMNH# E12367, 2, 12 April 2018). As-Samu (PMNH# E12368, 1, 12 April 2018). Zif 1 (PMNH# E12369, 2, 9 April 2018). Bayt Amra (PMNH# E12370, 2, 12 April 2018). Alsira (PMNH# E12371, 3, 15 April 2018). Al-Rayhiyya (PMNH# E12372, 2, 12 April 2018). Hadab al Fawar (PMNH# E12373, 2, 12 April 2018). Bani Na'im 1 (PMNH# E12374, 3, 9 April 2018). Bani Na'im 2 (PMNH# E12375, 3, 9 April 2018). At-Tuwani (PMNH# E12376, 3, 12 April 2018). AlShuyukh (PMNH# E12377, 1, 9 April 2018). Bani Na'im 3 (PMNH# E12378, 2, 9 April 2018). Al Baqa'a 1 (PMNH# E12379, 2, 9 April 2018). Al Baqa'a 2 (PMNH# E12380, 4, 9 April 2018). Si'ir (PMNH# E12381, 3, 9 April 2018). Al Buweib (PMNH# E12382, 4, 9 April 2018). Ruq'a (PMNH# E12383, 4, 12 April 2018). Zif 2 (PMNH# E12384, 3, 12 April 2018). Al Carmel 2 (PMNH# E12385, 1, 12 April 2018). Hadab Al'Alaqa (PMNH# E12386, 3, 15 April 2018). Duma (PMNH# E12387, 2, 15 April 2018). Abda (PMNH# E12388, 3, 15 April 2018). HaRasa (PMNH# E12389, 3, 15 April 2018). Dura 1 (PMNH# E12390, 2, 15 April 2018). Tarama (PMNH# E12391, 3, 15 April 2018). Dura 2 (PMNH# E12392, 3, 21 April 2018). Wadi abu al-Qamarah (PMNH# E12393, 2, 21 April 2018). Kreisa (PMNH# E12394, 1, 21 April 2018). Ein Hasaka (PMNH# E12395, 2, 21 April 2018). Hebron (PMNH# E12396, 4, 21 April 2018). Wadi Al Joz (PMNH# E12397, 3, 21 April 2018). Dura 3 (PMNH# E12399, 2, 21 April 2018). Jericho 2 (PMNH# E12400, 3, 23 April 2018). Deir Krntl 1 (PMNH# E12401, 1, 23 April 2018). Jericho 4 (PMNH# E12402, 2, 23 April 2018). Jericho 3 (PMNH# E12403, 2, 23 April 2018). Tulul Abu Al-Ala'iq 2 (PMNH# E12404, 2, 23 April 2018). Nu'eima Altahta 1 (PMNH# E12405, 1, 23 April 2018). Tulul Abu Al-Ala'iq 1 (PMNH# E12406, 2, 23 April 2018). Umm al-Tut (PMNH# E12407, 1, 13 June 2013). Bayt Fajar 2 (PMNH# E12408, 4, 23 August 2014). Wadi Kelt (PMNH# E12413, 1, 4 April 2015). Ein Fasa'll (PMNH# E12411, 2, 14 January 2015). Ein Samiya (PMNH# E12412, 1, 12 April 2013). Irtas 1 (PMNH# E12414, 1, 12 August 2014). Jenin (PMNH# E12417, 2, 12 April 2016). Bardala 2 (PMNH# E12418, 1, 18 April 2014). Salfit (PMNH# E12419, 2, March 2015). Wadi AlNaar (PMNH# E12421, 1, 13 April 2013). Jericho 1 (PMNH# E12423, 1, 6 February 2018). Wadi AlZurqa AlEulwii (PMNH# E12424, 1, 15 April 2017).

Remarks: *Coccinella septempunctata* is the most widely distributed and common coccinellid in the World, found mostly in the Palaearctic 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. This species avoids the arid regions (the Sahara 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 was the most common species feeding on 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 larvae of this species.

***Hippodamia (Adonia) variegata* (Goeze, 1777)**

(Fig. 2H, Fig. 6)

Material: Nahalin 1 (PMNH# E12466, 1, 20 August 2017). Nu'eima 2 (PMNH# E12467, 1, 5 March 2018). Bardala 1 (PMNH# E12468, 1, 8 March 2018). Marj Na'je 2 (PMNH# E12469, 1, 6 March 2018). Ein Al-Duok Al foqa (PMNH# E12470, 2, 4 March 2018). Al-Auja 1 (PMNH# E12471, 8, 6 March 2018). Dayr Balut (PMNH# E12472, 1, April 2017). Al Rushayda (PMNH# E12473, 1, 27 March 2018). Irtas 2 (PMNH# E12474, 5, 25 March 2018). Idhna 2 (PMNH# E12475, 1, 5 April 2018). Al Dayr (PMNH# E12476, 4, 3 April 2018). Bayt Jala 2 (PMNH# E12477, 2, 31 March 2018). Surif (PMNH# E12478, 1, 3 April 2018). Deir Razih 2 (PMNH# E12479, 1, 15 April 2018). Wadi Kelt (PMNH# E12480, 1, 16 April 2018). Bayt Amra (PMNH# E12481, 1, 12 April 2018). An-Nabi Musa (PMNH# E12482, 1, 16 April 2018). Bani Na'im 1 (PMNH# E12483, 1, 9 April 2018). AlShuyukh (PMNH# E12484, 1, 9 April 2018). Al Baqa'a 2 (PMNH# E12485, 1, 9 April 2018). Si'ir (PMNH# E12486, 1, 9 April 2018).

Ruq'a (PMNH# E12487, 4, 12 April 2018). Zif 2 (PMNH# E12488, 5, 12 April 2018). Ein Al Fawwar (PMNH# E12489, 1, 16 April 2018). Hadab Al'Alaqa (PMNH# E12490, 3, 15 April 2018). Duma (PMNH# E12491, 2, 15 April 2018). Tarama (PMNH# E12492, 1, 15 April 2018). Wadi Qana (PMNH# E12493, 1, 17 April 2018). Dura 2 (PMNH# E12494, 3, 21 of April 2018). Ein Hasaka (PMNH# E12495, 3, 21 April 2018). Hebron (PMNH# E12496, 1, 21 April 2018). Tel Alsamrat (PMNH# E12497, 1, 23 April 2018). Jericho 2 (PMNH# E12498, 5, 23 April 2018). Nu'eima Altahta 2 (PMNH# E12499, 9, 23 April 2018). Jericho 4 (PMNH# E12500, 1, 23 April 2018). Jericho 3 (PMNH# E12501, 8, 23 April 2018). Tulul Abu Al-Ala'iq 2 (PMNH# E12502, 3, 23 April 2018). Nu'eima Altahta 1 (PMNH# E12503, 1, 23 April 2018). Tulul Abu Al-Ala'iq 1 (PMNH# E12504, 5, 23 April 2018). Al Carmel 2 (PMNH# E12508, 1, 25 April 2018). Bayt Sahur 2 (PMNH# E12506, 1, 6 May 2018). Bayt Sahur 2 (PMNH# E12507, 1, 1 April 2018).

Remarks: *Hippodamia variegata* originated in the Palaearctic region. However, because it is considered an efficient aphidophagous lady beetle, it has been spread globally (Soleimani & Madadi 2015). When food is plentiful, *Hippodamia variegata* and *Coccinella septempunctata* do not compete for aphid prey, and they were often found together feeding on the same aphids on the same weeds.

***Oenopia conglobata* (Linnaeus, 1758)**

(Fig. 2I & J, Fig. 7)

Material: Nu'eima 1 (PMNH# E12556, 1, 5 March 2018). Ein AlBeida 1 (PMNH# E12557, 3, 8 March 2018). Bardala 1 (PMNH# E12558, 2, 8 March 2018). Ein Al-Sakout 1 (PMNH# E12559, 1, 7 March 2018). Ein Samiya (PMNH# E12560, 2, 4 March 2018). Ein Al-Duok Al foqa (PMNH# E12561, 1, 4 March 2018). Wadi Fukin 1 (PMNH# E12562, 3, 21 March 2018). Umm Salmuna (PMNH# E12563, 1, 27 March 2018). Kisan (PMNH# E12564, 1, 27 March 2018). Hindaza Bredhaa (PMNH# E12565, 1, 25 March 2018). Bethlehem 1 (PMNH# E12566, 1, 1 April 2018). Al Rushayda (PMNH# E12567, 1, 27 April 2018). Dayr Kremzan 1 (PMNH# E12568, 1, 31 March 2018). Bayt Sahur 2 (PMNH# E12569, 22, 1 April 2018). Dayr Al'Asal (PMNH# E12570, 1, 5 April 2018). Dayr Kremzan 2 (PMNH# E12571, 1, 31 March 2018). Ad-Dhahiriya 2 (PMNH# E12572, 23, 5 April 2018). Idhna 2 (PMNH# E12573, 2, 5 April 2018). Bayt Mirsim (PMNH# E12574, 2, 5 April 2018). Halhul 1 (PMNH# E12575, 1, 4 April 2018). Burj (PMNH# E12576, 1, 5 April 2018). Bayt Fajar 1 (PMNH# E12577, 1, 2 April 2018). Sika (PMNH# E12578, 1, 5 April 2018). Bethlehem 2 (PMNH# E12579, 1, 2 April 2018). Bayt Kahil (PMNH# E12580, 1, 4 April 2018). Bayt Jala 2 (PMNH# E12581, 7, 31 March 2018). Kharas 1 (PMNH# E12582, 7, 3 April 2018). Bayt Ula 2 (PMNH# E12583, 4, 4 April 2018). Al-Ramadin (PMNH# E12584, 4, 5 April 2018). Bayt Sahur 2 (PMNH# E12585, 2, 2 April 2018). Al-Kum (PMNH# E12586, 1, 5 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 1 (PMNH# E12587, 3, 4 April 2018). Surif (PMNH# E12588, 9, 3 April 2018). Nuba (PMNH# E12589, 5, 4 April 2018). Bayt Ummar (PMNH# E12590, 2, 3 April 2018). Bethlehem 1 (PMNH# E12591, 4, 1 April 2018). Deir Razih 2 (PMNH# E12592, 4, 15 April 2018). Al Hijra (PMNH# E12593, 2, 12 April 2018). Wadi Kelt (PMNH# E12594, 3, 16 April 2018). Wadi Kelt (PMNH# E12595, 1, 16 April 2018). Ein al 'Auja (PMNH# E12596, 1, 16 April 2018). As-Samu (PMNH# E12597, 4, 12 April 2018). An-Nabi Musa (PMNH# E12598, 3, 16 April 2018). Bani Na'im 1 (PMNH# E12599, 2, 9 April 2018). Bani Na'im 2 (PMNH# E12600, 1, 9 April 2018). At-Tuwani (PMNH# E12601, 1, 12 April 2018). Al Baqa'a 1 (PMNH# E12602, 1, 9 April 2018). Al Baqa'a 2 (PMNH# E12603, 1, 9 April 2018). Al Carmel 2 (PMNH# E12604, 2, 12 April 2018). Ein Al Fawwar (PMNH# E12605, 3, 16 April 2018). Hadab Al'Alaqa (PMNH# E12606, 1, 15 April 2018). Duma (PMNH# E12607, 4, 15 April 2018). Abda (PMNH# E12608, 2, 15 April 2018). HaRasa (PMNH# E12609, 1, 15 April 2018). Tarama (PMNH# E12610, 1, 15 April 2018). Dura 2 (PMNH# E12611, 1, 21 April 2018). Dura 2 (PMNH# E12612, 5, 21 April 2018). Tapuah (PMNH# E12613, 3, 21 April 2018). Jericho 2 (PMNH# E12614, 2, 23 April 2018). Nu'eima Altahta 2 (PMNH# E12615, 1, 23 April 2018). Tulul Abu Al-Ala'iq 1 (PMNH# E12616, 1, 23 April 2018). Jericho 1 (PMNH# E12617, 4, 23 April 2018). Irtas 2 (PMNH# E12618, 1, 25 March 2018). Ein Al-Duok Al Foqa (PMNH# E12619, 1, 4 March 2018).

Remarks: In the Mediterranean region, *Oenopia conglobata* is among the most common lady beetle found in residential areas (Lumbierres *et al.* 2018). This species was collected from almond trees infested with aphids in 90% of the localities visited. Intraguild predation between *Coccinella septempunctata* and *Oenopia conglobata* was observed on almond trees. Trees were dominated by one species or the other but not both. However, *Coccinella* consistently preyed on the *Oenopia* larvae.

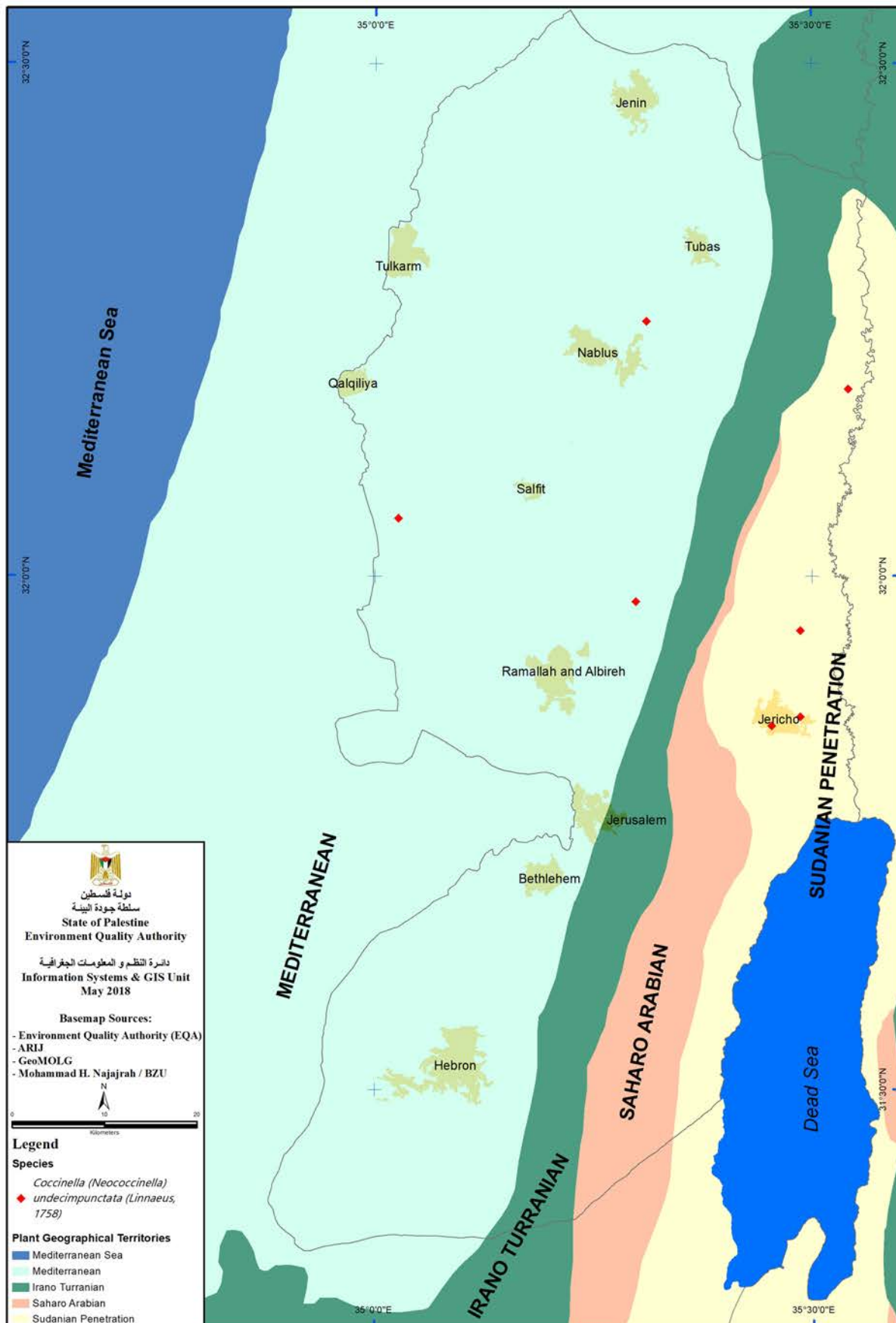


FIGURE 4. Localities where *Coccinella (Neococcinella) undecimpunctata* was collected during the course of this study.

