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Natural Enemies of *Ceroplastes* Species (Homoptera: Coccidae), Their Efficiency and Population Movement in Citrus Orchards in the Eastern Mediterranean Region of Turkey

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ABSTRACT

This study was carried out to determine natural enemies of *Ceroplastes* species, their efficiency and population movement due to increasing in population of the Floridae wax scale (Homoptera: Coccidae) in citrus orchards in the Eastern Mediterranean region of Turkey, recently. Survey was carried out in citrus orchards and non-cultivated areas in the provinces of (Adana, Mersin, Osmaniye and Hatay) the Eastern Mediterranean region according to the systematic sampling method, in terms of 0.01 % in totally numbers of tree. Moreover, natural enemies of the pest and population movement were determined in three citrus orchards infected with *Ceroplastes* spp. Sampling of each orchard was made in 10 citrus trees with 5 shoots and 20 leaves in different directions of each tree in every forthnight from April to October. The natural enemies were determined as *Scutellista* sp. (Hymenoptera: Pteromalidae), *Aprostocetus toddaliae* (Risbec) (Hymenoptera: Eulophidae), *Microterys neitneri* (Motschulsky) (Hymenoptera: Encyrtidae), *Chyrsoperla carnea* (Steph.), *Conwentzia* sp. (Neuroptera: Chrysopidae), *Paraseiulus soleiger* (Ribaga) (Acarina: Phytoseiidae), *Scymnus rubromaculatus* (Goeze), *Coccinella* spp., *Rodolia cardinalis* (Muls) and *Stethorus* sp. (Coleoptera: Coccinellidae) species. The highest parasitation rate was found in the third stage larvae followed by the second stage larvae and mature female individuals, respectively. The parasitation rate was 1-10 % in citrus orchards, 20-30 % on hosts (laurel) around the orchards.

Key words: Citrus, Floridae wax scale, natural enemies, parasitation rate, population movement.

INTRODUCTION

Wax scale is a group of the most important insects pests of citrus orchards, fruit trees and ornamental plants in Turkey (Ülgentürk *et al*., 2001; Kaydan *et al*., 2004). Florida wax scale (Homoptera: Coccidae) has become an important problem in citrus of Mediterranean Region in recent years. Wax scales damage the plants by sucking the juices. Heavily infested plants appear unhealthy and decrease new growth. Scales fed on leaves, fruit, twigs, branches, and/or tree trunks, excrete large amounts of

honeydew, excretion is an excellent medium for the growth of a fungus that coats the top side of leaves, reducing the photosynthetic capability of the leaves and low external fruit quality. It is difficult to control them due to their wax cover playing a protective role. Chemical control is frequently followed by recurrent infestations of the target pests and outbreaks of non-target organisms. For these reason, alternative pest control methods are being sought. Scale insect has many natural enemies, such as predators, parasites, and pathogens (Erler & Tunç, 2001; Ülgentürk *et al*., 2004). Under most conditions, predators and parasites suppress scale pest populations to a level where chemical intervention is unnecessary. When scale insects are not controlled, high populations damage leaf, fruit, twig, branch and trunk of tree. In these situations, integrated pest management (IPM) is used since it reduces negative effects on natural enemies (Futch *et al*., 2001). Data on the natural enemies observed and collected with the scale samples provide an important and useful role for biological control initiatives for IPM programs. The purpose of this study was to determine natural enemies of Florida wax scale, their efficiency and population movement in citrus orchards, during the years of 2003-2005 in the Eastern Mediterranean Region (Adana, Mersin, Osmaniye and Hatay) of Turkey. The study will be helpful for biological control of this pest based on the information on the natural enemy and its efficiency.

