This volume is dedicated to the chief-editor
Hüseyin Özdikmen's older brother

SUAT KIYAK

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THREE NEW EELS OF THE GENUS *DYSOMMA* ALCOCK, 1889 FROM OFF PHUKET ISLAND, THAILAND (TELEOSTEI: ANGUILLIFORMES: SYNAPHOBRANCHIDAE)

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[Prokofiev, A. M. 2019. Three new eels of the genus *Dysomma* Alcock, 1889 from off Phuket Island, Thailand (Teleostei: Anguilliformes: Synaphobranchidae). Munis Entomology & Zoology, 14 (1): 317-325**]**

ABSTRACT: Three new species of the ilyophine genus *Dysomma* are described from the Andaman Sea off Phuket Island, Thailand. A detailed comparison with the related species is given and a revised key for the species of the genera *Dysomma* and *Dysommina* is provided.

KEY WORDS: Synaphobranchid eels, Ilyophinae, *Dysomma*, new species, Andaman Sea

In October 2008 I visited Phuket Marine Biological Centre, Thailand (PMBC) where I was able to study a collection of demersal fishes trawled off Phuket Island in 1999-2000 during the BIOSHELF project. Within the numerous anguilliform fishes sampled I discovered seven specimens representing three undescribed species of the synaphobranchid eels of the genus *Dysomma*. This is the most species-rich synaphobranchid genus belonging to the subfamily Ilyophinae and currently comprising 17 species (Fricke et al., 2019; Ho & Tighe, 2018) distributed in tropical and subtropical latitudes of Atlantic and Indo-west-Pacific. They live mainly in the continental shelf and slope, and some species may have a rather restricted distribution. Three new species described herein, bringing the total number of species of *Dysomma* to 20, may be endemic for the north-eastern Indian Ocean.

MATERIAL AND METHODS

Data were taken from fishes fixed and stored in 4 % formaldehyde. Counts, measurements and terminology follow Böhlke (1989). All measurements were made point to point. Data for holotype are given first, followed by the paratypes in parentheses. Comparative data were taken from Robins & Robins (1989), Chen & Mok (2001), Ho et al. (2015), Fricke et al. (2018) and Ho & Tighe (2018). Abbreviations: TL, total length (from tip of snout to distal tip of caudal fin).

TAXONOMY

Dysomma achiropteryx sp. nov.

(Fig. 1)

Material examined: Holotype, 240 mm TL, PMBC uncatalogued, 240 mm TL, Andaman Sea off Phuket Island, depth 508–518 m, BIOSHELF st. 6–8/T, 20.11.1999, otter-trawl. Paratypes, 4 specimens, 220–235 mm TL, collected with the holotype.

Diagnosis: No pectoral fins; dorsal fin originates behind gill opening; lateral line complete; trunk length 22.6–24.4 % TL, body depth at anal-fin origin 4.6–5.8 % TL; body colouration brown, peritoneum black.

Description: Dorsal-fin origin positioned somewhat closer to anus than to gill opening; anus situated at anal-fin origin; pectoral fins absent; caudal fin well developed. Snout protruded anteriorly, rounded in lateral view; eye small, situated closer to snout tip than to rictus; interspace between gill openings clearly smaller than gill opening length. Anterior nostril opens near tip of snout as a short (sometimes poorly expressed) tube with scalloped margins. Posterior nostril opens at antero-ventral margin of eye as a pore with raised rim (sometimes almost as short tube) with smooth but somewhat irregular margins. Supraorbital pores 3 in number (before, above and behind anterior nostril); infraorbital pores 5 in number (1st, behind anterior nostril; 2nd and 3rd, below anterior and posterior border of posterior nostril, respectively; 4th, half eye-diameter behind hind border of eye; 5th, midway between hind border of eye and rictus); preoperculomandibular pores 7 in number; supratemporal pores 0–1 in number (usually present). Body lateral line complete. Two compound intermaxillary teeth in transverse row, not very enlarged; vomer with three, rarely four compound teeth, conspicuously enlarged from first to third one; if present, fourth tooth much smaller than third; maxillary teeth very small, conical, arranged in a single row. Intermaxillary teeth separated from maxillary row of teeth by small interspace; no space between intermaxillary and vomerine teeth. Lower jaw dentition consists of five or six compound teeth anteriorly followed by a row of very small conical teeth.

Colouration of body brown, vertical fins paler, darkened in posterior fourth of their length; mouth and gill chamber, stomach and intestine pale; peritoneum black, translucent through body wall.

Measurements (in % TL): head length 12.5 (11.8–12.9), snout length 2.5 (2.7–3.1), horizontal eye diameter 0.6 (0.5–0.7), length of mouth gape 5.4 (4.6–5.5), interorbital width 2.1 (1.9–2.2), body depth at anal-fin origin 4.6 (4.7–5.8), predorsal and preanal distance 19.2 (20.0–20.9) and 23.3 (22.6–24.4), respectively.

Etymology: The species epithet (Greek, “without pectoral fin”) reflects one of the diagnostic characters of this species; noun in apposition.

