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Leiophron (Euphorus) deficiens Ruthe (Hymenoptera, Braconidae, Euphorinae), A Parasitoid of *Campylomma diversicornis* (Reuter) (Heteroptera, Miridae) in Turkey

Levent EFİL[1] Coşkun GÜÇLÜ[2] Sergey A. BELOKOBYLSKIJ[3]

[1]Plant Protection Research Institute, 21100, Diyarbakir, TURKEY, e-mail: efil46@hotmail.com

[2]Atatürk University, Faculty of Agricultural, Department of Plant Protection, 25240 Erzurum, TURKEY, e-mail: cguclu@atauni.edu.tr (Corresponding author)

[3]Zoological Institute Russian Academy of Sciences, St. Petersburg, 199034, Russia; Museum and Institute of Zoology Polish Academy of Sciences, Wilcza 64, Warsaw 00-679, POLAND, e-mail: sb@zin.ru

ABSTRACT

Leiophron (Euphorus) deficiens Ruthe, 1856 (Hymenoptera, Braconidae) was firstly reared from the nymphs of *Campylomma diversicornis* (Reuter,1878) (Heteroptera, Miridae). This bug is a predator of nymphs and adults of *Tetranychus utricae* (Koch, 1836) (Acarina, Tetranychidae), as well as eggs and larvae of *Helicoverpa armigera* Hübner, 1805 (Noctuidae, Lepidoptera), pests causing important damage on the cotton plants in the plains of Bismil (Diyarbakır) and Kızıltepe (Mardin) district. *Leiophron (Euphorus)* first recorded for the Turkish fauna is redescribed, and some remarks on its biology and ecology are given.

Key Words: Parasitoid, predator, *Leiophron deficiens*, *Campylomma diversicornis* first record, Turkey.

INTRODUCTION

Euphorinae is a morphologically and biologically peculiar subfamily of Braconidae (Hymenoptera), including about 40 genera from 12 tribes worldwide (Shaw, 1985; Belokobylskij, 2000, van Achterberg, 2004). Most species are koinobiont endoparasitoids of insects from the orders Coleoptera, Heteroptera, Psocoptera, Hymenoptera, Neuroptera and Orthoptera (Shaw, 1985; 1988). The euphorins are usually solitary parasitoids except for the some gregarious species of *Perilitus* Nees *Microctonus* (Wesmael) and *Syntretus* Förster (McColloch, 1918; Wade & St George, 1923; Luff, 1976; Loan, 1967; Loan & Holiday, 1979; Doyen, 1984). Among the other genera, *Leiophron* Nees species attack primarily nymph and adult bugs (Heteroptera) (Leston, 1961; Waloff, 1967; New, 1970).

The bug *Campylomma diversicornis* (Reuter, 1878) plays an important role for biological control of pests of cotton (Göven & Efil, 1994; Liu *et al.* 2000). This bug feeds on nymphs and adults of *Tetranychus urticae* (Koch, 1836) (Acarina, Tetranychidae)

(Göven *et al.* 1995; Athanassiou et al., 2004), as well as eggs and newly emerged larvae of *Helicoverpa armigera* Hübner, 1805 (Lepidoptera, Noctuidae). Stam (1983) recorded *C. diversicornis* also as a predator of the eggs of bollworm (*Helicoverpa armigera*) and *Bemicia tabaci* Gennadius, 1889 (Hemiptera, Aleyrodidae) in Syria.