MATERIALS AND METHODS

Determination of Natural Enemies of *Ceroplastes* Species

The provinces where citrus growing is widespread are divided into subregions; Adana (Seyhan, Yüreğir, Karataş, Kozan), Mersin (Center, Tarsus, Erdemli, Silifke), Hatay (Erzin, Dörtyol, İskenderun, Samandağ) and Osmaniye (Kadirli, Sumbas). Survey was conducted according to the systematic sampling method based on 0.01% of the total trees (Bora & Karaca, 1970; Table 1). In these subregions, the numbers of the tree sampled in citrus orchards was determined with respect to Lazarov and Grigorov (1961).

Determining of Parasitoids: The shoots (15-20cm long) contaminated with *Ceroplastes floridensis* Comstock and *Ceroplastes rusci* (L.) were cultured after cleaning from pests except *Ceroplastes* sp. By making use of the light seeking feature of *C. floridensis* and *C. rusci* parasitoids, the shoots contaminated with *Ceroplastes* sp. were placed in darkened (with black polyethylene) plastic bottles to obtain parasitoids. A glass tube was placed to the open side of the bottle to collect the parasitoids and controlled twice a day. Moreover, the bush, fig and bay laurel plants were observed to determine the natural parasitation throughout.

Table 1. Research Conducted in Provinces and Villages and the Numbers of Tree in the Eastern Mediterranean Region of Turkey

Provinces	Subregions	The numbers of total citrus tree	The numbers of citrus tree surveyed
Adana	Seyhan	1.152.800	115
	Yüreğir	2.951.500	295
	Karataş	294.960	29
	Kozan	1.743.400	174
	Total	6.142.660	613
Mersin	Center	2.960.060	296
	Tarsus	1.355.920	135
	Erdemli	1.887.050	188
	Silifke	387.625	38
	Total	6.590.655	657
Hatay	Erzin	1.626.200	162
	Dörtyol	1.488.000	148
	İskenderun	503.000	50
	Samandağ	576.000	57
	Total	4.193.200	417
Osmaniye	Kadirli	70.386	7
	Sumbas	140.772	14
	Total	211.158	21

Determining of Predators: The "visual sampling" and "beat sheet sampling" were used to determine the predators. In visual sampling three trees were observed for three minutes; in beat sheet sampling, 15 to 20 trees were chosen and the sample were collected by using Japan umbrella (1x1m²) and each tree was stroke 3 times (totally 45-60 strikes). Among the insects, the predators were collected and recorded to be identified.

Population Movement of Natural Enemies of *Ceroplastes* Species

The population observation of pests was carried out in an orange orchard including 1550 orange trees contaminated with pest in Adana (Zağarlı) and in a lemon orchard including 10.000 trees in Mersin (Erdemli) in the first year; in a lemon and orange orchard including 550 trees in Adana (Kozan) in the second year. Sampling in each

orchard was made in 10 citrus trees with 5 shoots and 20 leaves in different directions of each tree in every forthnight from April to October (Ben-Dov, 1976) and examined in the laboratory (Ben-Dov, 1976; Soylu, 1976).

RESULTS AND DISCUSSION

Determination of Natural Enemies of *Ceroplastes* Species

Three parasitoids species belonging to three families (Pteromalidae, Eulophidae, Encyrtidae) of Hymenoptera and seven predators species belonging to four families (Chrysopidae, Cocinellidae, Phytoseiidae, Coniopterygidae) were collected from scale insects (Table 2). The parasitoids belonging to order of Hymenoptera were determined as *Scutellista* sp. (Hym.: Pteromalidae); *Aprostocetus toddaliae* (Risbec) (Hym.: Eulophidae) and *Microterys neitneri* (Motschulsky) (Hym.: Encyrtidae). Soylu (1976) found that *Scutellista cyanea* Motsch. (Hym.: Pteromalidae), *Coccophagus scutellaris* Dalm. (Hym.: Aphelinidae), *Tetrastichus* sp. (Hym.: Eulophidae) as parasitoids species of C. *floridensis.* Huang & Huang (1988), found eight parasitoids species belonging to order of Hymenoptera among the natural enemies of *C. floridensis* and the most widespread families were observed as Encyrtidae, Eulopidae, Aphelinidae and Pteromalidae. The most common species of *C. floridensis* was found as *Tetrastichus ceroplastae* (*Aprostocetus ceroplastae*), *Microterys flavus, Metaphycus flavus* Howard (Hym.: Encyrtidae), *Moranila californica* Howard (Hym.: Pteromalidae) and *Scutellista cyanea* Motsch. by Argov *et al*., (1992). Two parasitoids determined in the study were similar to the other survey studies. The most common species was *Scutellista* sp. Karacaoğlu *et al*., (2004) reported that three parasitoids species were found in *Ceroplastes* populations and the most common predator species was *Chilocorus bipustulatus* (L.) (Col.: Coccinellidae). In the study, 7 predator species differ from the earlier survey were determined (Table 2).