Comparisons: This new species is similar to *D. brachygnathos* Ho et Tighe, 2018, *D. brevirostre* (Facciola, 1887), *D. bussarawiti* sp. nov., *D. dolichosomatum* Karrer, 1983, *D. muciparus* (Alcock, 1891) and *D. tridens* Robins, Böhlke et Robins, 1989 in the absence of the pectoral fins. *D. achiropteryx* differs from *D. brachygnathos* in much longer trunk (22.6–24.4 % vs. 5.3–7.0 % TL), more posteriorly displaced dorsal-fin origin (slightly in front of gill opening in *D. brachygnathos*), presence of 5 (vs. 4) infraorbital and 2 (vs. 0) preopercular pores and complete (vs. incomplete) body lateral line. *D. achiropteryx* differs from *D. brevirostre* in somewhat longer trunk (18 % TL according to Robins & Robins (1989) in *D. brevirostre*), presence of 5–6 (vs. 3) compound teeth on lower jaw and 3–4 (vs. 5) compound teeth on vomer, 5 (vs. 4) infraorbital and 7 (vs. 6) preoperculomandibular pores and complete (vs. incomplete) body lateral line, and in darker body colouration. The new species can be distinguished from *D. dolichosomatum* in its longer trunk (14.3–17.7 % TL in *D. dolichosomatum*), uniserial (vs. biserial) maxillary dentition, 5 (vs. 4) infraorbital pores and complete (vs. incomplete) body lateral line, and in darker body colour. *D. achiropteryx* differs from the poorly known *D. muciparus* in possession of 5–6 compound teeth followed by a row of small teeth (vs. 4

compound teeth on the lower jaw followed by a band of small teeth) and 3–4 (vs. 5) compound teeth on vomer, trunk about twice longer than head (vs. shorter than head). The new species can be easily distinguished from *D. tridens* in presence of two intermaxillary teeth of moderate size (vs. 3 long teeth in *D. tridens*). Furthermore, *D. achiropteryx* can be distinguished from *D. brachygnathos* and *D. brevirostre* in the poorly ornamented tips of snout and of lower jaw. For comparison with *D. bussarawiti*, see below.

Dysomma bussarawiti sp. nov.

(Fig. 2)

Material examined: Holotype, 249 mm TL, Andaman Sea off Phuket Island, depth 520–532 m, BIOSHELF st. 25–8/T, 27.01.1999, line 4, T1.

Diagnosis: No pectoral fins; four supraorbital pores; lateral line complete; trunk length 27.3 % TL, body depth at anal-fin origin 2.8 % TL; body colouration light tan, peritoneum pale.

Description: Body very elongate; dorsal-fin origin positioned somewhat closer to anus than to gill opening; anus situated at anal-fin origin; pectoral fins absent; caudal fin well developed. Snout somewhat protruded anteriorly, rounded in lateral view; eye small, situated closer to snout tip than to rictus; interspace between gill openings clearly smaller than gill opening length. Anterior nostril opens near tip of snout as a poorly expressed tube with scalloped margins; posterior nostril opens at antero-ventral margin of eye, its rim raised almost as short tube. Supraorbital pores 4 in number (above anterior and posterior border of anterior nostril, above posterior nostril and on vertical of 5th infraorbital pore); infraorbital pores 5 in number (1st, behind anterior nostril; 2nd, midway between anterior and posterior nostrils; 3rd, below posterior nostril; 4th, half eye-diameter behind hind border of eye; 5th, midway between hind border of eye and rictus); preoperculomandibular pores 7 in number; supratemporal pores absent. Body lateral line complete. Two compound intermaxillary teeth in transverse row, not very enlarged; three compound teeth on vomer, conspicuously enlarged from first to third one; maxillary teeth very small, conical, arranged in a single row. Lower jaw dentition consists of five compound teeth anteriorly followed by a row of very small conical teeth.

Colouration of body light tan, fins whitish; mouth and gill chamber, peritoneum, stomach and intestine pale.

Measurements (in % TL): head length 9.6, snout length 1.4, horizontal diameter of eye 0.3, length of mouth gape 4.0, interorbital width 1.2, body depth at anal-fin origin 2.8, predorsal and preanal distance 19.7 and 27.3, respectively.

Etymology: This species is dedicated to Dr. Somchai Bussarawit, who made this material available for me.

Comparisons: This new species is very similar to the preceding one but can be easily distinguished by its paler body colouration, pale (vs. black) peritoneum, presence of 4 (vs. 3) supraorbital pores and much more elongated trunk and body (preanal length and body depth at anal-fin origin 27.3 % and 2.8 % TL vs. 22.6–24.4 % and 4.6–5.8 % TL in *D. achiropteryx*).

Dysomma phuketensis sp. nov.

(Fig. 3)

Material examined: Holotype, 225 mm TL, Andaman Sea off Phuket Island, depth 464–467 m, BIOSHELF st. Z–3/T, 24.01.1999, trawl.

Diagnosis: Pectoral fins present; intermaxillary teeth absent; maxillary and lower jaw dentition representing by multiple rows of conical teeth; anus situated well behind gill openings; lateral line complete; snout length 25.7 % of head, 4.0 % of TL; lower jaw shorter than upper one; 3 supraorbital, 4 infraorbital and 6 preoperculomandibular pores; body colouration pale with margins of fins and outlines of lateral-line pores blackish.