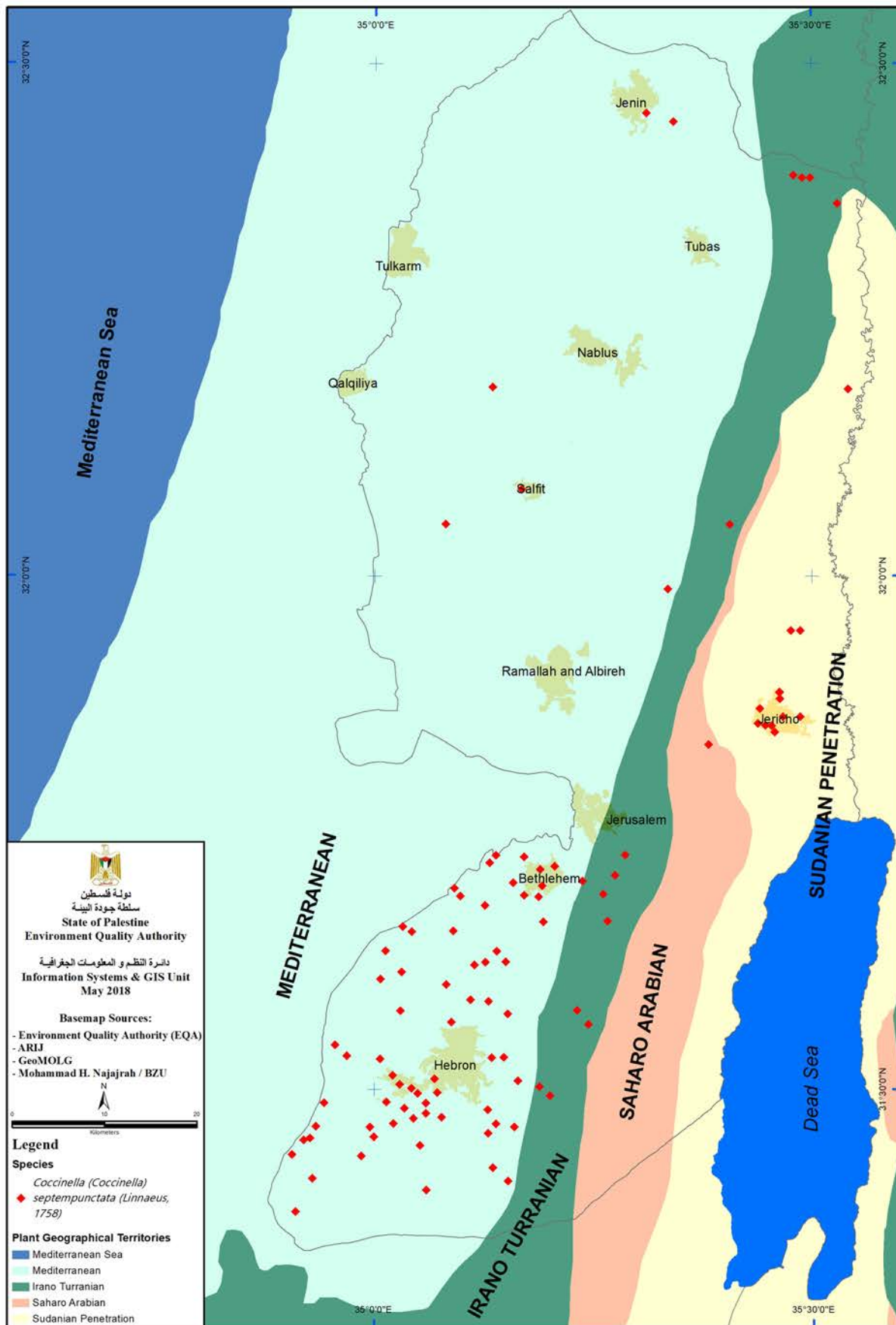


FIGURE 5. Localities where *Coccinella (Coccinella) septempunctata* was collected during the course of this study.

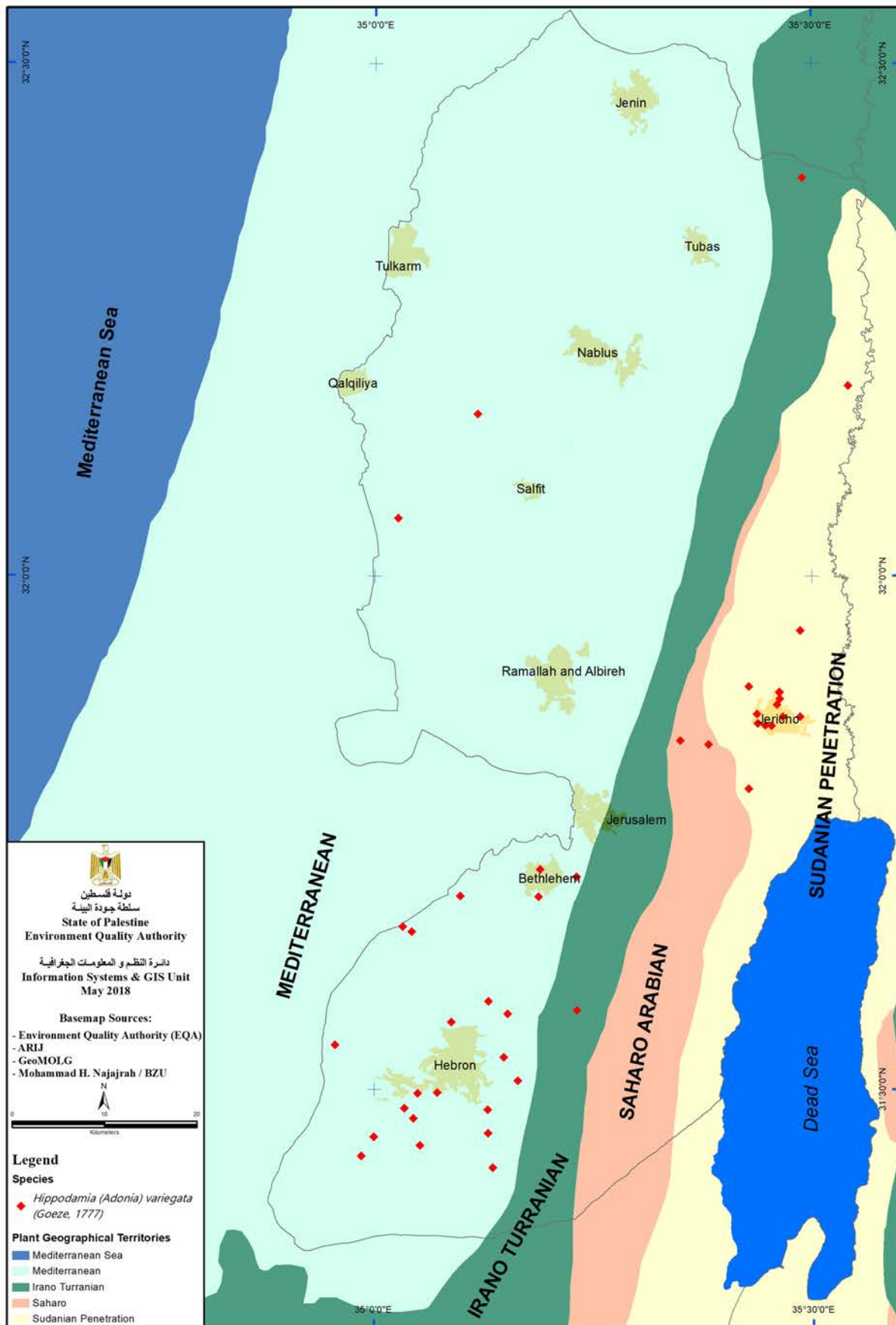


FIGURE 6. Localities where *Hippodamia (Adonia) variegata* was collected during the course of this study.

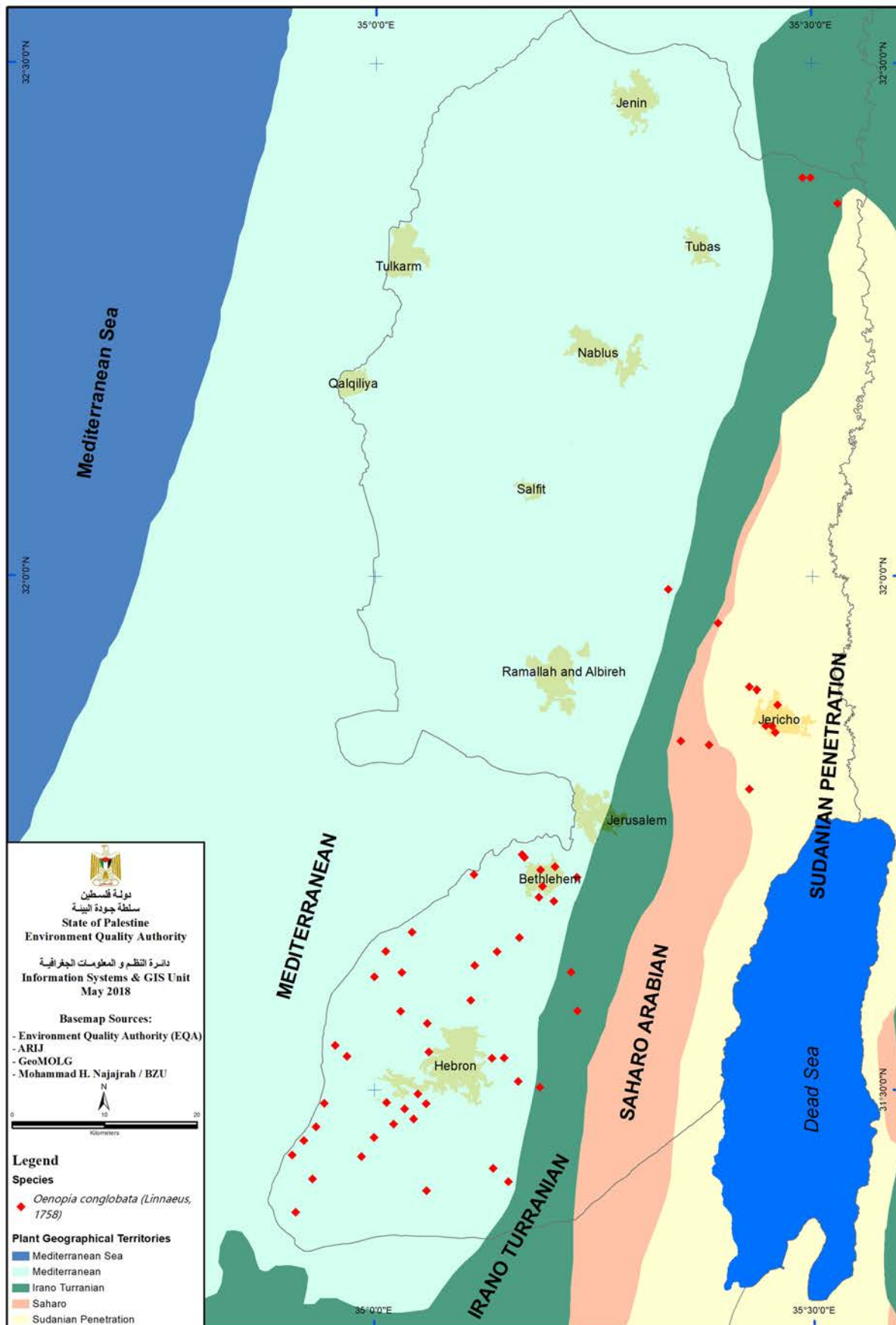


FIGURE 7. Localities where *Oenopia conglobata* was collected during the course of this study.

Subfamily Chilocorinae Mulsant, 1846

In the study area, Chilocorinae are represented by five rare and very rare species belonging to two tribes.

Tribe Chilacorini Mulsant, 1846

Chilocorus bipustulatus (Linnaeus, 1758)

(Fig. 8A, Fig. 9)

Material: Ein Samiya (PMNH# E12283, 4, 4 March 2018). Bayt Jala 1 (PMNH# E12284, 4, 22 March 2018). Nahalin 3 (PMNH# E12285, 6, 20 March 2018). Irtas 1 (PMNH# E12286, 2, 25 March 2018). Dayr Kremzan 2 (PMNH# E12287, 1, 31 March 2018). Halhul 1 (PMNH# E12288, 2, 4 April 2018). Bethlehem 2 (PMNH# E12289, 3, 2 April 2018). Kharas 2 (PMNH# E12290, 1, 4 April 2018). Deir Razih 2 (PMNH# E12291, 2, 15 April 2018). Al Baqa'a 1 (PMNH# E12292, 1, 9 April 2018). Al Baqa'a 2 (PMNH# E12293, 2, 9 April 2018). Dura 2 (PMNH# E12294, 1, 21 April 2018). Dura 3 (PMNH# E12295, 1, 21 April 2018).

Remarks: This species was found in a few localities in the West Bank, all of which were within the Mediterranean zone. 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. A similar predation habit for this species was observed in Kharas 2.