The information on parasitoids of Miridae is quite limited. Van Steenwyk & Stein (1976) recorded *Leiophron* (*Peristenus) stygicus* Loan, 1975 [(Hymenoptera, Braconidae, Euphorinae)] as a parasitoid of fourth nymphal stage of *Lygus hesperus* Knight, 1917 (Hemiptera, Miridae) in California. *Leiophron (Peristenus) pseudopallipes* Loan, 1970 and *Leiophron (Peristenus) howardi* Shaw, 1981 were determined as parasitoids of *Lygus lineolaris* (Palisot de Beauvois, 1969) (Shahjahan & Streams 1979) or *L. hesperus* and *L. lineolaris* (Day *et. al.* 1999) in USA respectively; *Leiophron (Peristenus) varisae* van Achterberg, 2001 as a parasitoid of *L. rugulipennis* Poppius in North Europe (Varis & van Achterberg, 2001) and *L. schusteri* Loan as a parasitoid of *Taylorilygus vosseleri* (Poppius, 1912) and *T. virens* (Taylor) (Miridae) in Kenya (Snodgrass *et al.* 1990). Bilewicz-Pawinska (1969; 1977a; 1977b) studied some *Leiophron* (*Peristenus*) species biology and role in reducing the plant bug populations in Poland. The keys to European and North American *Leiophron* (*Peristenus*) parasitoids of *Lygus* species were published by Loan & Shaw (1987) and Goulet & Mason (2006).

In this study, *L. deficiens* is first recorded as a parasitoid of *C. diversicornis.* This parasitoid is redescribed, and some information about its biology and parasitizing rate in Turkey is given.

MATERIAL AND METHODS

The study was conducted in four different cotton-growing areas located in the fields of Bismil (Diyarbakır) and Kızıltepe (Mardin) district, Southeastern Turkey (Fig. 1), between May and September 2002 and 2004. Populations of *C. diversicornis* and *L. deficiens* were monitored during the cotton growing season once a week. In addition, 150 specimens of fourth and fifth instars of *C. diversicornis* nymphs were collected randomly, twice a month from each locality during September when it reached maximum population levels.

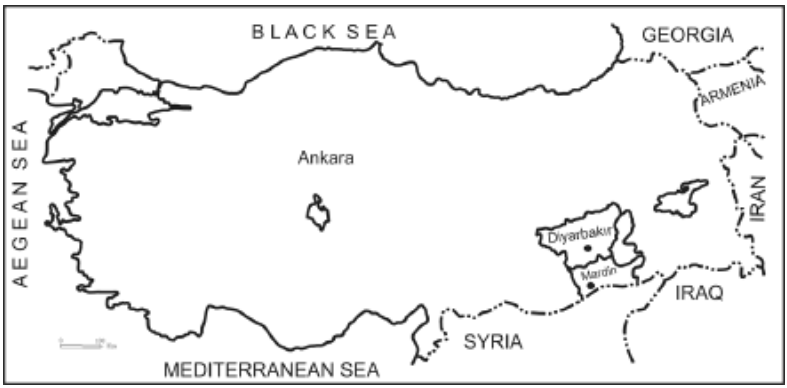

Fig. 1. Study areas, Bismil plain (Diyarbakır) and Kızıltepe Plain (Mardin) in South-Eastern Turkey.

The laboratory studies, to obtained parasitoids on the bugs, were carried out in special climate control cabinets (200x100x150 cm) which provide the conditions of 25±1°C, 65±5% RH and photoperiod of 16 hours light and eight hours dark.

For obtaining parasitoids from mirid nymphs in the laboratory, two flowers from each cotton plant, a total of 100 flowers, were cut and brought in the laboratory within plastic jars (17.0 x 27.0 cm) covered by a net. The cotton flowers with mirid nymphs were put into culture cups (5.0 x 6.0 cm), and filter paper was placed on the base.

In order to satisfy the water demand of *C. diversicornis*, small cups (3.0 x 1.5 cm) containing a piece of cotton balls were placed inside the culture cup, and each ball was saturated with water using an injector every day. Moreover, in order to provide nutrition, cotton leaves hosting *T. urticae* nymphs and adults were also placed into the culture cup. For this process, Sayar-314 cotton variety was used.

Larvae and pupae of *L. deficiens* were recorded by monitoring the culture cups twice per day. Adult emergence was determined after transferring every pupa to another cup. The female parasitoids were fed using the cotton absorbing fructose.

Larva and pupa of *L. deficiens* were later released into the field inside culture cups covered by net. Furthermore, the cups were sheltered by wooden blocks from above, leaving the sides open, in order to protect the samples from rain and snow.