Description: Pectoral fins nearly equal in length to length of gill opening, with 16 rays; pectoral-fin base situated fully above gill opening and separated from the latter by a short distance. Dorsal fin originates above the distal half of adpressed pectoral fin. Anus situated at anal-fin origin. Snout protruded anteriorly; tips of snout and of lower jaw symphysis with deep longitudinal folds; snout bearing small spinules. Eye positioned closer to rictus than to snout tip. Length of gill slit slightly exceeding interspace between right and left gill openings. Anterior nostril opens as a very short (hardly expressed) tube with irregular margin of its rim; posterior nostril opens at antero-ventral border of eye as a hardly expressed tube with irregular rim margin. Supraorbital pores 3 in number (1^{st} and 2^{nd}, above anterior nostril; 3^{rd}, just behind a vertical through 1^{st} infraorbital pore); infraorbital pores 4 in number (1^{st}, behind anterior nostril; 2^{nd}, between anterior and posterior nostrils; 3^{rd}, between posterior nostril and eye; 4^{th} below posterior third of eye); preoperculomandibular pores 6 in number. Body lateral line complete. Intermaxillary teeth absent. Vomer possesses four large compound teeth occupying almost all length of mouth roof. Maxillary and dentary teeth small, conical arranged in bands (about four rows of teeth anteriorly, reducing to three rows at midlength of tooth band and to two rows near rictus).

Colouration of body very light, margins of dorsal, anal and caudal fins blackish; lateral-line pores margined with black; mouth and gill chamber, stomach and intestine pale; peritoneum dark-brown to blackish.

Measurements (in % TL): head length 15.6, snout length 4.0, horizontal diameter of eye 1.3, length of mouth gape 6.2, interorbital width 2.2, body depth at anal-fin origin 5.1, pectoral-fin length 2.9, predorsal and preanal distance 17.3 and 24.0, respectively.

Etymology: This species is named from its type locality.

Comparisons: *D. phuketensis* is similar to *D. goslinei* Robins et Robins, 1976, *D. melanurum* Chen et Weng, 1967, *D. longirostrum* Chen et Mok, 2001 and *D. robinsorum* Ho et Tighe, 2018 in the absence of the intermaxillary teeth and of the compound teeth in the lower jaw dentition, and in the presence of the wide bands of the conical teeth on the maxillary and dentary. It can be easily distinguished from *D. goslinei* and *D. robinsorum* in the complete (vs. incomplete) lateral line, from *D. goslinei*, *D. melanurum* and *D. robinsorum* in the anus positioned well behind gill openings (vs. below gill openings in the compared species), and from *D. melanurum* in the snout overhanging the lower jaw (vs. lower jaw projecting before tip of snout in *D. melanurum*). The new species appears to be most similar to *D. longirostrum* from the western Pacific Ocean particularly in the long snout, but differs from that species in the presence of 3 supraorbital, 4 infraorbital and 6 preoperculomandibular pores (vs. 5, 8 and 9, respectively), 4 (vs. 5) compound vomerine teeth, anterior and posterior nostrils forming very short (vs. long) tubes and pale (vs. brownish) body colouration with lateral-line pores margined with black (vs. not stained).

KEY FOR THE IDENTIFICATION OF THE SPECIES OF THE GENERA *DYSOMMA* ALCOCK, 1889 AND *DYSOMMINA* GINSBURG, 1951

Nota Bene: As the limits between the genera *Dysomma* and *Dysommina* are uncertain, members of both these genera are included in the present key as it is commonly done (Fricke et al., 2018; Ho & Tighe, 2018).

1a. Pectoral fins absent **2**
1b. Pectoral fins present **8**

2a. Upper jaw with three elongated, ventrally protruded intermaxillary teeth .... ***Dysomma tridens* Robins, Böhlke et Robins, 1989**
2b. Upper jaw with two blunt intermaxillary teeth in a transverse row **3**

3a. Tip of snout bulbous, strongly plicate, symphysis of lower jaw strongly plicate; dorsal-fin origin slightly before or slightly behind the level of gill opening **4**
3b. Tip of snout pointed or rounded, as well as symphysis of lower jaw smooth or weakly plicate; dorsal-fin origin well behind gill opening **5**

4a. Trunk length 5.3–7.0 % TL; dorsal-fin origin slightly in front of gill opening; total vertebrae about 136 .... ***Dysomma brachygnathos* Ho et Tighe, 2018**
4a. Trunk length about 18 % TL; dorsal-fin origin slightly behind gill opening; total vertebrae 190–205 .... ***Dysomma brevirostre* (Facciola, 1887)**

5a. Lateral line complete [5 infraorbital pores; lower jaw dentition behind compound teeth uniserial] **6**
5b. Lateral line incomplete, with 8-11 pores only **7**

6a. Three supraorbital pores; body depth at anal-fin origin 4.6–5.8 % TL; peritoneum black .... ***Dysomma achiropteryx* sp. nov.**
6b. Four supraorbital pores; body depth at anal-fin origin 2.8 % TL; peritoneum pale .... ***Dysomma bussarawiti* sp. nov.**