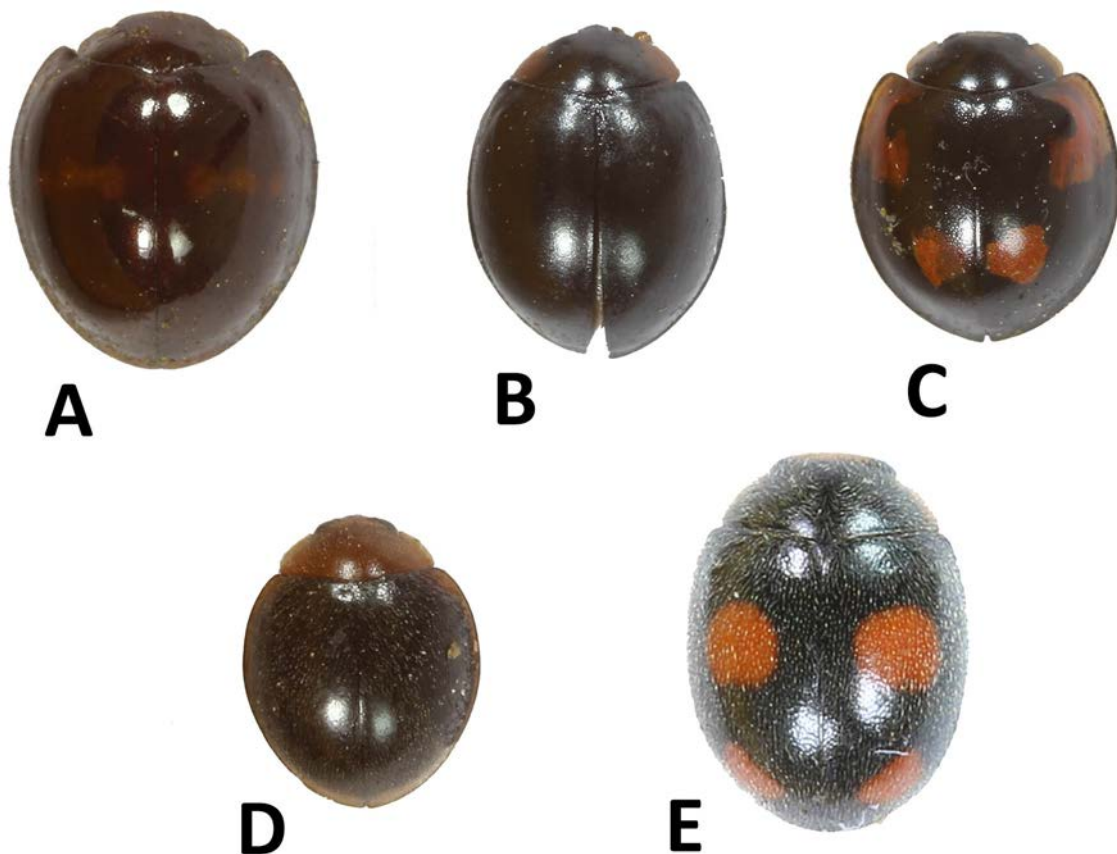


FIGURE 8. Dorsal habitus images of the Coccinellidae of the West Bank (continued): **A.** *Chilocorus bipustulatus*, **B.** *Exochomus nigromaculatus*, **C.** *Exochomus quadripustulatus*, **D.** *Exochomus pubescens*, **E.** *Platynaspis luteorubra* (Scale bar = 5mm).

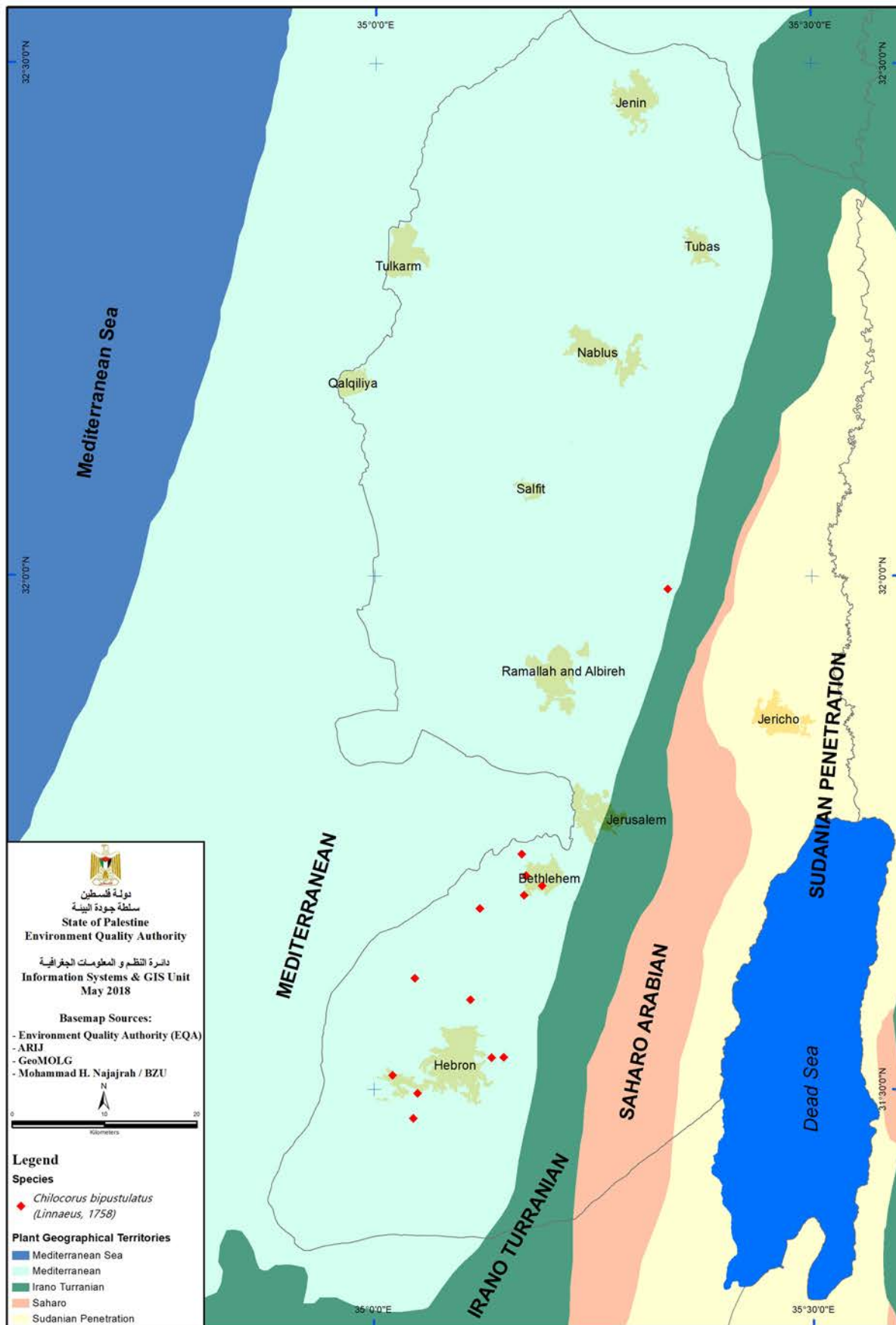


FIGURE 9. Localities where *Chilocorus bipustulatus* was collected during the course of this study.

***Exochomus nigromaculatus* (Goeze, 1777)**

(Fig. 8B)

Material: Bethlehem 1 (PMNH# E12438, 1, 28 July 2017). Bethlehem 1 (PMNH# E12440, 3, 21 July 2017). Dura 3 (PMNH# E12437, 1, 21 April 2018).

Remarks: In 1948, Halperin *et al.* (1995) recorded *Exochomus nigromaculatus* in many localities in Palestine. However, in the present study it was observed only in two localities, *Cupressus* woods near Dura in the Hebron Mountains and *Cupressus* woods near the Bethlehem region. *Exochomus nigromaculatus* is considered 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).

***Exochomus quadripustulatus* (Linnaeus, 1758)**

(Fig. 8C, Fig. 10)

Material: Husan (PMNH# E12446, 1, 21 March 2018). Umm Salmuna (PMNH# E12447, 2, 27 March 2018). Abu Nujaym 2 (PMNH# E12449, 4, 27 March 2018). Irtas 2 (PMNH# E12450, 2, 25 March 2018). Dayr Kremzan 1 (PMNH# E12451, 1, 31 March 2018). Khirbat Safa 2 (PMNH# E12452, 1, 3 April 2018). Bayt Fajar 2 (PMNH# E12453, 1, 2 April 2018). Bethlehem 2 (PMNH# E12454, 3, 2 April 2018). Bayt Ummar (PMNH# E12455, 1, 3 April 2018). Bayt Amra (PMNH# E12456, 1, 12 April 2018). AlShuyukh (PMNH# E12457, 1, 9 April 2018). Al Baqa'a 1 (PMNH# E12458, 1, 9 April 2018). Tapuah (PMNH# E12459, 1, 21 April 2018). Dura 2 (PMNH# E12460, 1, 21 April 2018). Ein Hasaka (PMNH# E12461, 3, 21 April 2018). Wadi Al Joz (PMNH# E12462, 1, 21 April 2018).

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

***Exochomus pubescens* (Kuster, 1848)**

(Fig. 8D)

Material: Al-Auja 2 (PMNH# E12441, 3, 5 March 2018). Al Carmel 2 (PMNH# E12442, 2, 12 April 2018). Deir Krntl 1 (PMNH# E12443, 4, 23 April 2018). Tulul Abu Al-Ala'iq 2 (PMNH# E12444, 5, 23 April 2018). Nu'eima Altahta 1 (PMNH# E12445, 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 farms and natural areas only in the Jordan Valley and one locality in the eastern slopes of Hebron Hills at Al-Carmel. Further work on the distribution of this species may be warranted.

Tribe Platynaspini Casey, 1899

***Platynaspis luteorubra* (Goeze, 1777) (Fig. 8E)**

Material: Battir 2 (PMNH# E12692, 1, 21 March 2018). Bethlehem 1 (PMNH# E12693, 1, 13 June 2018).

Remarks: Halperin *et al.* (1995) reported *Platynaspis luteorubra* as a rare species in the region. Khalil (2006) observed this species on 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.

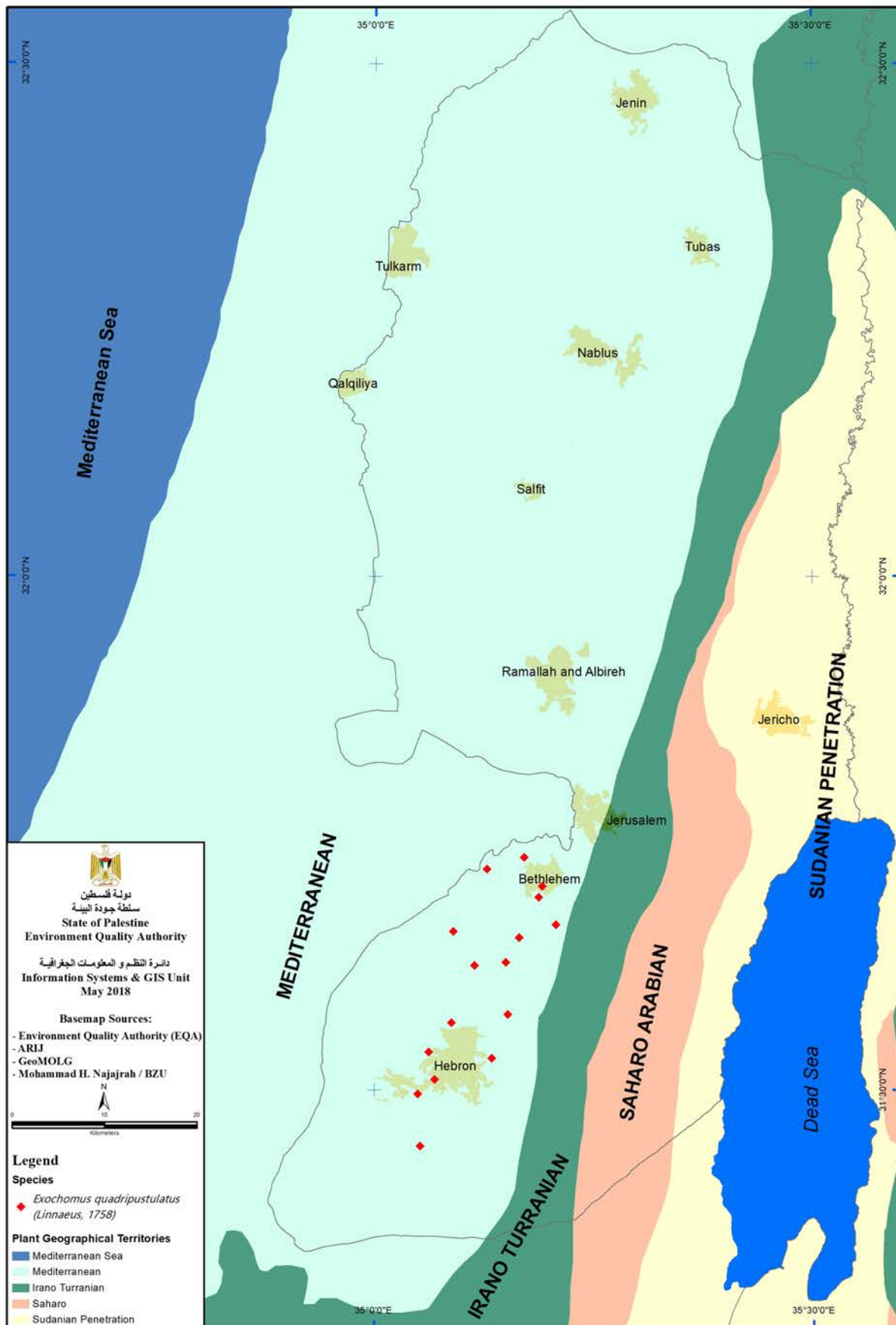


FIGURE 10. Localities where *Exochomus quadripustulatus* was collected during the course of this study.

Subfamily Scymninae Mulsant, 1846

With 19 species belonging to three tribes, Scymninae includes the largest number of species found in the study area.

Tribe Hyperaspidini Mulsant, 1846

Hyperaspis polita (Weise, 1885)

(Fig. 11A)

Material: Irtas 1 (PMNH# E12509, 2, 25 March 2018). Dayr Balut (PMNH# E12510, 1, 2 September 2017).

Remarks: *Hyperaspis polita* is one of the important predators of cotton mealybugs (Spodek *et al.* 2018; Seyfolahi *et al.* 2016). It was reported in the region 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* sp. plant and from Dayr Balut on a fennel plant.

Hyperaspis syriaca (Weise, 1885)

(Fig. 11B)

Material: Ein al 'Auja (PMNH# E12511, 2, 16 April 2018). Ein Al Fawwar (PMNH# E12512, 16, 16 April 2018).

Remarks: *Hyperaspis syriaca* was recorded in more than 25 sites from our region and it was observed in South of Syria on *Vitex agnus-castus* plants (Halperin *et al.* 1995; Khalil 2006). In the present study, it was collected from two sites on the same plant.