Specimens of parasitoids were examined uncoated under a Scanning Electronic Microscope (SEM) using secondary electron imaging at 5 kV and a spot size of two. Measurements were taken from 10 specimens using the same program, and mean and standard error were calculated by Statistical Package for the Social Sciences Version 13 (SPSS 13).

The wing venation, morphology surface sculpture, and taken measurements are used as defined by Belokobylskij & Tobias (1998). The following abbreviations are used: OD, maximum diameter of lateral ocellus; OOL, ocular-ocellar line; POL, postocellar line.

RESULTS

Leiophron (Euphorus) deficiens Ruthe, 1856 Re-description

Material examined**:** Turkey 20 females, 20 males, Mardin, Kiziltepe, cotton growing area, 37°06'N, 40°40'E, 469 m, 3.07.2002 (leg. Efil); 20 females, 20 males, Diyarbakır Bismil, cotton area, 37° 49'N, 40°30'E, 565m, 25.07.2002 (leg. Efil). Measurements were made on 10 specimens.

Redescription of female. Body length (Mean ± SE) 2.0±0.3 mm (range 1.90-2.20); fore wing length 1.56±0.16 mm (range 1.5-1.6) (Fig. 2a), Width of head 1.63± 0.01 (range 1.55-1.65) times its median length, 1.36±0.02 (range 1.2-1.4) times width of mesoscutum (Fig. 3a, b). Head behind eyes rather distinctly roundly narrowed; transverse diameter of eye (measured on the straight line) 1.30± 0.05 (range 1.30-1.34) times length of temple. Ocelli in triangle with base 1.53±0.08 (range 1.50-1.55) times its lateral sides; POL 2.42±0.41 (range 2.20-2.50) times Od, 0.95±0.02 (range 0.8-1.0) times OOL. Eye 1.66±0.02 (range 1.50-1.70) times as high as broad. Malar suture distinct. Malar space height 0.58±0.07 (range 0.55-0.60) times basal width of mandible, 0.13±0.08 (range 0.10-0.15) times height of eye. Face

convex, its width 1.25±0.03 (range 1.00-1.30) times median height, 0.53±0.07 (range 0.50-0.55) times height of eye. Distance between anterior tentorial pits 3.56±0.01 (range 3.50-3.60) times distance from pit to eye. Clypeus ventrally with very short and wide median lobe which is almost straight medioanteriorly. Width of clypeus 2.30±0.08 (range 2.00-2.50) times its median height, 0.55±0.01 (range 0.50-0.60) times width of face. Head (frontal view) distinctly and almost linearly narrowed below eyes (Fig. 3a, b). Occipital carina fused with hypostomal carina.

Antenna. Weakly claviform, 15-16-segmented. Scape about twice longer than wide. First flagellomere 2.18±0.04 (range 2.00-2.30) times longer than its apical width, 1.05±0.01 (range 1.00-1.10) times longer than second flagellomere (Fig. 3c). Length of penultimate flagellomere 1.12±0.03 (range 1.00-1.20) times its width, 0.47±0.01 (range 0.40-0.50) times length of apical flagellomere.