7a. Five infraorbital pores; lower jaw dentition behind compound teeth arranged in a band .... ***Dysomma muciparus* (Alcock, 1891)**
7b. Four infraorbital pores; lower jaw dentition behind compound teeth arranged in 1–2 irregular rows .... ***Dysomma dolichosomatum* Karrer, 1983**

8a. Intermaxillary teeth present; maxillary and dentary teeth uniserial **9**
8b. Intermaxillary teeth absent; maxillary and dentary teeth in multiple rows **16**

9a. Anus anterior, trunk shorter than head length **10**
9b. Anus posterior, trunk much longer than head length .... ***Dysomma opisthoproctus* Chen et Mok, 1995**

10a. Lower jaw with a series of 35–40 small, widely spaced teeth .... ***Dysomma bucephalus* Alcock, 1889**
10b. Lower jaw with a series of 7–32 teeth in varying sizes **11**
11a. Two large compound teeth followed by row of 22–31 smaller ones on lower jaw .... ***Dysomma polycatodon* Karrer, 1983**
11b. Seven to 17 large compound teeth on lower jaw may be followed by some small teeth **12**

12a. Peritoneum pale, may be covered by pigment spots **13**
12b. Peritoneum uniformly dark **15**

13a. Vomerine teeth 4; body depth at anus 2.4–6.0 % TL; vertical fins not uniformly pale **14**

13b. Vomerine teeth 3; body depth at anus 7.8 % TL; vertical fins pale .... ***Dysomma alticorpus*** **Fricke, Golani, Appelbaum-Golani et Zajonz, 2018**

14a. Body lateral line with 17–33 pores; total vertebrae 128–133; dorsal fin pale, base of posterior part of anal fin and lower part of caudal fin solid black .... ***Dysomma formosa*** **Ho et Tighe, 2018**
14a. Body lateral line with 57–75 pores; total vertebrae 119–128; dorsal and anal fins black, with a white margin .... ***Dysomma anguillare*** **Barnard, 1923**

15a. Total vertebrae 134–140; lateral-line pores 29–49 .... ***Dysomma taiwanense*** **Ho, Smith et Tighe, 2015**
15b. Total vertebrae 119–124; lateral-line pores 57–63 .... ***Dysomma fuscoventralis*** **Karrer et Klausewitz, 1982**

16a. Anus anterior, below pectoral fin **17**
16b. Anus posterior, well behind pectoral fin **19**

17a. Lower jaw projects beyond snout; body lateral line nearly complete .... ***Dysomma melanurum*** **Chen et Weng, 1967**
17b. Snout overhanging the lower jaw; body lateral line incomplete **18**

18a. Total vertebrae 130–131 .... ***Dysomma goslinei*** **Robins et Robins, 1976**
18b. Total vertebrae 122–124 .... ***Dysomma robinsorum*** **Ho et Tighe, 2018**

19a. Body lateral line complete or almost complete **20**
19b. Body lateral line fully absent **21**

20a. Vomerine teeth 4; supraorbital pores 3, infraorbital pores 4, preoperculomandibular pores 6; anterior and posterior nostrils forming very short tubes; lateral-line pores margined with black .... ***Dysomma phuketensis*** **sp. nov.**
20b. Vomerine teeth 5; supraorbital pores 5, infraorbital pores 8, preoperculomandibular pores 9; anterior and posterior nostrils forming long tubes; lateral-line pores unpigmented .... ***Dysomma longirostrum*** **Chen et Mok, 2001**

21a. Vomerine teeth 3; predorsal vertebrae 11–12 .... ***Dysommina orientalis*** **Tighe, Ho et Hatooka, 2018**
21b. Vomerine teeth 4; predorsal vertebrae 14–15 .... ***Dysommina rugosa*** **Ginsburg, 1951**

