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SURVEY AND DISTRIBUTION OF LADY BEETLES [*COCCINELLIDAE*] IN CITRUS GROVES IN ISRAEL (*)

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The importance of *Coccinellidae* species found in the citrus groves of Israel was evaluated according to their prey, frequency and distribution. Dense populations of aphidophagous coccinellids were found very often, feeding on scale insects in citrus groves where none of their usual prey was present; these may therefore also be important as scale predators. A few species were distributed equally in all areas, some were more frequent in the Coastal Plain and others in the warmer parts of the country.

Throughout the world, lady beetles are known to be very important in biological control. Some coccinellids, mainly predators of aphids, mites and date palm pests, have already been studied in Israel (AVIDOV & HARPAZ, 1969; BODENHEIMER & SWIRSKI, 1957; HARPAZ, 1953; KEHAT, 1967, 1968 a; PLAUT, 1949, 1965). However, relatively little research has been carried out to determine the importance of lady beetles in the citrus groves of Israel; only *Chilocorus bipustulatus* L. (HECHT, 1936; NADEL & BIRON, 1964; ROSEN & GERSON, 1965; YINON, 1969 a, b) and a few additional mealybug predators (BODENHEIMER, 1951; RIVNAY & PERZELAN, 1943) have been studied. The present work was therefore aimed at studying the Coccinellidae occurring in Israel's citrus groves, and their frequency and distribution throughout the country.

Materials and Methods

During the summers of the years 1967-1969, beetles were methodically collected in a few representative groves, in each of the citrus

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regions of this country. Their most frequent prey were scale insects, particularly *Aonidiella aurantii* MASK., *Ceroplastes floridensis* COMST., *Parlatoria pergandii* COMST., *Coccus hesperidum* L., *Saissetia oleae* BERN. and, to a considerably lesser extent, mealybugs and mites. The aphids *Toxoptora aurantii* BOYER and *Aphis gossypii* GLOVER. which may attack citrus groves, or other *Aphididae* which feed on herbaceous plants occurring in the groves, were entirely absent during the summer. The beetles collected were identified and the percentage of each species in the sample was calculated. The composition of the collected predators was calculated for each grove separately, since the groves in any one region may differ as to age, microclimate, host composition, etc.

Estimation of species frequency presents some difficulties, since it may differ from grove to grove within a region. In each given area, the frequency was rated as follows,: low—no grove with more than 10% of the species in the sample; intermediate—up to 20% of the sample from any one grove within the area; and high—more than 20% of the sample from any one grove within the area. The frequencies obtained (Table 1) are representative of the actual comparative species densities in most citrus groves within a given area. The importance of *Coccinellidae* species found in the citrus groves of Israel was evaluated according to their prey, frequency and distribution.

Results and Discussion

The coccinellids found in Israel citrus groves may be divided, according to their prey, into the following five groups: Group 1: Coccidophagous; Group 2: Aphidophagous; Group 3: Mealybug predators; Group 4: Acarophagous; Group 5: Fluted scale predators (Table 1).

This classification, which follows common entomological practices, is based on surveys and investigations carried out in Israel as well as abroad. However, due to the polyphagous nature of coccinellids and to their ability to exist on alternative foods when their particular prey is absent, this classification is rather artificial. Such a classification may not necessarily give a true estimation of the importance of coccinellids in citrus groves. Thus, many aphidophagous coccinellids or predators of mites and mealybugs were often found, in quite large numbers, feeding on crawlers of scale insects (SMIRNOFF, 1956). Some of the aphidophagous coccinellids collected in the present survey (*S. apetzi*, *S. subvillosus*, *S. frontalis*, *S. bipunctatus*) survived in our laboratory for a long time when fed on scale insects. Much additional evidence has been recorded on the wide range of foods accepted by coccinellids (CLAUSEN, 1956; EBELING, 1959; HAGEN,

TABLE 1

Coccinellidae found in the present survey in Israel citrus groves

Species	Prey (group)	Distribution (group)	Frequency & distribution (group)	Frequency in different regions: Warmer parts of the country: Hula Valley	Jordan Valley	Bet She'an Valley	Plain of Yizre'el	Northern Negev	Coastal Plain: Northern	Carmel	Shomron	Sharon	Rehovot	Southern
1. *Chilocorus bipustulatus* L.	1	I	A	++	+	+	+	++	+++	+++	+++	+++	+++	+++
2. *Pharoscymnus pharoides* MARS.	1	II	A	+++	++	++	++	+	+	+	+	+	+	—
3. *Lindorus lophantae* BLAISD.	1	II	A	—	+++	+++	+	+	+++	++	+	—	+	—
4. *Scymnus interruptus* GOEZE	2	I	A	—	+	++	+	+	+++	++	+++	+++	+++	+++
5. *Scymnus apetzi* MULS.	2, 3	I	A	+	++	++	—	—	++	+	+++	+++	+++	+++
6. *Scymnus subvillosus* GOEZE	2	III	A	—	+	++	+	—	++	++	+	+	+	++
7. *Scymnus pallidivestis* MULS.	2, 3	II	A	—	+	+++	+	+	+	—	+	—	+	++
8. *Rodolia cardinalis* MULS.	5	III	A	++	++	+	+	+++	++	++	++	++	++	++
9. *Stethorus gilvifrons* MULS.	4	II	A	++	+++	+	+	+++	—	—	—	—	+	+
10. *Exochomus quadripustulatus* L.	1, 2	I	B	—	—	—	—	—	—	—	++	+	+++	+
11. *Scymnus quadrimaculatus* HERBST.	2, 3	IV	B	+	+	—	+	—	—	+	+	—	—	++
12. *Scymnus bipunctatus* KUGEL.	2	II	B	—	++	++	+	—	—	—	+	—	—	+
13. *Scymnus frontalis* FABR.	2	IV	B	+	—	—	—	—	++	—	+	+	+	+
14. *Synharmonia conglobata* L.	2	I	B	—	++	+	—	—	—	+	+++	+++	+++	—
15. *Coccinella undecimpunctata* L.	2	III	B	+	+	+	—	++	+	—	++	+	+	++
16. *Coccinella septempunctata* L.	2	III	B	+	+	+	+	+	+	+	+	+	+	+
17. *Scymnus (pullus)* (unidentified)	»	II	B	—	—	—	—	+++	—	—	—	—	—	—
18. *Exochomus flavipes* THUNB.	1, 2	IV	C	+	+	+	—	—	—	—	+	—	—	—
19. *Propylaea quattuordecimpunctata* L.	2	IV	C	—	—	—	—	—	—	+	++	+	+	—
20. *Adonia variegata* GOEZE	2	IV	C	—	+	+	—	+	—	—	+	—	+	+
21. *Chilomenes vicina* MULS.	2	IV	C	—	—	—	—	—	—	—	—	+	—	—
22. *Adalia decempunctata* L.	2	IV	C	—	—	—	—	—	—	—	+	—	—	—
23. *Scymnus* sp. (unidentified)	»	IV	C	—	++	—	—	—	—	—	+	+	+	—