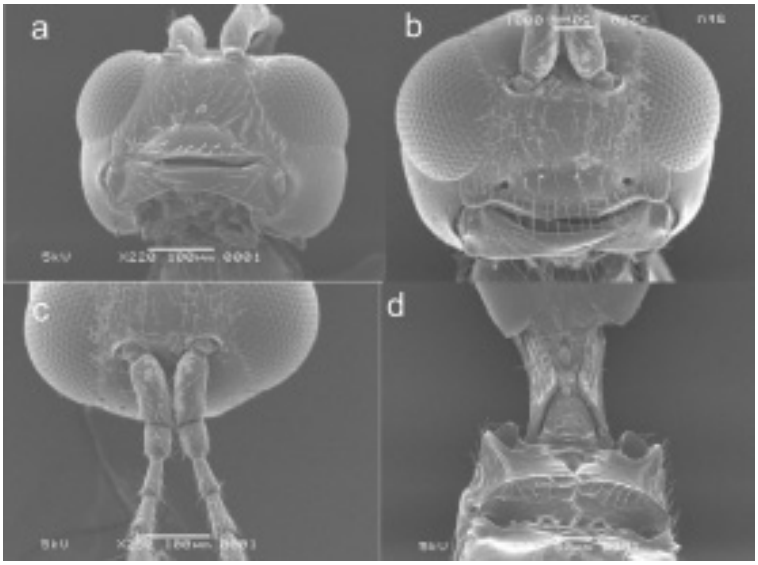

Fig. 3. Adult of *L. (E.) deficiens*. a-b) front of head, c) antenna, d) ventral of propodeum.

Mesosoma. Length 1.56±0.01 (range 1.50-1.60) times its maximum height. Notaulus on dorsal surface of mesoscutum very fine and marked by fine striation or puncture, or sometimes indistinct. Prescutellar depression long, with median and pair of lateral carinae, finely and usually entirely sculptured, 0.35±0.01 (range 0.30-0.40) times as long as scutellum. Scutellum convex. Subalar depression rather shallow, wide, striate with smooth areas. Sternaulus absent. Mesopleuron with fine oblique furrow. Metapleural lobe wide, rather long, and rounded apically.

Wings (Figs. 2a, b). Length of forewing 3.03±0.03 (range 2.80-3.10) times its width. Length of pterostigma about twice its maximum width. Radial cell 2.91±0.04 (range 2.60-3.00) times longer than wide. Metacarpus 0.26±0.04 (range 0.24-0.28) times as long as pterostigma, 0.38±0.04 (range 0.36-0.40) times as long as width of pterostigma. Radial vein with more or less regularly curved single abscissa, its base situated closely to first radiomedial vein. First and second abscissae of medial and first

radiomedial veins present. First and second abscissae of cubital and recurrent veins mostly spectral or sometimes absent. Nervulus weakly postfurcal. In hind wing, basal vein 0.65±0.02 (range 0.50-0.70) times as long as second abscissa of mediocubital vein, 0.63±0.02 (range 0.50-0.70) times as long as third abscissa of costal vein. Nervellus almost entirely present.

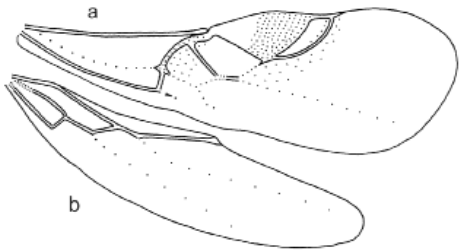

Fig. 2. Wings of *L. (E.) deficiens.* a) forewing, b) hindwing.

Leg. Hind femur 3.55±0.03 (range 3.40-3.75) times longer than wide. Hind tarsus 0.87±0.01 (range 0.75-0.90) times as long as hind tibia, its second segment 0.33±0.01 (range 0.25-0.40) times as long as first segment, 0.62±0.01 (range 0.50-0.66) times as long as fifth segment (without pretarsus). Fifth segment of fore and middle legs not thickened. Claw simple.

Metasoma. First tergite widened, apical width 1.23±0.03 (range 1.00-1.30) times its minimum width, length 2.23±0.03 (range 2.00-2.40) times its apical width (Fig. 3d). Length of second and third terga combined 2.10±0.03 (range 2.00-2.20) times basal width of second tergite, 1.20±0.04 (range 1.00-1.30) times their maximum width.

Sculpture and pubescence. Head mostly smooth, face finely and rather densely punctulate. Mesoscutum mostly smooth, with fine and narrow striation along trace of notauli. Mesopleura mostly smooth. Propodeum rather coarsely rugulose-reticulate, with short semicircular and almost smooth basolateral areas. Hind coxa smooth, all femora finely and sparsely punctulate. First metasomal tergum distinctly longitudinally striate. Mesoscutum almost entirely and sparse setose.