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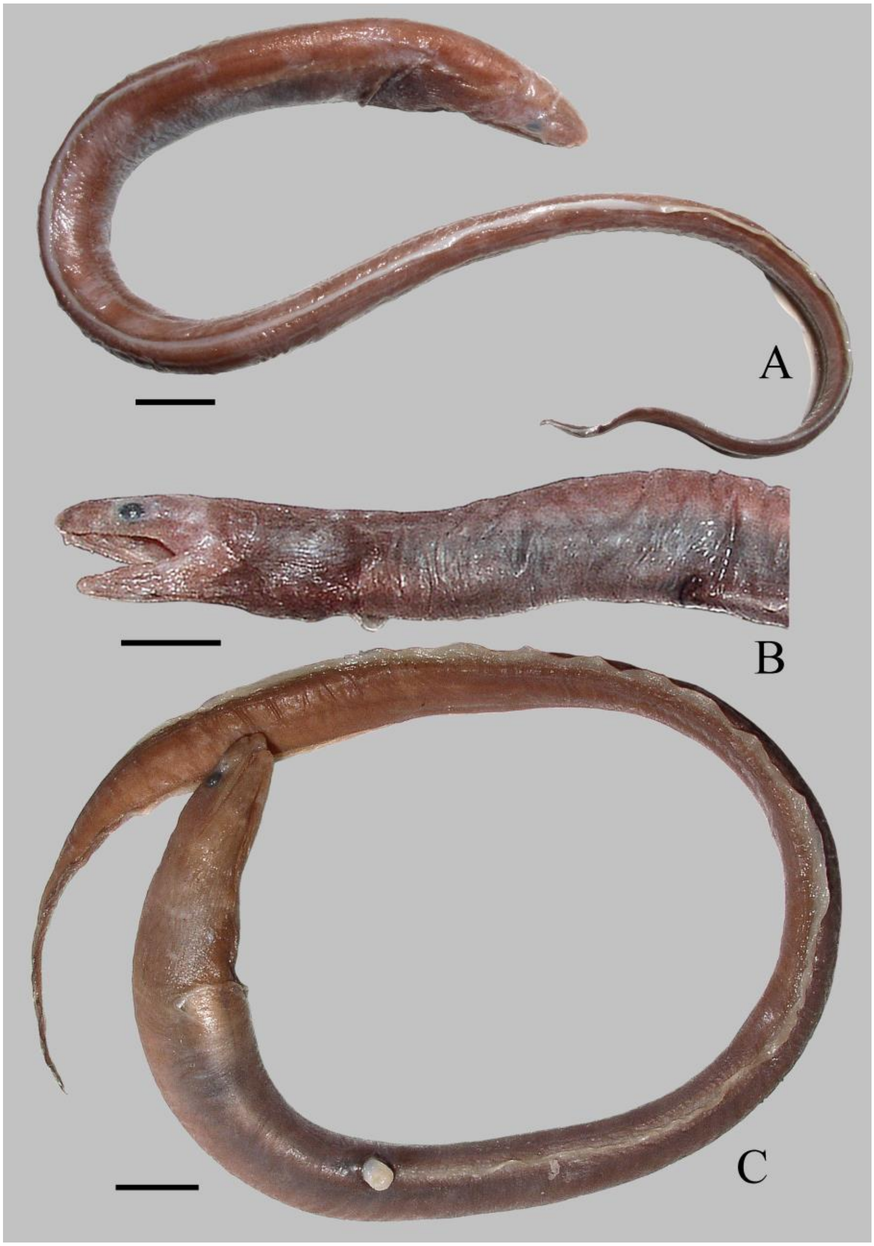

Figure 1. *Dysomma achiropteryx* sp. nov., holotype (A, B) and 220-mm TL paratype (C): (A) dorsal view; (B) head and trunk, lateral view; (C) ventral view. Scale bars: 10 mm.

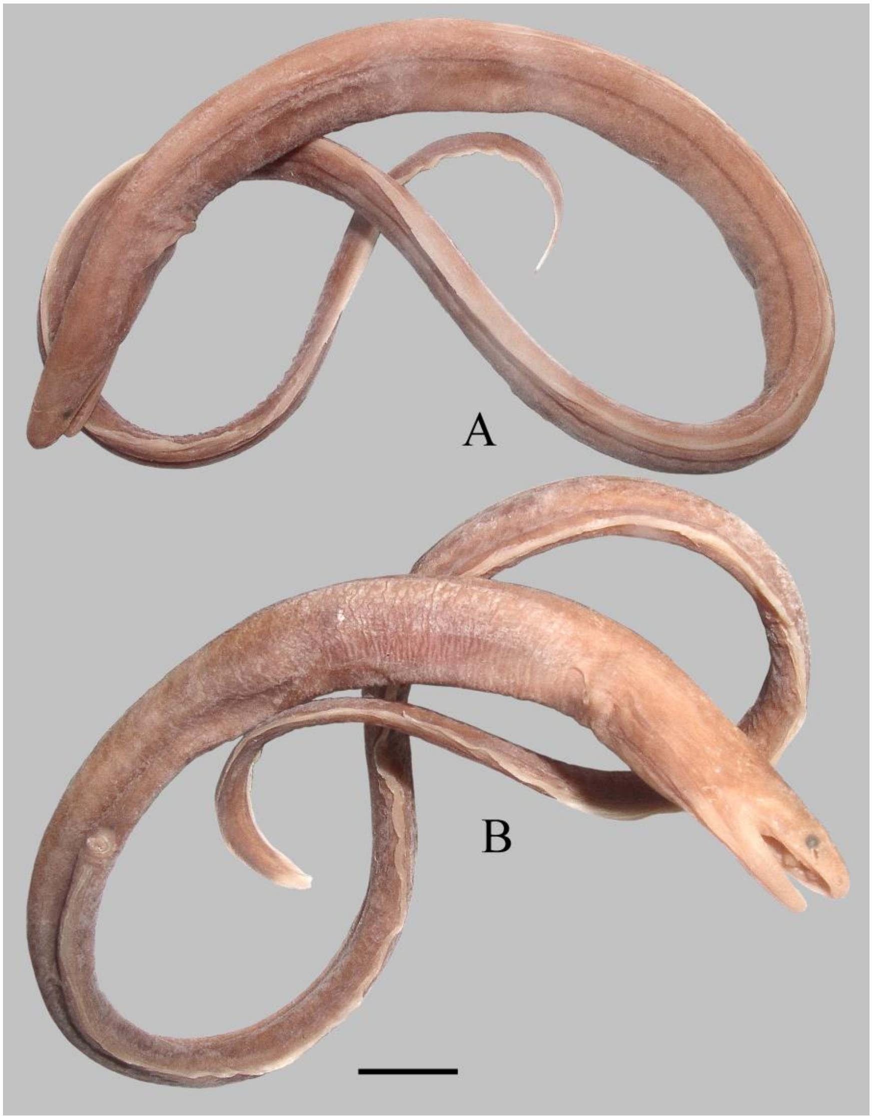

Figure 2. *Dysomma bussarawiti* sp. nov., holotype: (A) dorsal view; (B) lateral and ventral view. Scale bar (common): 10 mm.