Four different families were identified in Zağarlı, Erdemli and Kozan subregions (Table 2). S*tethorus* sp were abundant due to the excessive mite population in the orange orchard in Zağarlı in May. The decreasing number of pesticide performance led to the intensive population of *Stethorus,* which kept the pest under economic threshold. Besides, only two *Conwentzia* sp. were found. Various predators observed in accordance with pest populations in Erdemli orchard surrounded by bushy plants. *Rodolia cardinalis* (Muls) identified when the population of *Icerya purchasi* (Mask.) increased. *Scymnus rubromaculatus* (Goeze) was found in low intensity in June-

August period. This predator is mentioned among *Ceroplastes* sp. predators (Anonymous, 1997). *Coccinella* spp. were found in various numbers. *Chrysoperla carnea* (Steph) is a common predator noticed in all the three orchards at different times and amounts. *Paraseiulus soleiger* (Ribaga,) was recorded at periods when mature females and active larvae of *Ceroplastes* sp. were intensive in all three orchards. This beneficial acarus is found in leaf dropping trees (willow, oak, acacia etc.) (Kabirec, 2003). These trees are thought to be the host to pass on to citrus orchards. The same species was found but in varying amounts in all the three orchards (Table 2).

Table 2. The Numbers of Predator Determined in Adana (Zağarlı), Mersin (Erdemli) and Adana (Kozan) in Citrus Plantations

Predators	Order	Family	Zağarlı			Erdemli			Kozan	
			2003	2004	2005	2003	2004	2005	2004	2005
Chyrsoperla carnea (Steph.)	Neuroptera	Chrysopidae	9	16	22	44	48	40	32	28
Stethorus sp.	Coleoptera	Coccinellidae	-	142	132	6	-	-	2	6
Paraseiulus soleiger (Ribaga,)	Acarina	Phytoseiidae	-	19	15	23	33	28	95	69
Conwentzia sp.	Neuroptera	Coniopterygidae	-	2	-	7	10	12	2	3
Scymnus rubromaculatus (Goeze)	Coleoptera	Coccinellidae	-	-	-	11	18	23	25	23
Coccinella spp.	Coleoptera	Coccinellidae	-	-	-	3		11	-	-
Rodolia cardinalis (Muls)	Coleoptera	Coccinellidae	-	-	-	12	21	15	-	-
Total			9	179	169	106	130	129	156	129
			357			365			285	

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Population Movement of Natural Enemies of *Ceroplastes* Species

Population movement of alive and individuals emerged parasitoid of *C. floridensis* in orange orchards in Adana (Zağarlı) during the years of 2003-2005 is given in (Fig.1a, b). In the first year, only 25 parasitized individuals were identified till the end of September. In the second year, the parasitized individuals were seen only in October-January period and during the summer no parasitized individual was found. In the second generation; the numbers of parasitized individual was low in September due to not being found the third stage larvae of wax scale which parasitoids prefer. Most of the larvae were in the first stage. The emerged parasitoid observed in December and January thought to be the individuals left over from the previous months. In the third year, the numbers of parasitized individual was low (15-20 individuals) in May and June. The highest parasitation rate was found in the third stage larvae followed by the second stage larvae and mature female individuals, respectively (Fig. 1a, b). Wakgari (2001) pointed out the pest prefers third stage larvae and the preoviposition period of females.