Color. Body yellowish brown or light reddish brown, face pale, metasoma behind first tergum dark brown to almost black. Antenna yellow or brownish yellow, infuscate apically. Palps yellow or pale yellow. Legs yellow. Wings hyaline, faintly infuscate in radial and discoidal cells. Pterostigma brown or brownish grey, pale in basal 0.3.

Hosts. *Polymerus cognatus* (Fieber), *Campylomma diversicornis* (Reuter) (new record) (Hemiptera: Miridae)

Distribution. Sweden, Denmark, Netherlands, Germany, Finland, Poland, Greece, Turkey (new record), Moldova, Ukraine, Russia (European part, Yakutia, South of Far East), Kazakhstan, Korea.

PARASITOIDS

Biological data. Under laboratory conditions, *L. deficiens* attacked the first and second nymphal stages of *C. diversicornis* and left them at third and fourth stages.

No parasitoid was observed in the adult samples collected from the field. In parasitized nymphs the last segment of the abdomen was deformed and subsequently died 1-2 hours later. Parasitoid larvae were white in color and about 3.5 mm in length, just after becoming pupa with white cocoon by fixing itself from the abdomen to a stable point. Under field conditions, 50 pupae were placed back in culture cups at each of the two areas and times indicated above, and adult emergence occurred within the time period starting from 12th day continuing until the 15th day. The day with the most adult emergence was observed to be 12th with a 62.5 % (Table 1).

Table 1. Parasiting rate of *L.(E.) decifiens* on the *C. diversicornis*, duration of pupal stage and *L.(E.) decifiens* rate of infestation.

	Parasiting Rate					Duration of Pupal Stage								
2002	Location	CdT*	Cd**	Ld***	R	TP	12.day	R%	13.day	R%	14.day	R%	15.day	R%
	Bismil	150	120	30	20	50	31	62,5	12	24	0	0	7	14
	Kızıltepe	150	108	42	28									
	Parasiting Rate					Duration of Pupal Stage								
2003	Location	CdT*	Cd**	Ld***	R	TP	12day	R%	13.day	R%	14.day	R%	15.day	R%
	Bismil	150	117	33	22	50	31	62,5	12	24	0	0	7	14
	Kızıltepe	150	102	48	32									

CdT: Total nimf C. diversicornis; ** Cd: Alive C. diversicornis ***Ld: L. decifiens; TP: Total pupa of L. decifiens R:Rate %

The pupae obtained from the parasitoid larvae collected in the last week of September spent the whole winter without emergence. The adults emerged from these hibernating pupae during the period of April 20-25. The adults were observed to be feeding on nectar of some flowering plants. It has been determined that, under laboratory conditions, females feeding on cotton saturated with fructose lived for 14-17 days, while males lived for 8-11 days.

Parasitizing level. A total of 150 specimens of fourth and fifth instars nymphs were collected randomly from both localities in September, the time when *C. diversicornis* population was dense. The parasitizing rates on the bugs were observed 20 % in Bismil and 28 % in Kiziltepe in 2002; 22 % and 32 % in 2003, respectively (Table 1).

Field Surveys. Populations of *C. diversicornis* and *L. deficiens* were monitored in four fields on Kiziltepe and Bismil plains. At each of the four locations, the development of predator mirids and its parasitoids showed similar characteristics. However, both populations presented a significant growth in 2003.

Campyloma diversicornis specimens were appeared at the beginning of July. At the end of August the population peaked and drastically decreased. Adults of *Leiophron deficiens* were seen far later than the population development of *C. diversiconis*. It was observed that the parasitoid population peaked at the end of August and gradually decreased afterwards (Figs 5, 6).