Tribe Scyminini Mulsant, 1846

Cryptolaemus montrouzieri (Mulsant, 1853)

(Fig. 11C)

Materials: An-Nabi Musa (PMNH# E12432, 1, 16 April 2018). Ein Al Fawwar (PMNH# E12433, 1, 16 April 2018). Tel Alsamrat (PMNH# E12434, 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 mealybugs. 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 *et al.* 2017), which may help in mass rearing for biological control purposes. It is one of 24 introduced species of coccinellids in our region (Mendel *et al.* 2017).

Nephus (Bipunctatus) bipunctatus (Kugelann, 1794)

(Fig. 11D)

Material: Kisan (PMNH# E12513, 1, 27 March 2018).

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

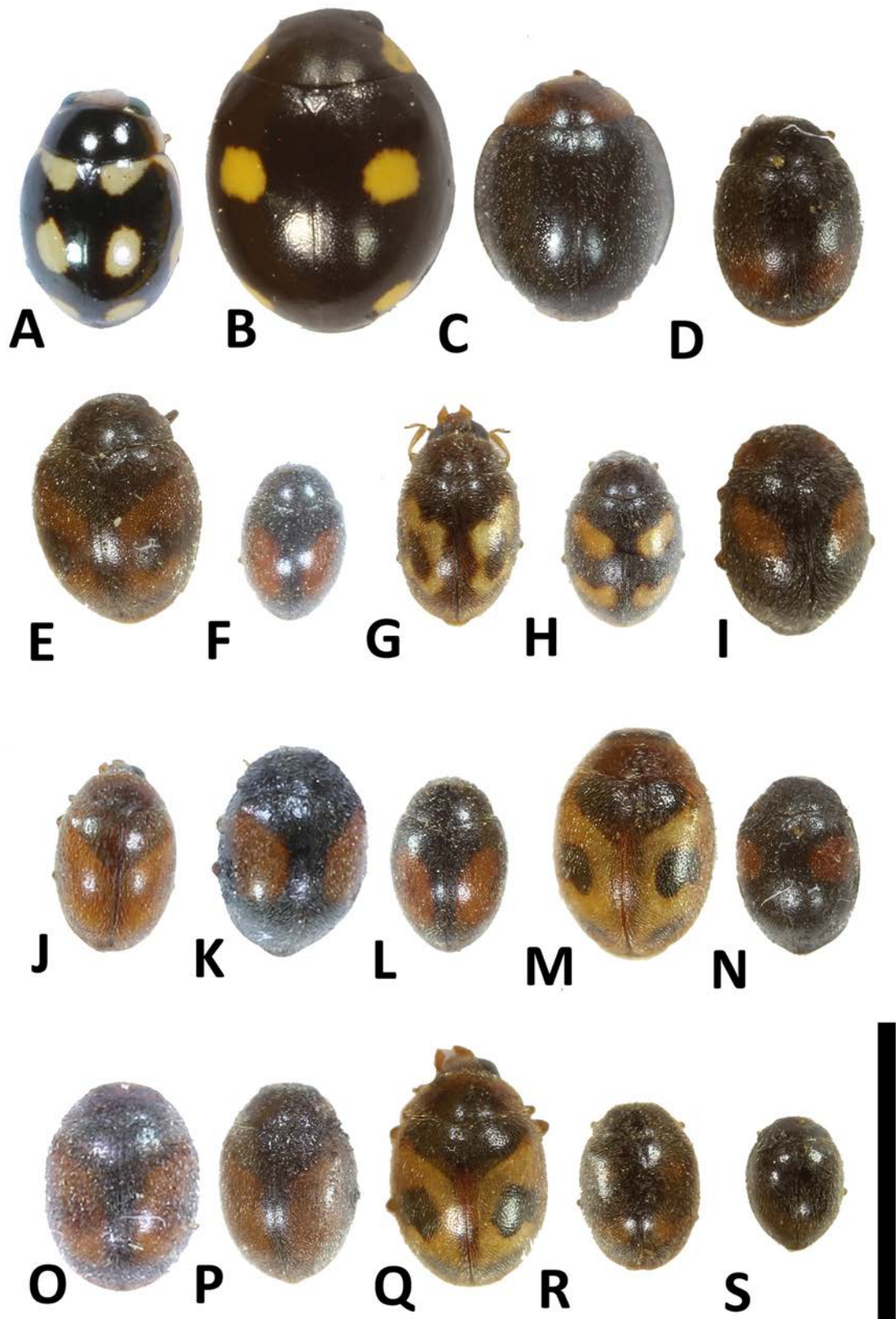


FIGURE 11. Dorsal habitus images of the Coccinellidae of the West Bank (continued): **A.** *Hyperaspis polita*, **B.** *Hyperaspis syriaca*, **C.** *Cryptolaemus montrouzieri*, **D.** *Nephus (Bipunctatus) bipunctatus*, **E.** *Nephus crucifer*, **F.** *Nephus (Sidis) hiekei*, **G.** *Nephus (Nephus) peyerimhoffi*, **H.** *Nephus (Nephus) quadrimaculatus*, **I.** *Scymnus (Scymnus) flavicollis*, **J.** *Scymnus (Parapullus) abietis*, **K.** *Scymnus (Scymnus) interruptus*, **L.** *Scymnus (Neopullus) limbatus*, **M.** *Scymnus nigropictus*, **N.** *Scymnus (Scymnus) pallipediformis*, **O.** *Scymnus (Pullus) subvillosus*, **P.** *Scymnus (Pullus) suturalis*, **Q.** *Scymnus (Pullus) syriacus*, **R.** *Diomus anemicus*, **S.** *Stethorus gilvifrons* (Scale bar = 3mm).

***Nephus crucifer* (Fleischer, 1900)**

(Fig. 11E)

Material: Zif 2 (PMNH# E12514, 1, 12 April 2018), Dura 3 (PMNH# E12515, 1, 21 April 2018). Jericho 1 (PMNH# E12516, 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 is recorded from three localities in the West Bank. This is the first record of this species in Palestine,

***Nephus (Sidis) hiekei* (Fursch, 1965)**

(Fig. 11F)

Material: Dura 1 (PMNH# E12517, 1, 15 April 2018).

Remarks: *Nephus (Sidis) hiekei* is a common species in the Mediterranean area in our region (Halperin *et al.* 1995). In the present study, it was noted in one locality in the south of the West Bank. This species preys on mealybugs and whiteflies (Raimundo & van Harten 2000). The species is parasitized by the hymenopteran *Homalotylus turkmenicus* (Fallahzadeh *et al.* 2016).

***Nephus (Nephus) peyerimhoffi* (Sicard, 1923)**

(Fig. 11G)

Material: Bethlehem 1 (PMNH# E12518, 2, 1 April 2018). Al-Kum (PMNH# E12519, 1, 5 April 2018). Deir Krntl 1 (PMNH# E12520, 2, 23 April 2018).

Remarks: *Nephus peyerimhoffi* is reported from citrus trees in Europe (Saharaoui *et al.* 2015). In the region, it was released on avocado trees in 1986 (Swirski *et al.* 1995), but was not recorded subsequently (Halperin *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.

***Nephus (Nephus) quadrimaculatus* (Herbst, 1783)**

(Fig. 11H, Fig. 12)

Material: Bethlehem 1 (PMNH# E12522, 1, 23 November 2016). Ein Samiya (PMNH# E12523, 4, 4 March 2018). Bayt Jala 1 (PMNH# E12524, 2, 22 March 2018). Bayt Jala 1 (PMNH# E12525, 2, 22 March 2018). Battir 1 (PMNH# E12526, 2, 21 March 2018). Kisan (PMNH# E12528, 1, 27 March 2018). Asakra (PMNH# E12529, 3, 27 March 2018). Bethlehem 1 (PMNH# E12530, 4, 1 April 2018). Bethlehem 1 (PMNH# E12531, 2, 1 April 2018). Karme (PMNH# E12532, 1, 11 March 2018). Irtas 1 (PMNH# E12533, 8, 25 March 2018). Irtas 2 (PMNH# E12534, 1, 25 March 2018). Dayr Kremzan 1 (PMNH# E12535, 2, 31 March 2018). Bayt Sahur 1 (PMNH# E12536, 2, 1 April 2018). Ad-Dhahiriya 2 (PMNH# E12537, 1, 5 April 2018). Bethlehem 1 (PMNH# E12538, 1, 1 April 2018). Bayt Fajar 1 (PMNH# E12539, 2, 2 April 2018). Bethlehem 2 (PMNH# E12540, 3, 2 April 2018). Bayt Jala 2 (PMNH# E12541, 1, 31 March 2018). Al-Ramadin (PMNH# E12542, 1, 5 April 2018). Bayt Sahur 2 (PMNH# E12543, 1, 2 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 1 (PMNH# E12544, 4, 4 April 2018). Bayt Ula 1 (PMNH# E12545, 1, 4 April 2018). Al Aroub (PMNH# E12546, 3, 3 April 2018). Bani Na'im 3 (PMNH# E12548, 2, 9 April 2018). Al Baqa'a 1 (PMNH# E12549, 1, 9 April 2018). Zif 2 (PMNH# E12550, 1, 12 April 2018). Al Carmel 2 (PMNH# E12551, 3, 12 April 2018). Tapuah (PMNH# E12552, 1, 21 April 2018). Nu'eima Altahta 1 (PMNH# E12553, 1, 23 April 2018). Idhna 1 (PMNH# E12554, 1, 5 April 2018). Wadi Al Joz (PMNH# E12555, 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. It is a coccidophagous species that feeds on leaf curl aphids (Almatni & Khalil 2008).

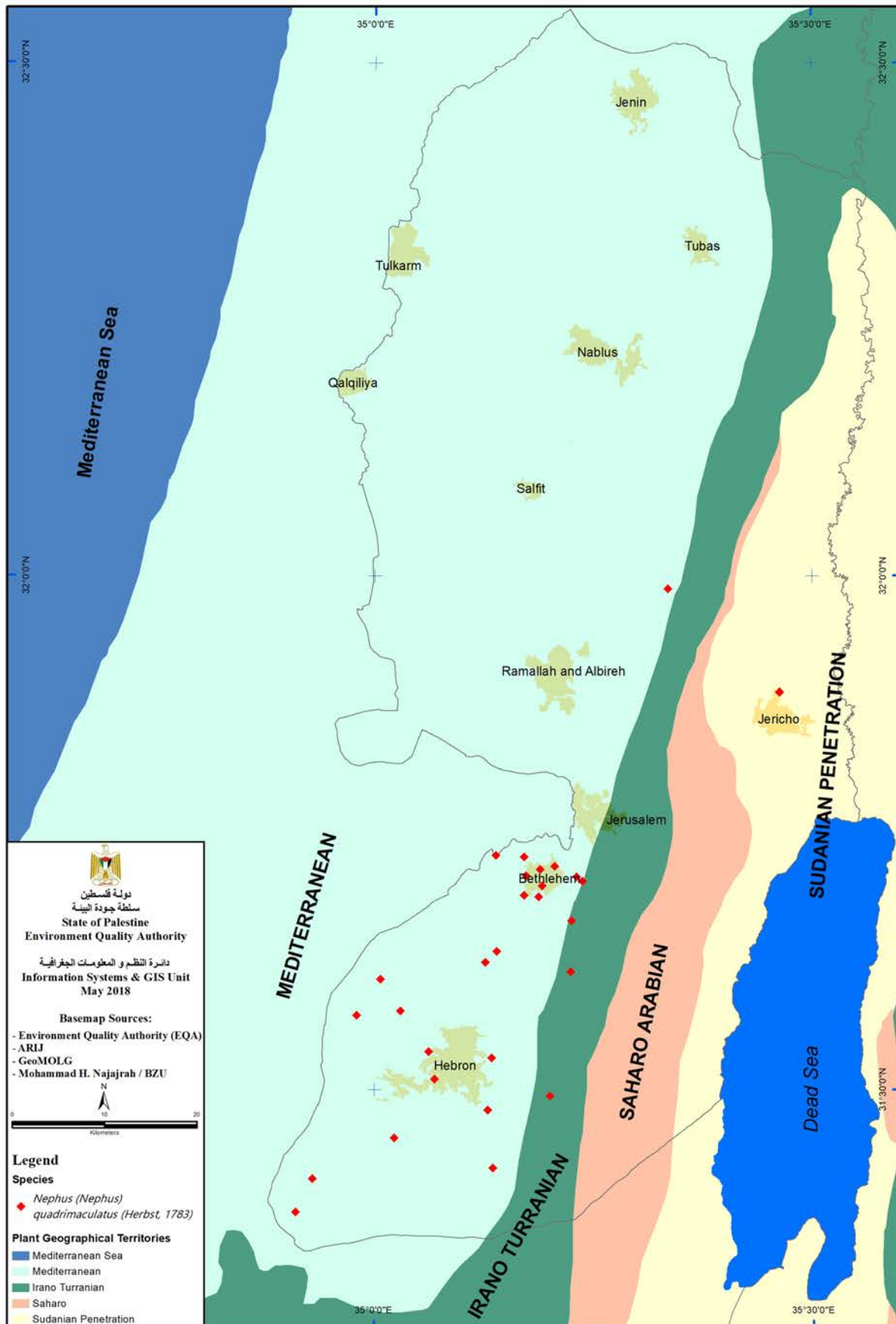


FIGURE 12. Localities where *Nephus (Nephus) quadrimaculatus* was collected during the course of this study.

Scymnus (Scymnus) flavicollis (Redtenbacher, 1843)

(Fig. 11I)

Material: Wadi Kelt (PMNH# E12711, 5, 16 April 2018). Deir Krntl 1 (PMNH# E12712, 1, 23 April 2018). Bethlehem 1 (PMNH# E12713, 1, 30 May 2016). Bethlehem 1 (PMNH# E12714, 1, 28 February 2018).

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

Scymnus (Parapullus) abietis (Paykull, 1798)

(Fig. 11J)

Material: Bethlehem 1 (PMNH# E12706, 2, 11 September 2017). Ein Samiya (PMNH# E12707, 1, 4 March 2018). Bethlehem 1 (PMNH# E12708, 1, 1 April 2018). Bayt Ula1 (PMNH# E12709, 1, 4 April 2018). Hadab Al'Alaqa (PMNH# E12710, 2, 15 April 2018).

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

Scymnus (Scymnus) interruptus (Goeze, 1777)

(Fig. 11K)

Material: Ein Al 'Auja (PMNH# E12715, 1, 16 April 2018). Ein Fasa'll (PMNH# E12716, 1, 16 April 2018). Jericho 1 (PMNH# E12717, 1, 23 April 2018).

Remarks: *Scymnus interruptus* was collected from *Vitex agnus-castus* and citrus trees around the Jordan Valley region. It was recorded from the south of Syria feeding mainly 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.