Population movement of alive and emerged parasitoid of *C. floridensis* and *C. rusci* in lemon orchards in Mersin (Erdemli) during the years of 2004-2005 is given in (Fig. 2 and 3). The parasitation rate of *C. floridensis* was similar to the *C. rusci* in lemon orchard. The individuals of second and third stage larvae with mature female were found parasitized from the beginning of August although there was no any parasitation from March to July. The highest rate of parasitation was seen in September in the second stage larvae followed by third stage and mature female individuals, respectively. No parasitation was noticed in the first stage larvae. In the individuals of the second generation, the parasitation has been noticed to rise in October (Fig. 2 and 3.)

Population movement of alive and emerged parasitoid of *C. rusci* in lemon orchards in Adana (Kozan) during the years of 2004-2005 is given in (Fig. 4). The numbers of parasitized individual was found low with10-15 individuals in the first

year and 25-30 individuals in the second year only in August and September due to using a broad spectrum insecticide against pests in previous year. In the second year, there was a rise in parasitation even if a very low one (Fig. 4).

The highest parasitation rate was observed in the second and third stage larvae. Parasitation was started to be noticed in July. Similarly, Soylu (1976) pointed out parasitation was highly seen in the third stage larvae followed in the second stage larvae and mature females, respectively.

The parasitation rate was 1-10 % in citrus orchards, 20-30 % on hosts (laurel) around the orchards. Huang & Huang (1988) pointed out that the parasitation rate of *C. floridensis* was 26.3%.

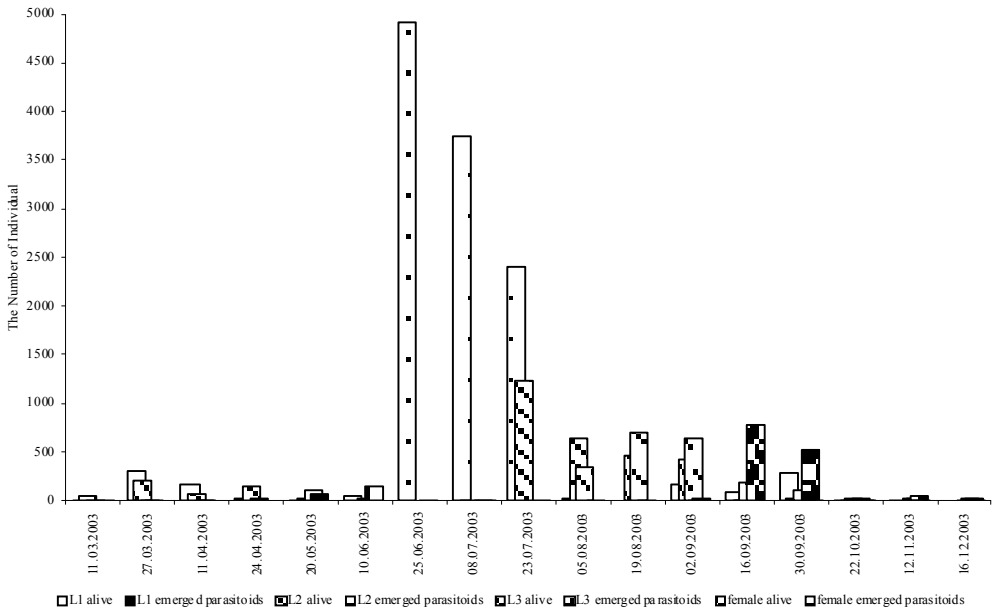


Fig. 1a. Population movement of alive and emerged parasitoid of *Ceroplastes floridensis* in orange orchards in Adana (Zağarlı) during the year of 2003.