Figure 3. *Dysomma phuketensis* sp. nov., holotype: (A) dorsolateral view; (B) ventral view. Scale bar (common): 10 mm.

A NEW SPECIES OF *HYDROTHASSA* C. G. THOMSON, 1859 FROM TURKEY (CHRYSOMELIDAE: CHRYSOMELINAE)

Didem Coral Şahin* and Hüseyin Özdikmen**

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[Coral Şahin, D. & Özdikmen, H. 2019. A new species of *Hydrothassa* C. G. Thomson, 1859 from Turkey (Chrysomelidae: Chrysomelinae). Munis Entomology & Zoology, 14 (1): 326-343**]**

ABSTRACT: A new species, *Hydrothassa anatolica* sp. nov., is described from Kayseri province in Turkey. For the time being, the species is endemic to the Turkey. *Hydrothassa anatolica* sp. nov., was compared to the related Palaearctic species in the subgenus *Hydrothassa* (*Agrostithassa*) Jakobson, 1921. It can be distinctively differentiated from these species based on body size, epipleural punctuation and aedeagal characters especially. In addition, the paper presents ultrastructures observed by SEM of aedeagus and spermatheca of *Hydrothassa anatolica* sp. nov. from Turkey for the first time. Photos of aedeagus and spermatheca in SEM as weel as in stereo microscope are given in the text. A short key of the species of subgenus *Hydrothassa* (*Agrostithassa*) Jakobson, 1921 is also given in the text.

KEY WORDS: Coleoptera, Chrysomelidae, Chrysomelinae, *Hydrothassa*, new species, SEM, ultrastructures, aedeagus, spermatheca, Turkey, Palearctic region

The genus *Hydrothassa* C. G. Thomson, 1859 (Coleoptera: Chrysomelidae: Chrysomelinae) is distributed in the Holarctic region (Seeno & Wilcox, 1982). It numbers 12 species, which occur in the Palaearctic and Nearctic regions (Winkelman & Debreul, 2008). *Hydrothassa* C. G. Thomson, 1859 that was accepted as a subgenus of the genus *Prasocuris* Latreille, 1802, is represented by 8 species in the Palaearctic region (Kippenberg in Löbl & Smetana, 2010). Palaearctic species classified into two subgenera (Warchalowski, 2003, 2010). *Hydrothassa bicolora* Rapilly, 1981 occurs only in Iran and *Hydrothassa oblongiuscula* (Fairmaire, 1884) occurs only in North Africa (Algeria and Tunisia). The remaining six species as *Hydrothassa fairmairei* (Brisout de Barneville, 1866), *Hydrothassa flavocincta* (Brullé, 1832), *Hydrothassa glabra* (Herbst, 1783), *Hydrothassa hannoveriana* (Fabricius, 1775), *Hydrothassa marginella* (innaeus, 1758) and *Hydrothassa suffriani* (Küster, 1852) are known from Europe (Warchalowski, 2003, 2010; Kippenberg in Löbl & Smetana, 2010). Two of them as *Hydrothassa flavocincta* (Brullé, 1832) and *Hydrothassa glabra* (Herbst, 1783) are distributed also in Turkey (Ekiz et al., 2013; Özdikmen, 2014).

Many specimens of *Hydrothassa* was collected in Kayseri province, Turkey. They are described as a new species.

The spermathecae and aedeagi were dissected from abdomen, remaining tissue were removed with fine tweezers.

For light microscopic examination after cleaning, the samples were placed 70% ethanol and examined with Olympus SZX7 stereomicroscope.

For scanning electron microscopy (SEM), cleaned samples were dehydrated using an ascending series of ethanol (70%, 80%, 90%, and 100%) and then air dried. After that the specimens were mounted onto SEM stubs using a double-sided adhesive tape, coated with gold using a Polaron SC 502

Sputter Coater, and examined with a JEOL JSM 6060 Scanning Electron Microscope (SEM) at 10 kV.

***Hydrothassa* (*Agrostithassa*) *anatolica* sp. nov.**
(Figs. 1-26)

The new species *Hydrothassa anatolica* sp. nov., comes from central Anatolia of Turkey, Kayseri province (Fig. 1). Until now, it is a species endemic to Turkey, which was compared with closely related two Turkish and one North African species of *Hydrothassa* C. G. Thomson, 1859. It can be distinctively differentiated from these species based on its body size, epipleural punctuation and aedeagal characters especially.