Scymnus (Neopullus) limbatus (Stephens, 1831)

(Fig. 11L)

Material: Nahalin 1 (PMNH# E12718, 1, 20 March 2018). Al-Ramadin (PMNH# E12719, 1, 5 April 2018).

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

Scymnus nigropictus (Wollaston, 1867)

(Fig. 11M)

Material: Ein Al 'Auja (PMNH# E12720, 1, 16 April 2018). Jericho 1 (PMNH# E12721, 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. This is the first record of this species in our region.

Scymnus (Scymnus) pallipediformis (Gunther, 1958)

(Fig. 11N, Fig. 13)

Material: Nahalin 1 (PMNH# E12722, 1, 20 August 2017). Irtas 1 (PMNH# E12723, 2, 25 March 2018). Al Carmel 2 (PMNH# E12724, 2, 12 April 2018). Ein Al Fawwar (PMNH# E12725, 2, 16 April 2018). Ein Fasa'll (PMNH# E12726, 1, 16.4.2018). Tel Alsamrat (PMNH# E12727, 1, 23 April 2018). Kufir Al-Dik (PMNH# E12728, 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 earlier from our region (Halperin *et al.* 1995). In the present study, it is recorded near springs and ditch water areas.

Scymnus (Pullus) subvillosus (Goeze, 1777)

(Fig. 11O, Fig. 14)

Material: Al-Auja 3 (PMNH# E12729, 1, 6 March 2018). Nahalin 1 (PMNH# E12730, 1, 20 March 2018). Idhna 1 (PMNH# E12731, 1, 4 April 2018). Bayt Fajar 1 (PMNH# E12732, 1, 2 April 2018). Surif (PMNH# E12733, 2, 3 April 2018). Bani Na'im 1 (PMNH# E12734, 2, 9 April 2018). Ein Al Fawwar (PMNH# E12735, 1, 16 April 2018). Dura 3 (PMNH# E12736, 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 is an aphidophagous species that is widely distributed on citrus groves and more frequent in the warmer parts (Kehat & Greenberg 1970). It was reported earlier from our region (Halperin *et al.* 1995). Most of our samples were collected from barley fields and almond trees in the study area.

Scymnus (Pullus) suturalis (Thunberg, 1795)

(Fig. 11P, Fig. 15)

Material: Ein Samiya (PMNH# E12737, 2, 4 March 2018). Ein Samiya (PMNH# E12738, 1, 4 March 2018). Ein Al 'Auja (PMNH# E12743, 1, 16 April 2018). Bayt Jala 1 (PMNH# E12739, 3, 22 March 2018). Bayt Sahur 1 (PMNH# E12740, 4, 1 April 2018). Ad-Dhahiriya 2 (PMNH# E12741, 1, 5 April 2018). Dura 1 (PMNH# E12746, 1, 15 April 2018). Irtas 1 (PMNH# E12745, 4, 25 March 2018). Wadi Kelt (PMNH# E12742, 1, 16 April 2018). Bethlehem 1 (PMNH# E12744, 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 the current study and noted feeding on scale insects of these trees. 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.

Scymnus (Pullus) syriacus (Marseul, 1868)

(Fig. 11Q, Fig. 16)

Materials: Nu'eima 1 (PMNH# E12747, 1, 5 March 2018). Ein AlBeida 1 (PMNH# E12748, 1, 8 March 2018). Ein Samiya (PMNH# E12749, 1, 4 March 2018). An-Nabi Musa (PMNH# E12750, 2, 16 April 2018). Ein Fasa'll (PMNH# E12751, 3, 16 April 2018). Jericho 2 (PMNH# E12752, 1, 23 April 2018). Deir Krntl 1 (PMNH# E12753, 1, 23 April 2018). Jericho 1 (PMNH# E12754, 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 our region (Halperin *et al.* 1995). Most of our samples were collected from the Sudanian penetration zone on *Atriplex*, cane, citrus, *Prosopis* and jujube plants.

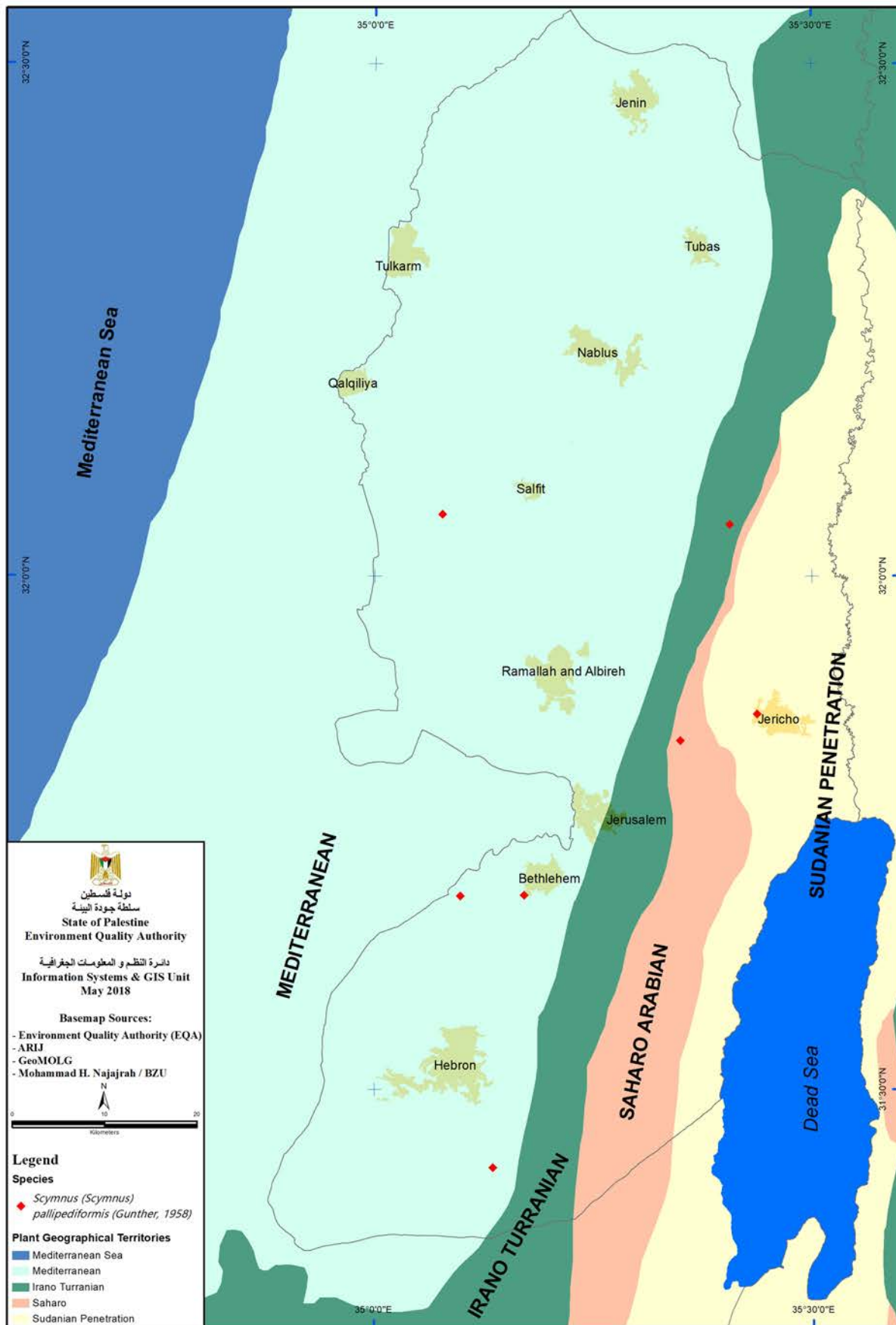


FIGURE 13. Localities where *Scymnus (Scymnus) pallipediformis* was collected during the course of this study.

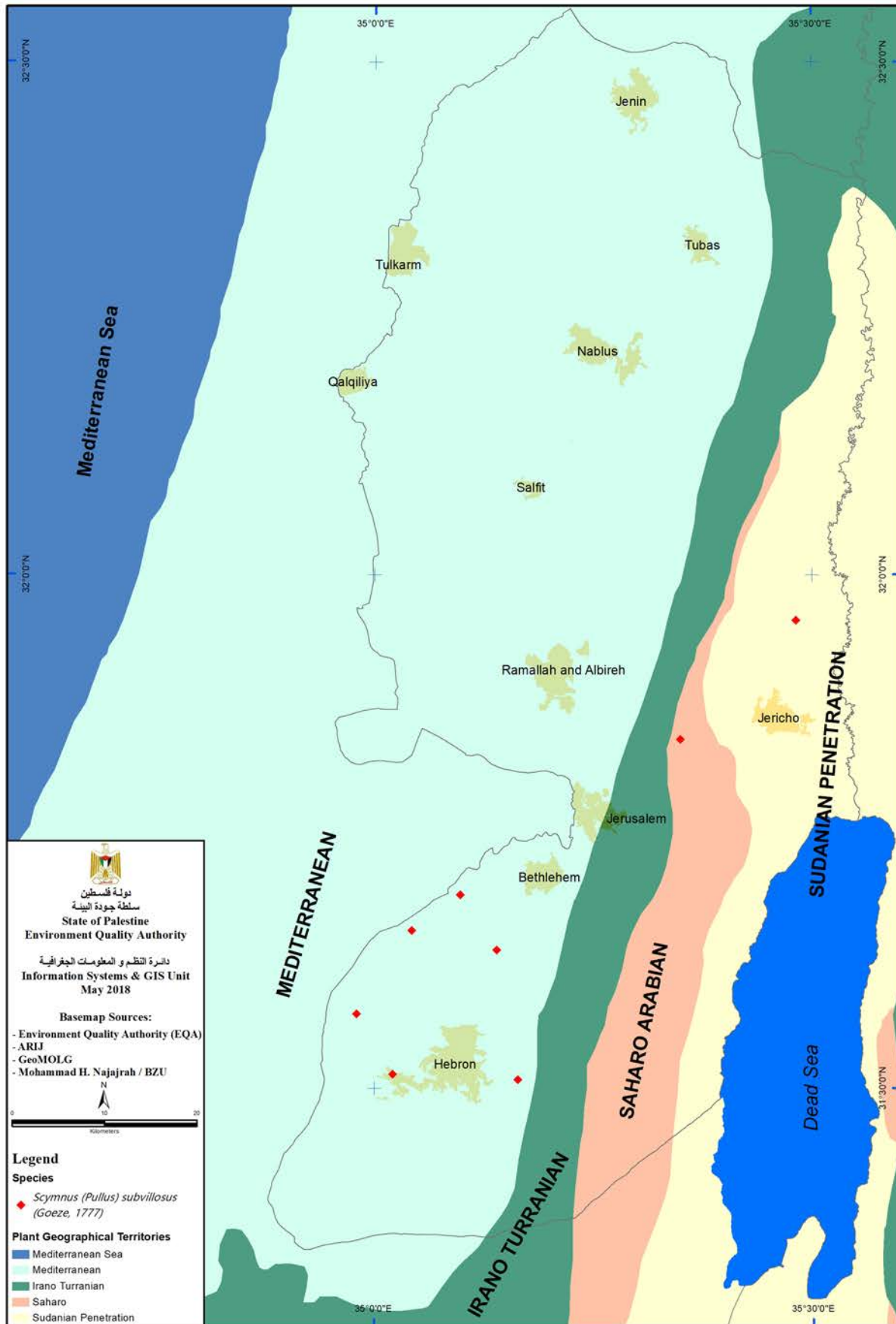


FIGURE 14. Localities where *Scymnus (Pullus) subvillosus* was collected during the course of this study.

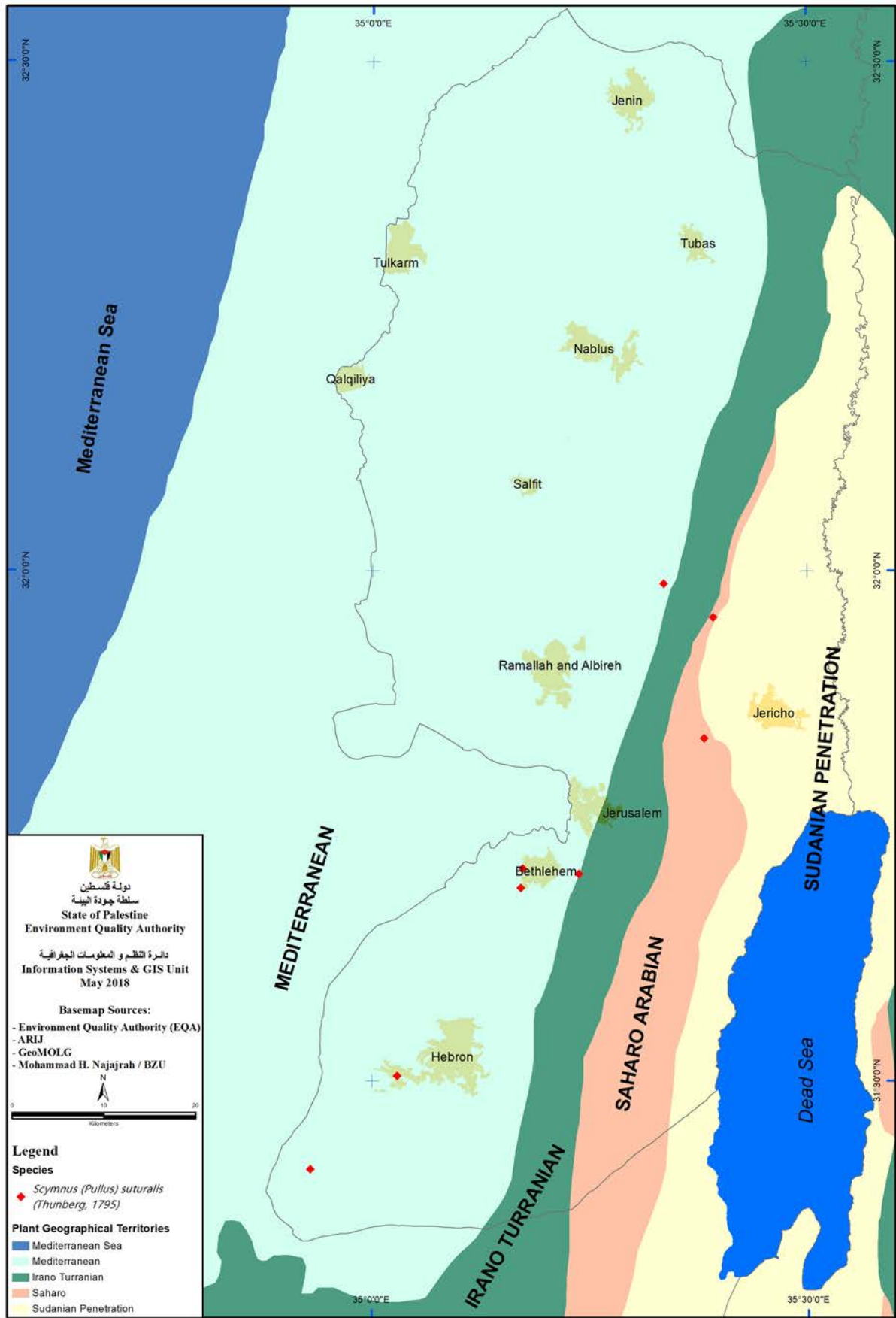


FIGURE 15. Localities where *Scymnus (Pullus) suturalis* was collected during the course of this study.