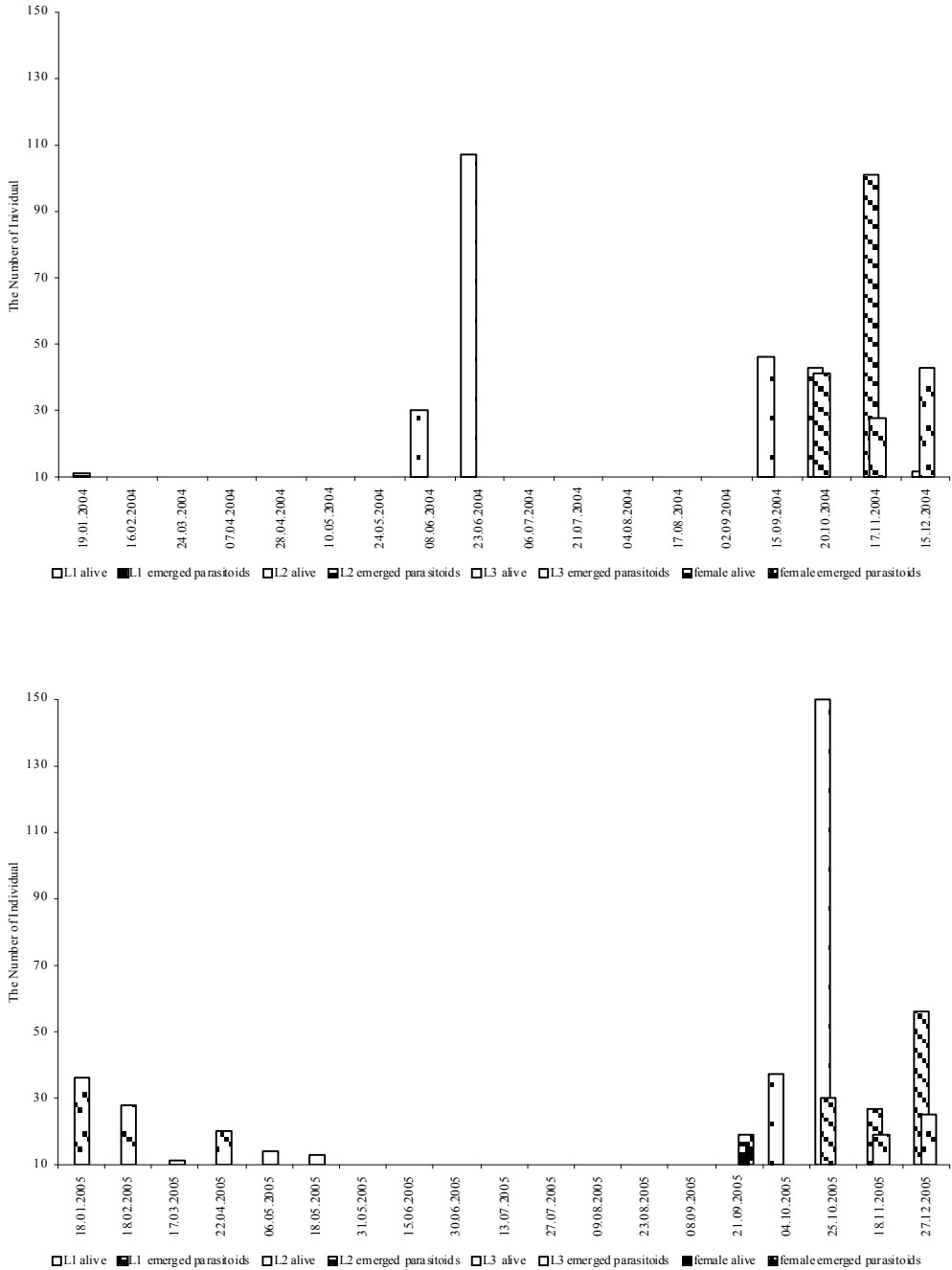


Fig. 1b. Population movement of alive and emerged parasitoid of *Ceroplastes floridensis* in orange orchards in Adana (Zağarlı) during the years of 2004-2005.