PREY: 1, Coccidophagous; 2, Aphidophagous; 3, Mealybug predators; 4, Acarophagous; 5, Fluted scale (*Icerya purchasi* MASK.) predators.

DISTRIBUTION: I, Mainly prevalent in the Coastal Plain; II, more frequent in the warmer parts; III, distributed equally in all areas; IV, distribution tendencies not yet clear.

FREQUENCY AND DISTRIBUTION: A, frequent and widely distributed; B, less frequent and widely distributed or frequent but locally distributed; C, low frequency and locally distributed; D, not found in the present survey.

FREQUENCY IN DIFFERENT REGIONS: +++, high; ++, intermediate; +, low; —, not found.

1962; HAGEN & BOSCH, 1968; HODEK, 1967; KEHAT, 1968 b). Dense populations of aphidophagous beetles, when constantly found in citrus groves where none of their particular prey is present, may therefore be of some significance in controlling scale insects and other pests — even though this may be due to their adult activity only. Such a situation very often prevails in Israel. The importance of lady beetles should therefore be evaluated not only by their food specificity or voltinism type, but also by their frequency and distribution in the grove.

The common, relatively frequent species, may be divided according to their distribution into the following groups: Group I. Species mainly prevalent in citrus groves of the Coastal Plain. Group II. Species more frequent in the warmer parts of the country. Group III. Species distributed equally in all areas. Group IV. Infrequent species, the distribution of which is difficult to determine (Table 1).

Frequency and distribution of lady beetles, as indicated in this work, might change in the future with alterations of microclimatic conditions, host composition and cultural practices. Nevertheless, since we have to consider primarily the combined efficiency of all the Coccinellidae present as a group, rather than the specific efficiency of each species, frequency and distribution are of great significance. Bearing this in mind, the species may be divided into the three groups presented in Table 1 : Group A includes the most frequent and widely distributed species. These constitute the most important predators of citrus pests. Group B includes the less frequent species and those whose distribution is somewhat restricted. These species may be of some value as citrus pest predators. Group C includes the species with low frequency, found only in a few groves. These are of either little or no importance in the biological control of citrus pests. Group D, the species known in the past to occur in citrus groves (BODENHEIMER, 1951; RIVNAY & PERZELAN, 1943) but not found in the present survey are of no importance in citrus groves.

These species are : *Hyperaspis polita* WS., *H. pumila* MULS., *Cryptolaemus montrouzieri* MULS., *Scymnus includens* KIRSCH., *Sc. fenestratus* J. SHALB., *Littophilus marginatus* RTT., mealybug predators; *Scymnus suturalis* THUMB., aphidophagous and mealybug predator; *Stethorus punctillum* WS., acarophagous.

RÉSUMÉ

Inventaire et distribution des Coccinellides dans des plantations d'agrumes en Israël

Le rôle des différentes espèces de Coccinellides rencontrées dans les plantations d'agrumes en Israël a été évalué selon leurs proies, leur fréquence et leur distribution.

Très souvent des Coccinellides aphidiphages ont été trouvées dévorant des cochenilles dans des plantations dépourvues de leur proie habituelle; elles peuvent donc être considérées aussi comme des prédateurs importants de cochenilles. Parmi certaines espèces ubiquistes, une partie a été plus fréquente dans la région côtière et une autre dans les régions chaudes du pays. 29 espèces ont été déterminées, dont les suivantes ont été rencontrées en nombre élevé : *Chilocorus bipustulatus* L., *Lindorus lophantae* BLAISD., *Pharoscymnus pharoides* MARS., *Scymnus interruptus* GOEZE, *Sc. apetzi* MULS., *Sc. pallidivestis* MULS., *Sc. subvillosus* GOEZE, *Stethorus gracilis* MOTSCH., *Rodolia cardinalis* MULS.; elles sont d'une importance primordiale comme prédateurs d'insectes nuisibles aux agrumes. Huit autres espèces plus rares, ayant aussi une répartition plus limitée, ont une valeur prédatrice moindre, tandis que l'importance de 12 autres espèces peut être considérée comme négligeable.

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