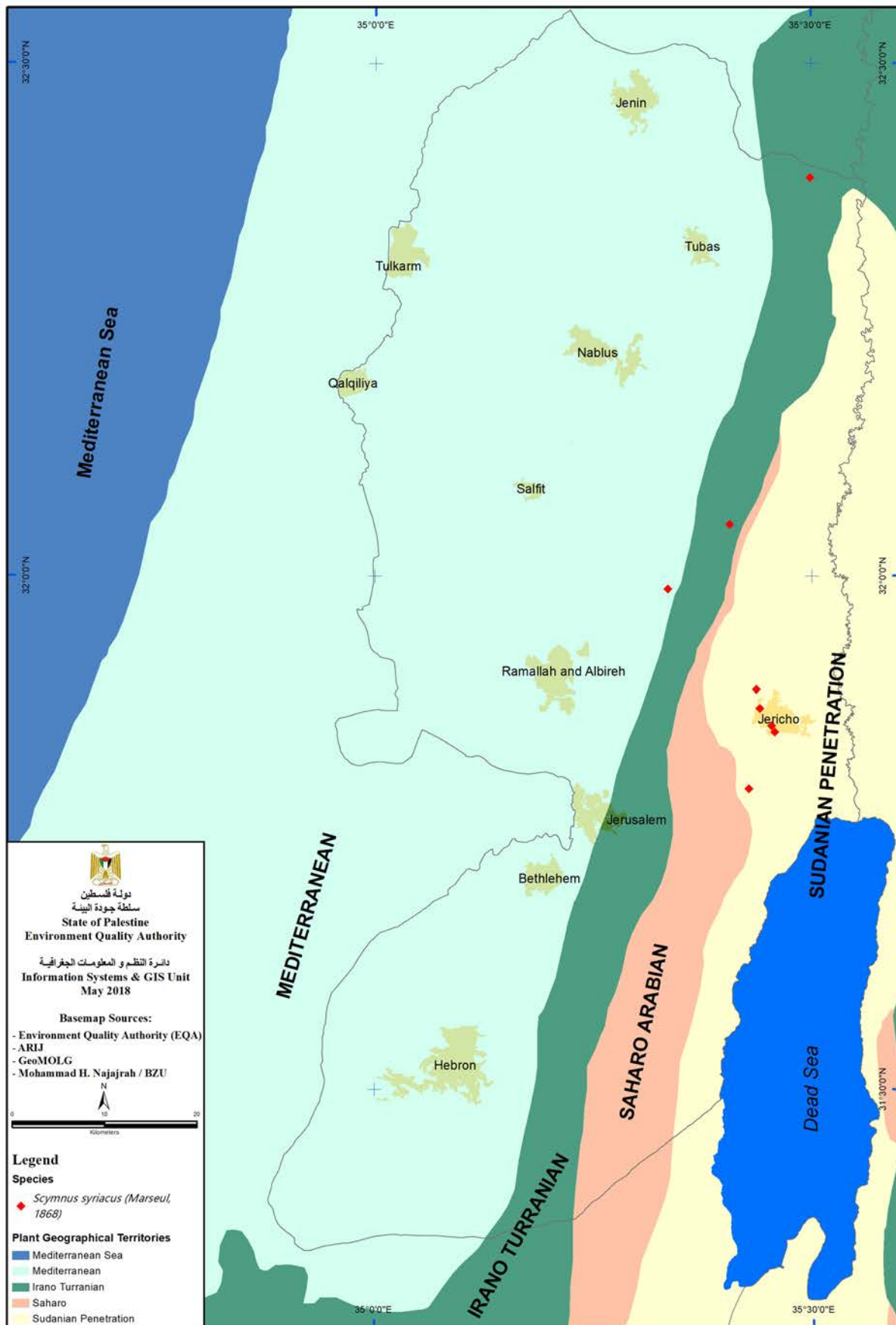


FIGURE 16. Localities where *Scymnus (Pullus) syriacus* was collected during the course of this study.

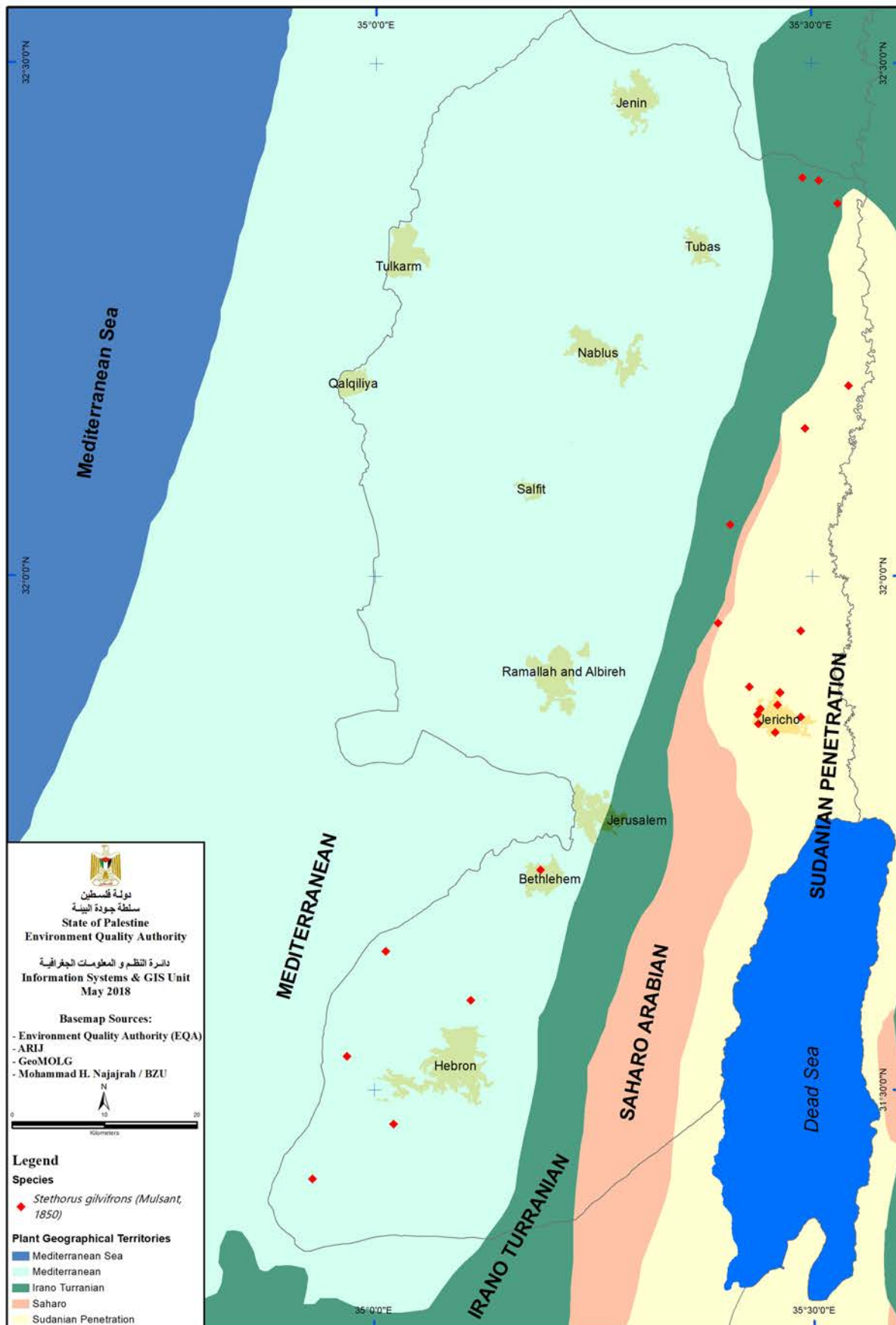


FIGURE 17. Localities where *Stethorus gilvifrons* was collected during the course of this study.

***Diomus anemicus* (Fursch, 1960)**

(Fig. 11R)

Material: Asakra (PMNH# E12435, 1, 27 March 2018). Bethlehem 1 (PMNH# E12436, 1, 1 April 2018).

Remarks: *Diomus anemicus* is 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 our study (two localities near Bethlehem) is an interesting finding. It was reported earlier from our region (Halperin *et al.* 1995).

Tribe Stethorini Dobzhansky, 1924

***Stethorus gilvifrons* (Mulsant, 1850)**

(Fig. 11S, Fig. 17)

Material: Ein AlBeida 2 (PMNH# E12756, 7, 8 March 2018). Bardala 1 (PMNH# E12757, 5, 8 March 2018). Ein Al-Sakout 1 (PMNH# E12758, 1, 7 March 2018). Far'a El-Giftlik 1 (PMNH# E12759, 14, 8 March 2018). Marj Na'je 2 (PMNH# E12760, 8, 6 March 2018). Ein Al-Duok Al Foqa (PMNH# E12761, 1, 4 March 2018). Al-Auja 1 (PMNH# E12762, 2, 6 March 2018). Ad-Dhahiriya 2 (PMNH# E12763, 8, 5 April 2018). Halhul 1 (PMNH# E12764, 1, 4 April 2018). Bayt Jala 2 (PMNH# E12765, 3, 31 March 2018). Kharas 1 (PMNH# E12766, 15, 3 April 2018). Al-Kum (PMNH# E12767, 19, 5 April 2018). Ein Al 'Auja (PMNH# E12768, 1, 16 April 2018). Ein Fasa'll (PMNH# E12769, 3, 16 April 2018). Abda (PMNH# E12770, 1, 15 April 2018). Tel Alsamrat (PMNH# E12771, 1, 23 April 2018). Nu'eima Altahta 2 (PMNH# E12772, 4, 23 April 2018). Deir Krntl 1 (PMNH# E12773, 5, 23 April 2018). Jericho 4 (PMNH# E12774, 1, 23 April 2018). Tulul Abu Al-Ala'iq 2 (PMNH# E12775, 13, 23 April 2018). Nu'eima altahta 1 (PMNH# E12776, 4, 23 April 2018). Jericho 1 (PMNH# E12777, 37, 23 April 2018). Bethlehem 1 (PMNH# E12780, 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. 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 previously from our region (Halperin *et al.* 1995).

Subfamily Sticholotidinae Weise, 1901

The Sticholotidinae are represented by two species belonging to two tribes, one common (*Pharoscygnus fleischeri*) and one very rare (*Serangium parcesetosum*).

Tribe Sticholotidini Weise, 1901

***Pharoscygnus fleischeri* (Weise, 1883)**

(Fig. 18A, Fig. 19)

Material: Ein AlBeida 2 (PMNH# E12620, 5, 8 March 2018). As-Samu (Amnyzl) (PMNH# E12621, 1, 11 March 2018). Karme (PMNH# E12622, 2, 11 March 2018). Ein Samiya (PMNH# E12623, 7, 4 March 2018). Ein Samiya (PMNH# E12624, 4, 4 March 2018). Ein Al-Duok Al Foqa (PMNH# E12625, 1, 4 March 2018). Bayt Jala 1 (PMNH# E12626, 12, 22 March 2018). Al-Khader (PMNH# E12627, 2, 22 March 2018). Bayt Jala 1 (PMNH# E12628, 10, 22 March 2018). Nahalin 3 (PMNH# E12629, 3, 20 March 2018). Nahalin 2 (PMNH# E12630, 2, 20 March 2018). Wadi Fukin 1 (PMNH# E12631, 8, 21 March 2018). Battir 2 (PMNH# E12632, 11, 21 March 2018). Battir 1 (PMNH# E12633, 6, 21 March 2018). Battir 1 (PMNH# E12634, 3, 21 March 2018). Alkhas (PMNH# E12635, 1, 18 March 2018). Umm Salmuna (PMNH# E12636, 7, 27 March 2018). Kisan (PMNH# E12637, 2, 27 March 2018). Abu Nujaym 2 (PMNH# E12638, 8, 27 March 2018). Hindaza Bredhaa (PMNH# E12639, 2, 25 Mar-

ch 2018). Asakra (PMNH# E12640, 1, 27 March 2018). Bethlehem 1 (PMNH# E12641, 10, 1 April 2018). Khamat Hamad (PMNH# E12642, 11, 27 March 2018). Irtas 1 (PMNH# E12643, 7, 25 March 2018). Irtas 2 (PMNH# E12644, 5, 25 March 2018). Bayt al-Rush (PMNH# E12645, 6, 5 April 2018). Dayr Kremzan 1 (PMNH# E12646, 9, 31 March 2018). Bayt Sahur 1 (PMNH# E12647, 1, 1 April 2018). Dayr Kremzan 2 (PMNH# E12648, 3, 31 March 2018). Ad-Dhahiriya 2 (PMNH# E12649, 10, 5 April 2018). Khirbat Safa 2 (PMNH# E12651, 2, 3 April 2018). Bayt Mirsim (PMNH# E12652, 3, 5 April 2018). Halhul 1 (PMNH# E12653, 1, 4 April 2018). Idhna 1 (PMNH# E12654, 1, 4 April 2018). Burj (PMNH# E12655, 1, 5 April 2018). Bayt Fajar 1 (PMNH# E12656, 8, 2 April 2018). Sika (PMNH# E12657, 2, 5 April 2018). Sika (PMNH# E12658, 1, 5 April 2018). Bethlehem 2 (PMNH# E12659, 6, 2 April 2018). Bayt Jala 2 (PMNH# E12660, 6, 31 March 2018). Bayt Sahur 2 (PMNH# E12661, 5, 2 April 2018). Halhul 2 (PMNH# E12662, 3, 4 April 2018). Halhul 2 (PMNH# E12663, 1, 4 April 2018). Tarqumiyah (Wadi Al Quff Reserve) 2 (PMNH# E12664, 4, 4 April 2018). Nuba (PMNH# E12665, 2, 4 April 2018). Al Aroub (PMNH# E12666, 1, 3 April 2018). Al Aroub (PMNH# E12667, 6, 3 April 2018). Bayt Ummar (PMNH# E12668, 2, 3 April 2018). Bethlehem 1 (PMNH# E12669, 3, 1 April 2018). Deir Razih 2 (PMNH# E12670, 4, 15 April 2018). Al Hijra (PMNH# E12671, 2, 12 April 2018). As-Samu (PMNH# E12672, 2, 12 April 2018). Zif 1 (PMNH# E12673, 1, 9 April 2018). Bayt Amra (PMNH# E12674, 1, 12 April 2018). Al-Rayhiyya (PMNH# E12675, 2, 12 April 2018). Hadab Al Fawar (PMNH# E12676, 12, 12 April 2018). Bani Na'im 1 (PMNH# E12677, 1, 9 April 2018). At-Tuwani (PMNH# E12678, 1, 12 April 2018). Bani Na'im 3 (PMNH# E12679, 2, 9 April 2018). Al Baqa'a 2 (PMNH# E12680, 1, 9 April 2018). Si'ir (PMNH# E12681, 2, 9 April 2018). Duma (PMNH# E12683, 13, 15 April 2018). Duma (PMNH# E12684, 1, 15 April 2018). Abda (PMNH# E12685, 1, 15 April 2018). HaRasa (PMNH# E12686, 2, 15 April 2018). Dura 1 (PMNH# E12687, 1, 15 April 2018). Tarama (PMNH# E12688, 4, 15 April 2018). Kreisa (PMNH# E12689, 5, 21 April 2018). Surif (PMNH# E12690, 3, 3 April 2018). Dura 3 (PMNH# E12691, 1, 21 April 2018).