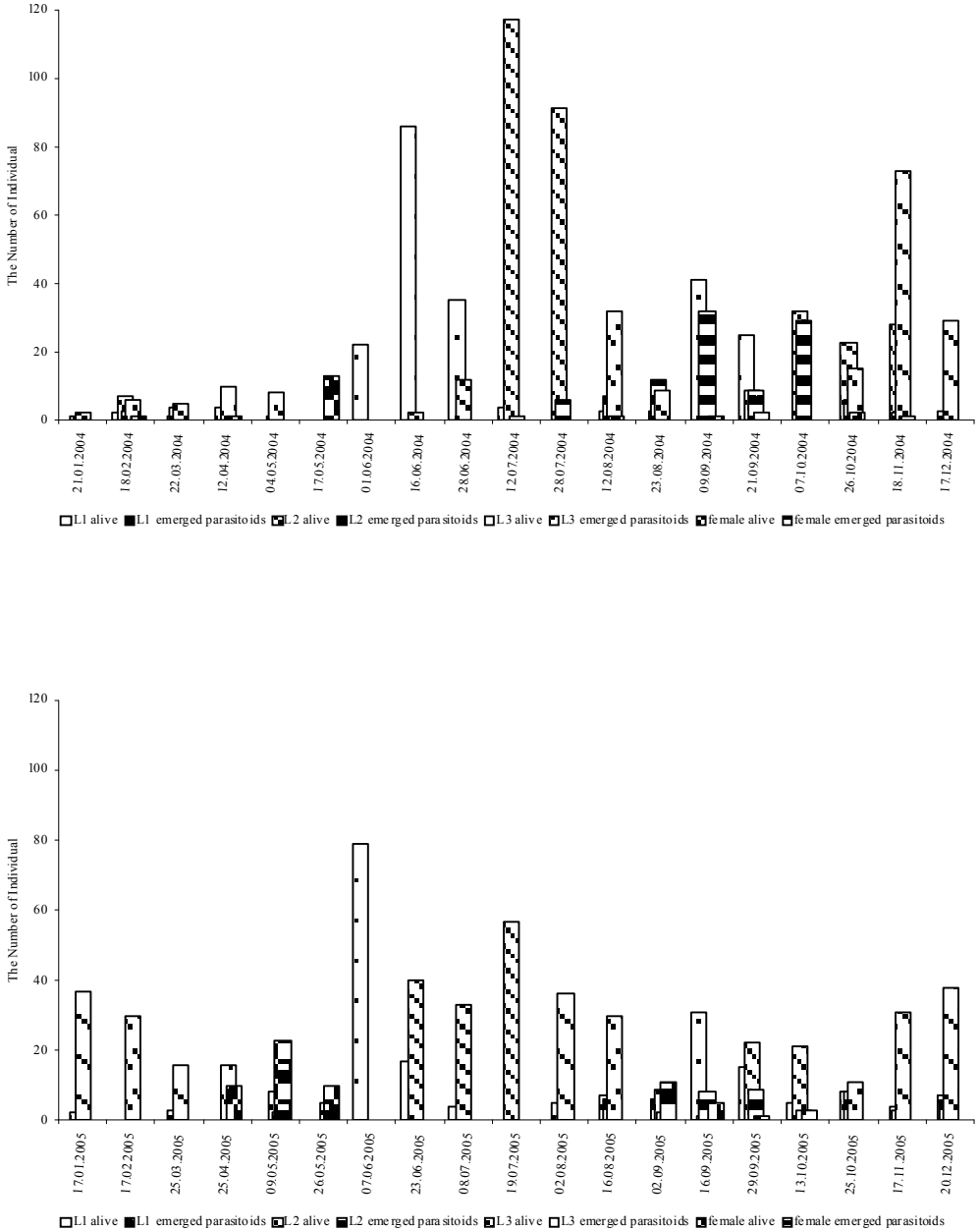


Fig. 2. Population movement of alive and emerged parasitoid of *Ceroplastes floridensis* in lemon orchards in Mersin (Erdemli) during the years of 2004-2005.