HOLOTYPE: Male – Turkey, Kayseri province, Sarız, Çörekdere, 38°28'50" N 36°27'29"E, 1637 m, 06.VI.2018, leg. D. Coral Şahin. The holotype is stored in Nazife Tuatay Plant Protection Museum (NTM) (Turkey, Ankara).

PARATYPES: Males – Turkey, Kayseri province, Sarız, Çörekdere, 38°28'50" N 36°27'29"E, 1637 m, 06.VI.2018, leg. D. Coral Şahin, 32 specimens. Females – Turkey, Kayseri province, Sarız, Çörekdere, 38°28'50" N 36°27'29"E, 1637 m, 06.VI.2018, leg. D. Coral Şahin. 26 specimens. The paratypes are stored in Nazife Tuatay Plant Protection Museum (NTM) (Turkey, Ankara).

Description of holotype.
Length: 3.02 mm.
Body: Almost completely black (except for reddish lateral stripes on elytra and partly brownish black labrum and mouthparts). Upper side almost completely glabrous (except for antennae). Underside and legs clothed with short, very sparsely, recumbent or semirecumbent, light hairs.
Head: Almost completely black (except for partly brownish black labrum and mouthparts). Almost completely glabrous (with sparsely light hairs on mouthparts and apical margin of clypeus and labrum). Fronto-clypeal suture distinct and archwise. Frontal callus sometimes visible. Head with distinct, scattered and sparsely punctures (except for labrum). The area between punctures larger than diameter of punctures. Antennae entirely black and clothed with short, very sparsely, semirecumbent, light hairs.
Pronotum: Completely black. Entirely glabrous. Pronotum with distinct, scattered and sparsely punctures (similar on the head). Pronotum clearly transverse and approximately as long as 3/5 its width.
Scutellum: Triangular. Completely black. Entirely glabrous. With a few distinct, scattered and sparsely punctures.
Elytra: In the most part black and with reddish lateral stripes. Entirely glabrous. Each elytron with 11 regular rows of punctures (9 rows on black part and 2 rows on reddish lateral stripe). Punctures larger than on head and pronotum. Epipleura reddish with more or less fine and scattered punctures.
Legs: Completely black and clothed with short, very sparsely, recumbent or semirecumbent, light hairs.
Underside: Completely black and abdomen clothed with short, very sparsely, recumbent or semirecumbent, light hairs.

Aedeagus and spermatheca of *Hydrothassa anatolica* sp. nov. were studied with both stereo microscope and SEM. Obtaining observations on ultrastructures of them are presented as follows:

Aedeagus: In lateral view, median lobe distinctly curved median foramen to apex (almost semicircularly). Strongly sharpened towards to apex (Figs. 2, 6, 7, 10).

In dorsal view, median lobe at the apex broadly rounded (Figs. 2, 13-14, 16-17). Upper and lateral margins of orifice rounded (Figs. 2, 13-14, 16-17). Dorsal plate distinct, large and entire (Figs. 2, 13-14, 16-17). Median lobe in lateral parts and fore part of orifice thickened. Thickening in lateral parts smaller than the fore part (Figs. 2, 16-17). Median lobe behind the dorsal plate flattened (Figs. 2, 6-8, 13-14, 16-17).

Median lobe especially in anterior half with distinct, scattered, irregular and sparsely ultrastructural pits (Figs. 7-15, 18). The pits located only in lateral parts of terminal part of median lobe in dorsal view. The terminal area from upper margin of orifice to aedeagal apex almost without ultrastructural pits in dorsal view. Dorsal plate and the area behind it with ultrastructural pits in dorsal view (Figs. 8-9, 13-18).

Spermatheca: General view of spermatheca C-shaped (Figs. 3, 19-20). Nodulus almost equal width with cornu or slightly wider than apical part of cornu (Figs. 3, 19-20). Apex of cornu obtuse (Figs. 3, 19-20, 26). Collum + ramus distinct, clearly visible (Figs. 3, 19-23). Ductus spermatheca long and straight, but only broadly twisted, not spiral in streo microscope (not photographed). Ductus spermatheca ruptured in SEM (Figs. 19-23). Spermathecal gland long and straight (Figs. 19-24). Nodulus, cornu, collum, ramus and spermathecal gland with scattered, irregular and sparsely ultrastructural pits (Figs. 21-24, 26).

Female: The same male. No sexual dimorphism, but body size larger than the males.

Variations: Body almost completely black, sometimes dark blue black or dark greenish black. Length of males 2.9-3.3 mm and females 3.3-3.7 mm.

Differential diagnosis. The new species *Hydrothassa anatolica* sp. nov., exerts considerable morphological features differentiation from other species of the subgenus and genus. First of all, pronotal punctuation and aedeagus are unique in the new species.

The closest species to the new species with regard to pronotal punctuation and aedeagal form is *Hydrothassa suffriani* (Küster, 1852). Elytra are uniformly colored in *Hydrothassa suffriani* (Küster, 1852) while elytra have orange lateral stripes in the new species.