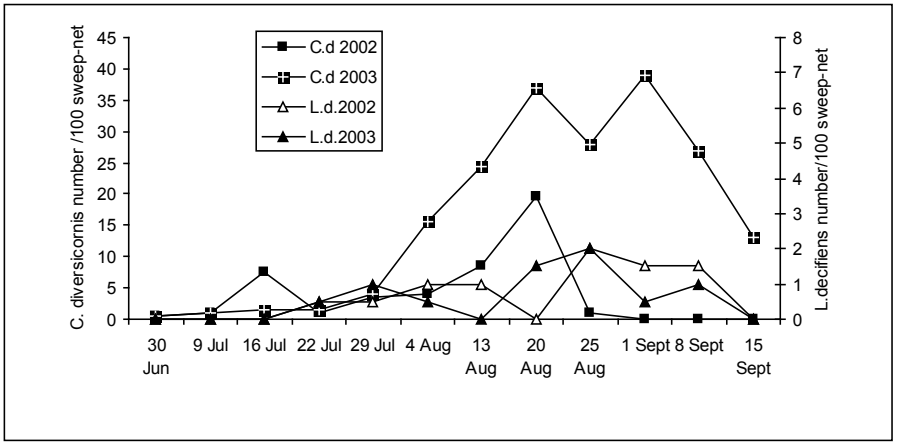

Fig. 4. Seasonal abundance of *L. decifiens* and *C. diversicornis* in the Bismil plain during 2002-2003.

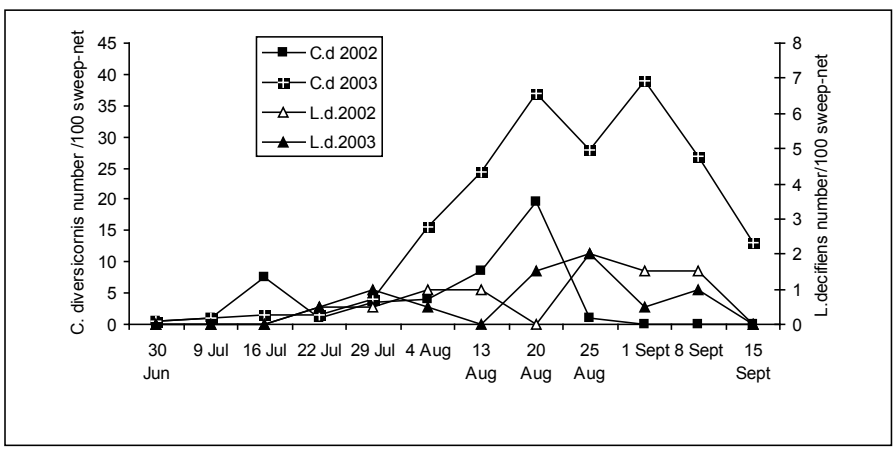

Fig. 5. Seasonal abundance of *L. decifiens* and *C. diversicornis* in the Kızıltepe plain during 2002-2003.

CONCLUSIONS

While studying braconid parasitoids associated with Hemiptera, we observed that they emerged mostly from harmful insects inhabiting plants with economic importance (van Steenwyk & Stein, 1976; Shahjahan & Streas 1979; Snodgrass *et al.* 1990). However, we found that *L. deficiens* emerged from the predator *C. diversicornis.*

Under laboratory conditions, *C. diversicornis* feeds on eggs and newly hatched larvae of *H. armigera* and has a considerable impact on the pest population towards the end of the cotton season (Stam, 1983; Liu *et al.* 2000). In the study conducted at the Bismil plain, Göven and Efil (1994) collected 158 specimens of *C. diversicornis* per 100 sweeps at the fields having *H. armigera* population and also 83 specimens at the field lacking *H. armigera* on the same date.

It has been shown that *C. diversicornis* population reaches its peak towards the end of the cotton season (Göven *et al.* 1995). This period is the time when the cotton plant is in its most productive state, in which it generates and develops the bolls. Also in this time period, it is advised to preserve *C. diversicornis* population to assist the struggle of protecting the cotton plant from one of its major harmful pests *T. urticae* (Göven *et al.*, 1995). It is also noted that, the increasing of *H. armigera* population again in this same period causes important damage in cotton plant (Göven & Efil 1994).

At end of this study, the parasitism rate of *L. deficiens* was between 20 -32% in both years and should be taken into consideration for the further studies. The high parasiting on such a useful insect might negatively effect the success of some classical biological control that will be conducted in cotton growing areas.

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