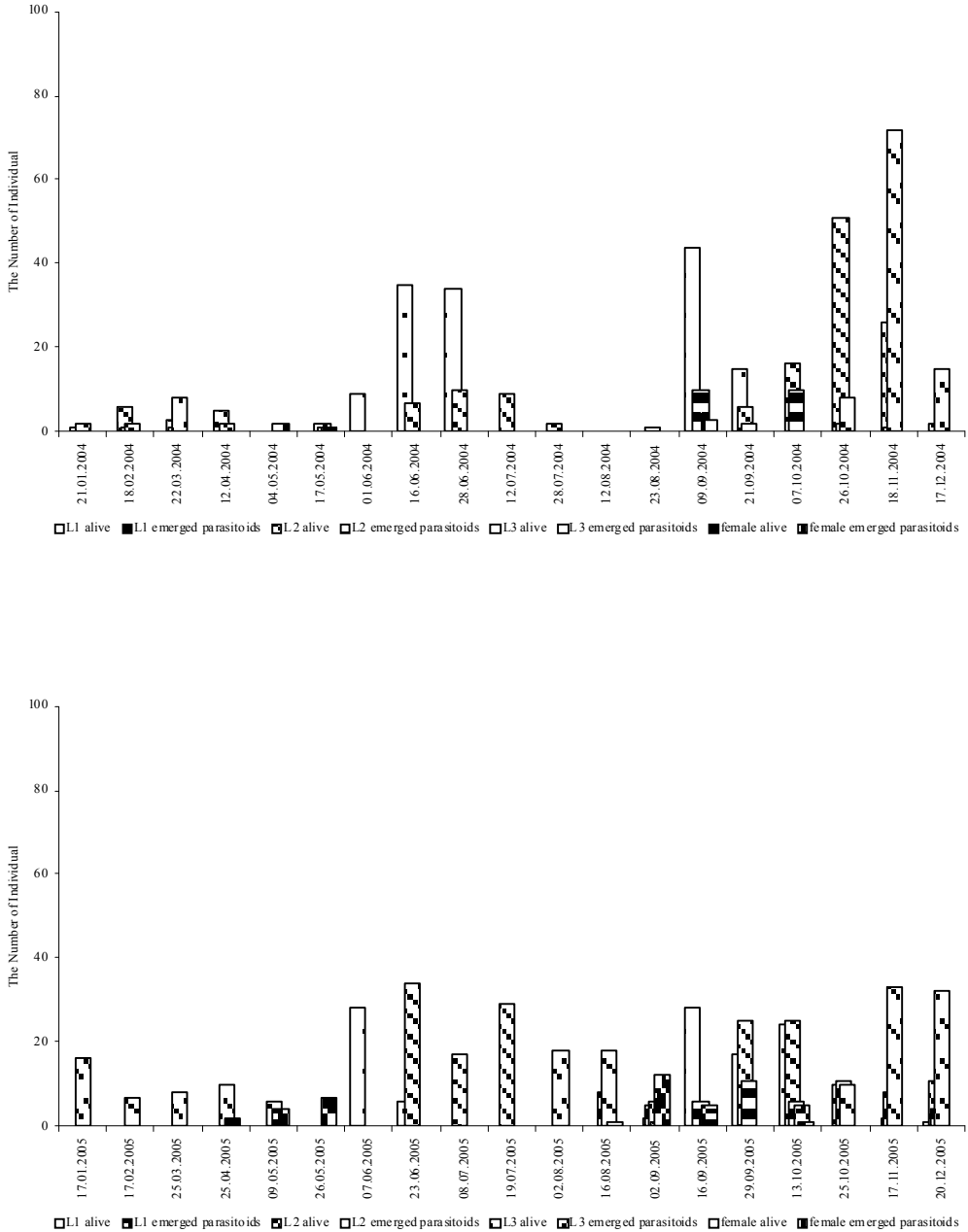
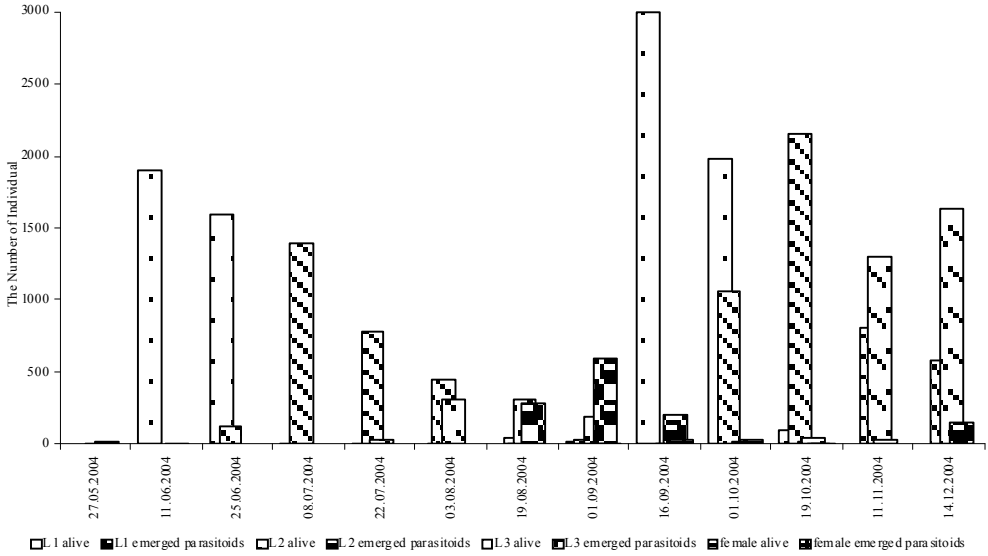