Remarks: *Pharoscygnus fleischeri* is a common species in our region (Halperin *et al.* 1995). During this study, it was noted mostly in the Mediterranean zone on *Cupressus*, pine and oak trees.

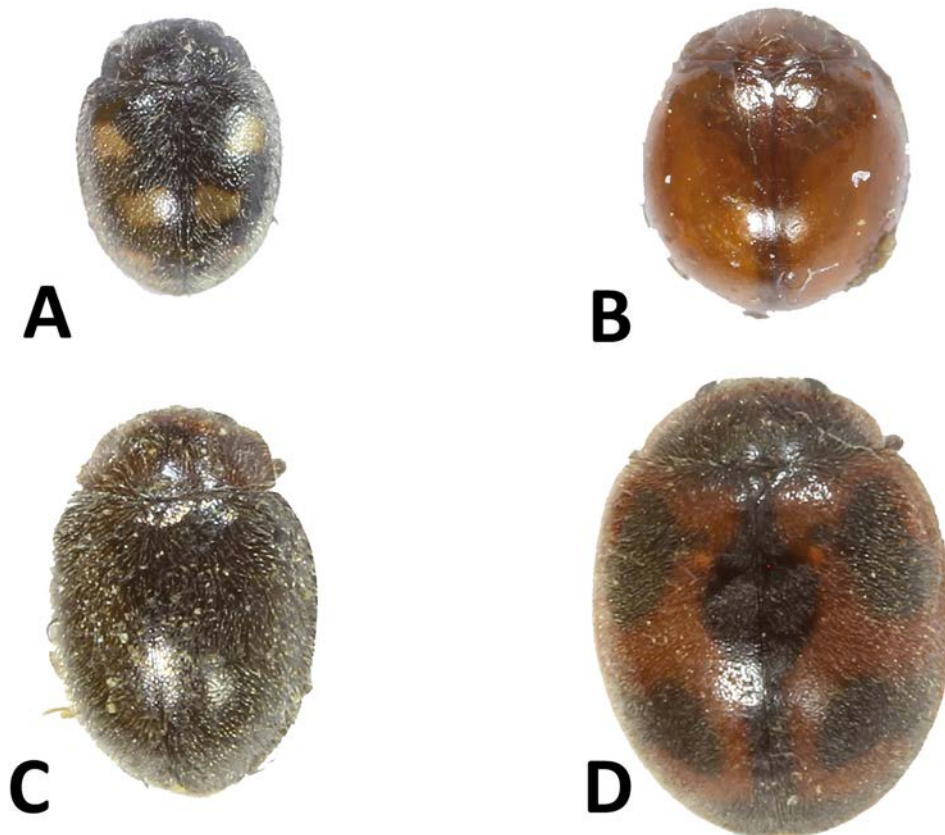


FIGURE 18. Dorsal habitus images of the Coccinellidae of the West Bank (continued): **A.** *Pharoscygnus fleischeri*, **B.** *Seranigium parcesetosum*, **C.** *Rhyzobius (Lindorus) lophanthae*, **D.** *Rodolia cardinalis* (Scale bar = 3mm).

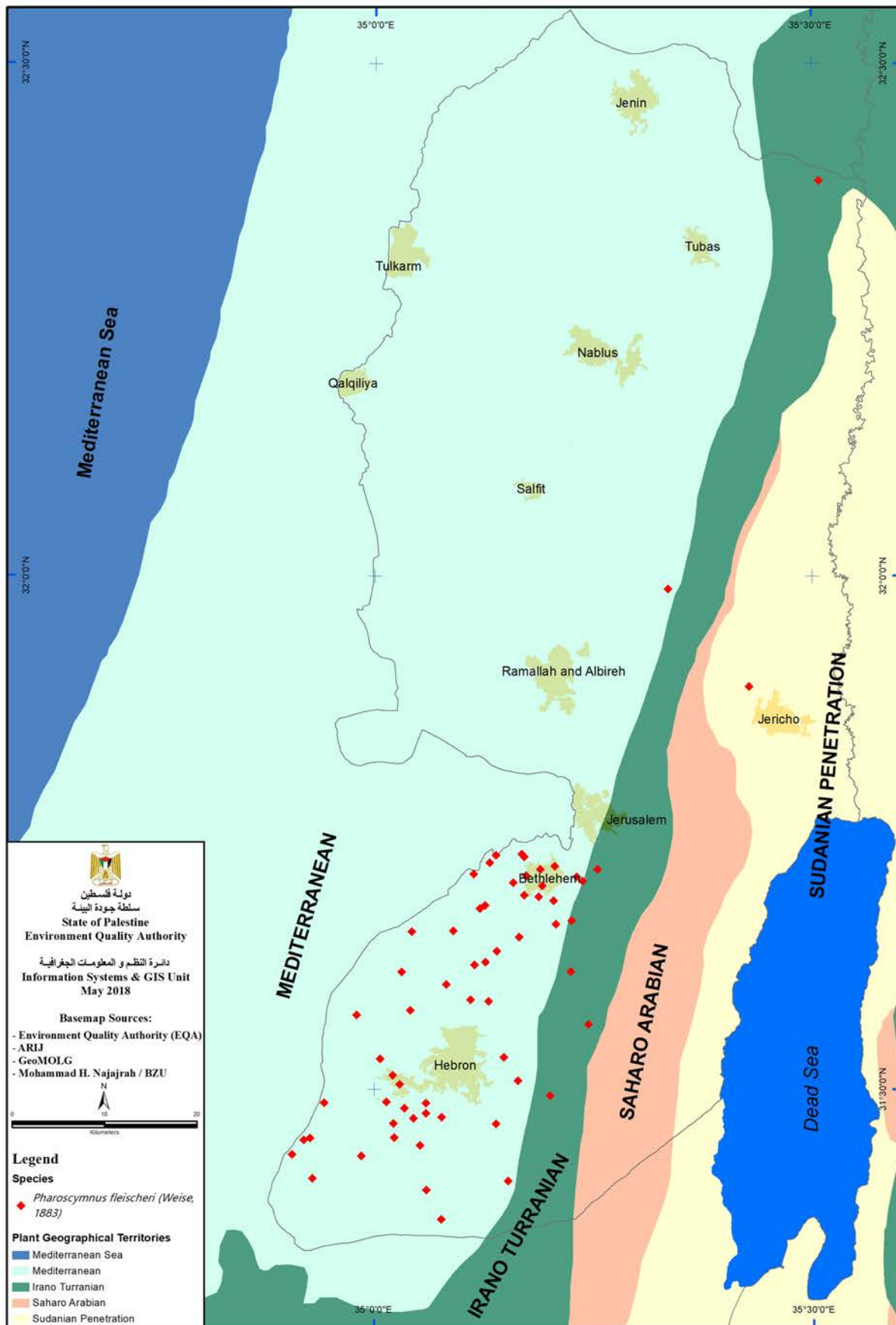


FIGURE 19. Localities where *Pharoscymnus fleischeri* was collected during the course of this study.

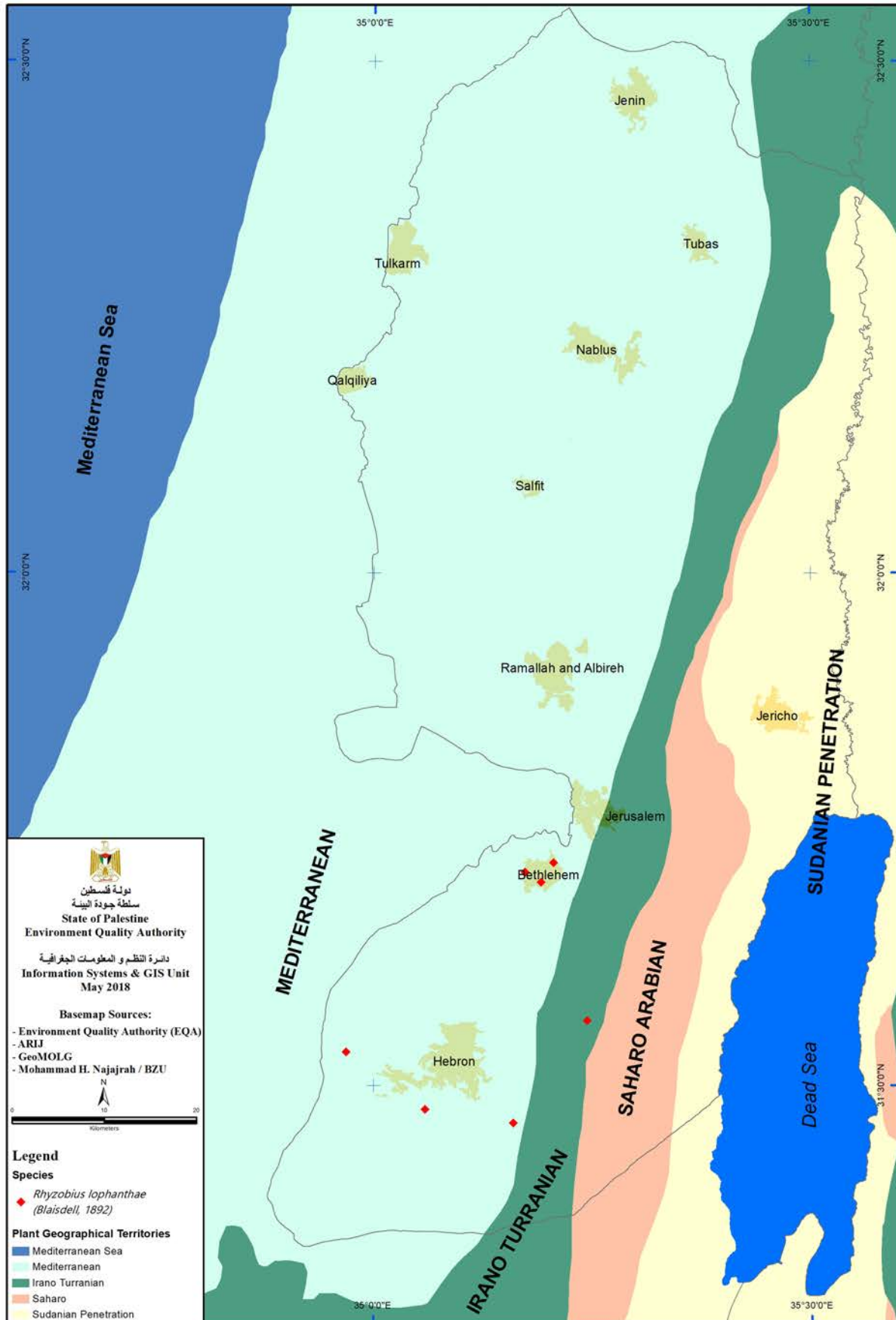


FIGURE 20. Localities where *Rhyzobius (Lindorus) lophanthae* was collected during the course of this study.

Tribe Serangiini Blackwelder, 1945

Serangium parcesetosum (Sicard, 1929)

(Fig. 18B)

Material: Ein Al-Duok Al foqa (PMNH# E12755, 41, 4 March 2018).

Remarks: *Serangium parcesetosum*, was introduced in our region in 1989 (Argov 1994; Mendel *et al.* 2017). Our specimens seem closer to *S. montazerii* in morphology, but examination of the reproductive organs confirm that the sample is *Serangium parcesetosum*. During this study, it was found in one site in a high density of *Ligustrum* plants infested with scale insects. A *Serangium* species (unidentified by the authors) was also noted feeding on *Bemisia tabaci* (Asiimwe *et al.* 2007).

Subfamily Coccidulinae Mulsant, 1846

The Coccidulinae are represented by one coccidiphagous species from the tribe Coccidulini.

Tribe Coccidulini Mulsant, 1846

Rhyzobius (Lindorus) lophanthae (Blaisdell, 1892)

(Fig. 18C, Fig. 20)

Material: Bayt Jala 1 (PMNH# E12694, 1, 22 March 2018). Khamat Hamad (PMNH# E12695, 10, 27 March 2018). Bethlehem 2 (PMNH# E12696, 2, 2 April 2018). Al-Kum (PMNH# E12697, 4, 5 April 2018). Bethlehem 1 (PMNH# E12698, 1, 1 April 2018). Hadab al Fawar (PMNH# E12700, 32, 12 April 2018). Al Buweib (PMNH# E12701, 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 is highly predatory on *Chrysomphalus dictyospermi* (Branco *et al.* 2017). It was reported previously from our region (Halperin *et al.* 1995). During this study, it was recorded from seven localities in the south of the West Bank.

Subfamily Ortaliinae Mulsant, 1850

The Ortaliinae are represented by one introduced species from the tribe Noviini

Tribe Noviini Mulsant, 1850

Rodolia cardinalis (Mulsant, 1850)

(Fig. 18D)

Material: Kufir al-Dik (PMNH# E12705, 2, 1 October 2017). Ad-Dhahiriya 2 (PMNH# E12702, 1, 5 April 2018). Bethlehem 1 (PMNH# E12703, 1, 1 April 2018). Wadi Kelt (PMNH# E12704, 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 *et al.* 2017). It was reported from our region before as an introduced species (Halperin *et al.* 1995). In the present study, it was observed in Kufir al-Dik and Ad-Dhahiriya 2 and was found feeding on *Icerya purchase*.

Discussion

In total, 35 species in 19 genera belonging to ten tribes representing six subfamilies of lady beetles were identified from the West Bank of Palestine. Specimens were categorized according to rarity of spreading in the study areas based on Halperin *et al.* (1995) (Table 2). Six species were noted as common 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 (we noted as rare) and nineteen species were noted in five or fewer localities and thus described as very rare (Table 2).

TABLE 2. List of the 35 species of lady beetles collected from the West Bank during the present study (March–May 2018) and their commonness. common (26–99 records), rare (6–25 records), very rare (1–5 records).