Fig. 3. Population movement of alive and emerged parasitoid of *Ceroplastes rusci* in lemon orchards in Mersin (Erdemli) during the years of 2004-2005.



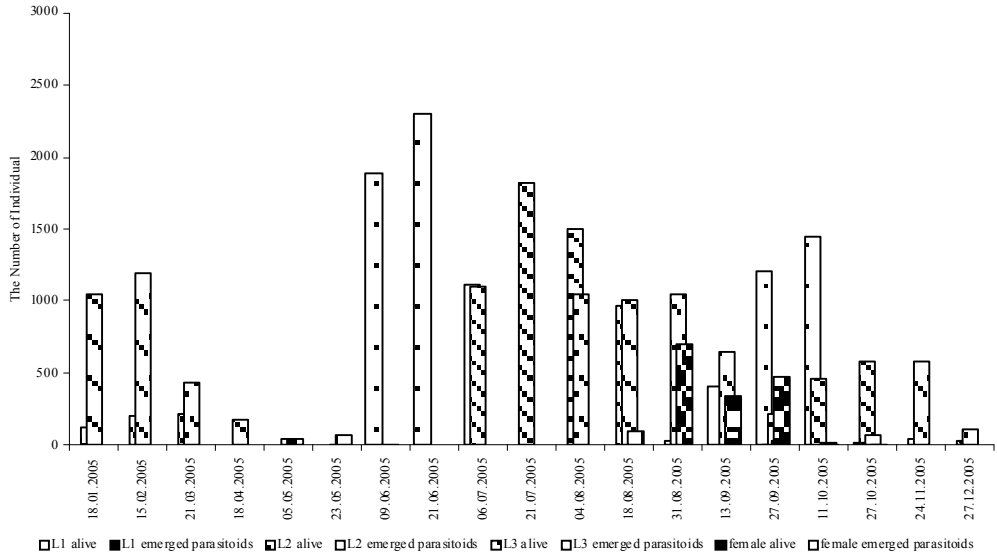


Fig. 4. Population movement of alive and emerged parasitoid of *Ceroplastes rusci* in lemon orchards in Adana (Kozan) during the years of 2004-2005.

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