Subfamily	Tribe	Species	Commonness	
Coccinellinae	Coccinellini	<i>Adalia (Adalia) decempunctata</i> (Linnaeus, 1758)	common	
		<i>Cheilomenes propinqua nilotica</i> (Mulsant, 1850)	very rare	
		<i>Coccinella (Coccinella) septempunctata</i> (Linnaeus, 1758)	common	
		<i>Coccinella (Neococcinella) undecimpunctata</i> (Linnaeus, 1758)	rare	
		<i>Harmonia quadripunctata</i> (Pontoppidan, 1763)	very rare	
		<i>Hippodamia (Adonia) variegata</i> (Goeze, 1777)	common	
		<i>Oenopia conglobata</i> (Linnaeus, 1758)	common	
Chilocorinae	Chilocorini	<i>Chilocorus bipustulatus</i> (Linnaeus, 1758)	rare	
		<i>Exochomus nigromaculatus</i> (Goeze, 1777)	very rare	
		<i>Exochomus pubescens</i> (Kuster, 1848)	very rare	
		<i>Exochomus quadripustulatus</i> (Linnaeus, 1758)	rare	
Scymniinae	Platynaspini	<i>Platynaspis luteorubra</i> (Goeze, 1777)	very rare	
	Hyperaspidini	<i>Hyperaspis polita</i> (Weise, 1885)	very rare	
		<i>Hyperaspis syriaca</i> (Weise, 1885)	very rare	
		Scymnini	<i>Cryptolaemus montrouzieri</i> (Mulsant, 1853)	very rare
			<i>Nephus (Bipunctatus) bipunctatus</i> (Kugelann, 1794)	very rare
			<i>Nephus crucifer</i> (Fleischer, 1900)	very rare
			<i>Nephus (Sidis) hiekei</i> (Fursch, 1965)	very rare
			<i>Nephus peyerimhoffi</i> (Sicard, 1923)	very rare
			<i>Nephus (Nephus) quadrimaculatus</i> (Herbst, 1783)	common
			<i>Scymnus flavicollis</i> (Redtenbacher, 1843)	very rare
			<i>Scymnus (Parapullus) abietis</i> (Paykull, 1798)	very rare
			<i>Scymnus (Scymnus) interruptus</i> (Goeze, 1777)	very rare
			<i>Scymnus (Neopullus) limbatus</i> (Stephens, 1831)	very rare
<i>Scymnus nigropictus</i> (Wollaston, 1867)	very rare			
<i>Scymnus (Scymnus) pallipediformis</i> (Gunther, 1958)	rare			
<i>Scymnus (Pullus) subvillosus</i> (Goeze, 1777)	rare			
<i>Scymnus (Pullus) suturalis</i> (Thunberg, 1795)	rare			
<i>Scymnus syriacus</i> (Marseul, 1868)	rare			
<i>Diomus anemicus</i> (Fursch, 1960)	very rare			
Stethorini	<i>Stethorus gilvifrons</i> (Mulsant, 1850)	rare		
	Sticholotidini	<i>Pharoscymnus fleischeri</i> (Weise, 1883)	common	
Serangiini		<i>Serangium parcesetosum</i> (Sicard, 1929)	very rare	
Coccidulinae	Coccidulini	<i>Rhyzobius lophanthae</i> (Blaisdell, 1892)	rare	
Ortaliinae	Noviini	<i>Rodolia cardinalis</i> (Mulsant, 1850)	very rare	

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 fewer localities: *Cheilomenes propinqua nilotica*, *Exochomus nigromaculatus*, *Harmonia quadripunctata*, *Platynaspis luteorubra*, *Hyperaspis polita*, *Hyperaspis syriaca*, *Cryptolaemus montrouzieri*, *Nephus (Bipunctatus) bipunctatus*, *Nephus crucifer*, *Nephus (Siddis) hiekei*, *Nephus peyerimhoffi*, *Scymnus flavicollis*, *Scymnus (Neopullus) limbatus*, *Scymnus nigropictus*, *Scymnus (Parapullus) abietis*, *Scymnus (Scymnus) interruptus*, *Diomus anemicus*, *Serangium parcesetosum*, and *Rodolia cardinalis*.

Seven species out of the 35 were recorded for the first time in the West Bank: *Nephus (Bipunctatus) bipunctatus*, *N. crucifer*, *Scymnus (Scymnus) interruptus*, *S. (Parapullus) abietis*, *S. (Neopullus) limbatus*, *S. nigropictus*, and *S. (Pullus) suturalis*. All are very rare (1–5 localities) except the last one, which was found in 10 localities. One species that was introduced to Palestine in 1986 (*Nephus peyerimhoffi*) and believed to have been extirpated (Halperin *et al.* 1995) was recorded from three localities in this study.

Because of the intensive nature of the sampling in the four biogeographical zones, it is worthwhile to discuss distribution of species in those zones (Table 3).

Mediterranean Zone Species: Twenty-nine species of Coccinellidae were found to inhabit various habitats within the Mediterranean zone (comprising about 83% of the total recorded species). The high rainfall rate (>400 mm and up to 1000 mm in certain areas of the Mediterranean climatic zone) and the mild temperatures (Isaac 2002) help increase the vegetation cover and agricultural practices providing rich habitats for coccinellids. Many of the species are found in Turkey and southern Europe (which share similar climate and vegetation). Among these 29 species, ten were restricted to the Mediterranean zone. Only one species was 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) variegata*, *Oenopia conglobata*, *Scymnus (Scymnus) pallipediformis* and *Stethorus gilvifrons*, which are aphidophagous species and have a wide range of prey. Coccidulinae and Ortaliinae were represented by a single species for each subfamily in this area, while Sticholotidinae was represented by two species (Table 3).

Irano-Turanian Zone Species: The Coccinellidae 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 *Pharoscyrmus 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 3). *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 3) including *Oenopia conglobata*, *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 3). The southern part of the Sudanian zone around the Dead Sea basin harbored species such as *Hippodamia (Adonia) variegata* and *Stethorus gilvifrons* as the dominant species.

Ubiquitous species: *Coccinella septempunctata* is the most widely distributed and common species in the study area and was found in all biogeographical zones, mostly feeding on aphids on both wild plants and agricultural crops. Other species seem to follow agricultural and conifer trees wherever they are planted. For example, *Adalia (Adalia) decempunctata* was observed on almond and pine trees and *Oenopia conglobata* on almond trees. *Pharoscyrmus fleischeri* was noted in coniferous woods especially *Cupressus* trees.

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, and our data supports a need for revisions (see his figure and compare with the distribution maps shown above). The nuances of this map may actually reflect better the distribution of coccinellids than the simplified maps based on Zohary's (1947) work. 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. Further Soto-Berelev *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 at the expense of the Mediterranean zones with two major episodes (likely climatic related) happening at 4200 BP and 3000 BP. This again may explain the distribution of certain coccinellids and other fauna in our region. For example, the current distribution of *Scymnus (Pullus) suturalis* likely follows an Irano-Turanian distribution that has now invaded two other biogeographical zones (Mediterranean and Saharo Arabian).

TABLE 3. Distribution of lady beetle species collected between March–May 2018 within the four biogeographic zones of the West Bank of Palestine.

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

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

Another peculiarity of the distributions is the presence of remarkably high numbers of coccinellid species in certain localities. For example, the locality labelled “Bethlehem 1” was found to contain 15 species of coccinellids comprising 42.8 % of the total species recorded (Table 4). It may have been isolated for decades from human interference and there was no use of pesticides in the area. The area also contains olive trees, almond, lemon, cypress,

pine, apple, pear, grapes, carob, willow and rosemary as well as many wild plants such as hawthorn, oak and wild pear in addition to some vegetable crops cultivated without the use of pesticides. The Botanical Garden of the Palestine Institute of Biodiversity and Sustainability (Palestine Museum of Natural History, palestinenature.org) is also located there. The next richest localities (Ein Samiya and Dahriya 1) also had little noted pesticide and included a rich floral element.

TABLE 4. Regions of high Coccinellidae species richness of the West Bank of Palestine.

Locality	Species	Commonness	Notes
Bethlehem 1	<i>Adalia (Adalia) decempunctata</i>	common	
	<i>Coccinella (Coccinella) septempunctata</i>	common	
	<i>Oenopia conglobata</i>	common	
	<i>Harmonia quadripunctata</i>	very rare	
	<i>Exochomus nigromaculatus</i>	very rare	
	<i>Nephus peyerimhoffi</i>	very rare	Introduced species
	<i>Nephus (Nephus) quadrimaculatus</i>	common	
	<i>Scymnus flavicollis</i>	very rare	
	<i>Scymnus (Parapullus) abietis</i>	very rare	First record
	<i>Scymnus (Pullus) suturalis</i>	rare	First record
	<i>Platynaspis luteorubra</i>	very rare	
	<i>Diomus anemicus</i>	very rare	
	<i>Pharoscymnus fleischeri</i>	common	
	<i>Rhizobius lophanthae</i>	rare	
	<i>Rodolia cardinalis</i>	very rare	Introduced species
Ein Samiya	<i>Adalia (Adalia) decempunctata</i>	common	
	<i>Coccinella (Coccinella) septempunctata</i>	common	
	<i>Oenopia conglobata</i>	common	
	<i>Chilocorus bipustulatus</i>	rare	
	<i>Nephus (Nephus) quadrimaculatus</i>	common	
	<i>Scymnus (Parapullus) abietis</i>	very rare	First record
	<i>Scymnus (Pullus) suturalis</i>	rare	First record
	<i>Scymnus syriacus</i>	rare	
	<i>Pharoscymnus fleischeri</i>	common	
Ad-Dhahiriya 2	<i>Adalia (Adalia) decempunctata</i>	common	
	<i>Coccinella (Coccinella) septempunctata</i>	common	
	<i>Oenopia conglobata</i>	common	
	<i>Nephus (Nephus) quadrimaculatus</i>	common	
	<i>Scymnus (Pullus) suturalis</i>	rare	First record
	<i>Stethorus gilvifrons</i>	rare	
	<i>Pharoscymnus fleischeri</i>	common	
	<i>Rodolia cardinalis</i>	very rare	Introduced species
Bayt Jala 2	<i>Adalia (Adalia) decempunctata</i>	common	
	<i>Coccinella (Coccinella) septempunctata</i>	common	
	<i>Hippodamia (Adonia) variegata</i>	common	
	<i>Oenopia conglobata</i>	common	
	<i>Nephus (Nephus) quadrimaculatus</i>	common	
	<i>Stethorus gilvifrons</i>	rare	
	<i>Pharoscymnus fleischeri</i>	common	

.....continued on the next page

TABLE 4. (Continued)

Locality	Species	Commonness	Notes
Bethlehem 2	<i>Coccinella (Coccinella) septempunctata</i>	common	
	<i>Oenopia conglobata</i>	common	
	<i>Chilocorus bipustulatus</i>	rare	
	<i>Exochomus quadripustulatus</i>	rare	
	<i>Nephus (Nephus) quadrimaculatus</i>	common	
	<i>Pharoscymnus fleischeri</i>	common	
	<i>Rhizobius lophanthae</i>	rare	
Deir Krntl 1	<i>Adalia (Adalia) decempunctata</i>	common	
	<i>Coccinella (Coccinella) septempunctata</i>	common	
	<i>Exochomus pubescens</i>	rare	
	<i>Nephus peyerimhoffi</i>	very rare	Introduced species
	<i>Scymnus flavicollis</i>	very rare	
	<i>Scymnus syriacus</i>	rare	
	<i>Stethorus gilvifrons</i>	rare	
Irtas 1	<i>Coccinella (Coccinella) septempunctata</i>	common	
	<i>Chilocorus bipustulatus</i>	rare	
	<i>Hyperaspis polita</i>	very rare	
	<i>Nephus (Nephus) quadrimaculatus</i>	common	
	<i>Scymnus (Scymnus) pallipediformis</i>	rare	
	<i>Scymnus (Pullus) suturalis</i>	rare	First record
	<i>Pharoscymnus fleischeri</i>	common	
Jericho 1	<i>Coccinella (Coccinella) septempunctata</i>	common	
	<i>Oenopia conglobata</i>	common	
	<i>Nephus crucifer</i>	very rare	First record
	<i>Scymnus (Scymnus) interruptus</i>	very rare	First record
	<i>Scymnus nigropictus</i>	very rare	First record
	<i>Scymnus syriacus</i>	rare	
	<i>Stethorus gilvifrons</i>	rare	

Of the 35 species of coccinellids recorded from 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 fewer localities). Perhaps this is related to their low adaptability to local climate and habitats and competition with native species. In Palestinian areas behind the 1948 greenline, 24 species out of 90 were introduced species but many were not well-established (Mendel *et al.* 2017). The discrepancy in percentage of introduced species in our area vs that of 1948 Palestine (11.4% versus 26.6%) is not well understood, any many species may simply not have dispersed yet. Globally coccinellid introductions have been common but the percentage established has varied. For example, of 179 species introduced in Canada and the USA, only 27 were established (Honek 2015). However, established introduced species are known to occasionally displace native species of Coccinellidae (Honek 2015).

Most species of coccinellids are considered to be predators, which has attracted the attention of many researchers for use them in biological control (Salehi *et al.* 2011). Where 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). 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. Environmental threats in Palestine are indeed causing decline in biodiversity and warrant significant interventions to help preserve

what remains (EQA 2015; Qumsiye & Amr 2018; Qumsiye *et al.* 2017). Our data may work as a baseline for comparison to assess such changes.

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. Heavy use of pesticides in farms has resulted in the elimination of many of the Coccinellidae 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. The presence of some trees such as *Ligustrum*, *Cupressus* and almond trees in some of the farms has been noted and the presence of lady beetles on these trees was recorded during the use of pesticides in the farms. *Coccinella (Coccinella) septempunctata* and *Hippodamia (Adonia) variegata* are 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. This suggests the use of pesticides causes lady beetles to escape to farm edges where vegetation should not be sprayed. Farms that use a polyculture system have higher lady beetle diversity than the farms that have a monoculture system (Cook-Patton *et al.* 2011). Our data points to additional work that must be undertaken to understand dynamics of native biological control species in our region, as well as educating farmers about their use.

Acknowledgements

The authors would like to thank Birzeit University for the financial support of the study and for Palestine Museum of Natural History whose provided laboratory space to process and identify samples during this study. The cooperation of the Environmental Quality Authority represented by Dr. Issa Moussa and Mr. Khalid Salem in the Information Systems & GIS Unit in drawing the distribution maps is highly appreciated. In addition, we would like to thank Mr. Elias Handel from the Museum for photographing the samples and we would to thank Mr. Mohammad Abu Sarhan for his help to the first author. Finally, we would to extend our thanks to our editor Dr. Tommy McElrath, as well as special thanks for Dr. Natalia J. Vandenberg and an anonymous reviewer, for their edits and suggestions to improve the text.

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