Pronotal punctuation is relatively denser and fine in *Hydrothassa flavocincta* (Brullé, 1832) while pronotal punctuation is relatively sparser and fine in the new species. In addition, epipleura is impuntated in *Hydrothassa flavocincta* (Brullé, 1832) while epipleura is punctated in the new species. Anyway, a size of *Hydrothassa flavocincta* (Brullé, 1832) was given as 3.4-4.4 mm by Warchałowski (2003, 2010), but it is correct only for females. A size of males is 2.9-3.2 mm.

Pronotal punctuation is relatively denser and larger in *Hydrothassa glabra* (Herbst, 1783) and *Hydrothassa oblongiuscula* Weise, 1900 while pronotal punctuation is relatively sparser and fine in the new species. Median lobe of aedeagus is longer, thiner and slightly curved ventrad in lateral view, apex of median lobe is slightly sharpened and more or less straight in lateral view, dorsal plate is smaller and shorter in dorsal view in *Hydrothassa glabra* (Herbst, 1783) while median lobe of aedeagus is longer, thiner and strongly curved (almost semicircularly) ventrad in lateral view, apex of median lobe is sharpened and straight in lateral view, dorsal plate is larger and longer in dorsal view in the new species. Median lobe of aedeagus is shorter, thicker and slightly curved ventrad in lateral view, apex of median lobe is sharpened and also slightly curved ventrad in lateral view, dorsal plate is smaller and shorter in dorsal view in *Hydrothassa oblongiuscula* Weise, 1900 while median lobe of aedeagus is longer, thiner and strongly curved (almost semicircularly) ventrad in lateral view, apex of median lobe is sharpened and straight in lateral view, dorsal plate is larger and longer in dorsal view in the new species.

Distribution: The new species is known from Kayseri province (Sarız) in entral Anatolian region of Turkey. For the time being, the species is endemic to the Turkey.

Hydrothassa flavocincta (Brullé, 1832) was firstly reported by Apfelbeck (1901, 1916) from Turkey. Then, Gruev (1992, 2004, 2005) recorded the species to Turkey. Also, it was mentioned by Warchalowski (2003, 2010) and Kippenberg in Löbl & Smetana (2010) for Turkey. Ekiz et al. (2013) and Özdikmen (2014) reported it only from İstanbul province in north-western part of Turkey for European Turkey (Thrace) and Asian Turkey (Anatolia) on the base of previously literatures. Later, the SE-European species *Hydrothassa flavocincta* (Brullé, 1832) was reported by Medvedev (2015) from Muş province (Varto) in Eastern Anatolian region of Turkey. He stated that "*A size of this species was given as 3.4-4.4 mm (Warchałowski, 2003), but it is correct only for females. A size of males is 2.8–3 mm*". Consequently, the record of *Hydrothassa flavocincta* (Brullé, 1832) in Medvedev (2015) should belongs to the new species *Hydrothassa anatolica* sp. nov..

On the other side, the Europeo-Mediterranean species *Hydrothassa glabra* (Herbst, 1783) was firstly recorded by Aslan et al. (2003) from Erzurum province in Eastern Anatolian region of Turkey. However, Warchalowski (2003, 2010) were never mentioned *Hydrothassa glabra* (Herbst, 1783) for Turkey while Kippenberg in Löbl & Smetana (2010) was reported the species for Asian Turkey (Anatolia). A single objective record from Turkey of *Hydrothassa glabra* (Herbst, 1783) in Aslan et al. (2003) was repeatedly given by Ekiz et al. (2013) and Özdikmen (2014). In this case, the record of Aslan et al. (2003) should be confirmed. It may also belongs to the new species *Hydrothassa anatolica* sp. nov..

Etymology: The specific name of the new species *Hydrothassa anatolica* sp. nov., is based on Anatolia, synonym of Asia Minor.

A short key of the Palaearctic species of subgenus *Hydrothassa* (*Agrostithassa*) Jakobson, 1921 (the key based on Warchalowski, 2010)

1. Elytra with orange lateral stripes...**2**
-. Elytra uniformly blue black or greenish black; length 3.0-4.1 mm; distributed only in Sardinia and Corsica...***Hydrothassa suffriani* (Küster, 1852)**

2. Epipleura not punctured; length 3.4-4.4 mm; distributed in Albania, Bosnia & Herzegovina, Bulgaria, Croatia, Greece, Hungary, Yugoslavia, European and Asian Turkey... ....***Hydrothassa flavocincta* (Brullé, 1832)**
-. Epipleura sometimes sparsely and unevenly, but distinctly punctured..............................**3**

3. Sides of elytra slightly rounded; aedeagus apically slightly narrowed; length 3.2-4.4 mm; distributed in almost all Europe, North Africa (Morocco) and Asian Turkey..***Hydrothassa glabra* (Herbst, 1783)**
-. Sides of elytra almost parallel; aedeagus apically rather broadly rounded...........................**4**

4. Pronotal punctuation denser; median lobe of aedeagus shorter, thicker and slightly curved ventrad in lateral view; apex of median lobe sharpened and also slightly curved ventrad in lateral view; dorsal plate smaller and shorter in dorsal view; distributed only in North Africa (Algeria and Tunisia)................***Hydrothassa oblongiuscula* Weise, 1900**
-. Pronotal punctuation sparser; median lobe of aedeagus longer, thiner and strongly curved (almost semicircularly) ventrad in lateral view; apex of median lobe sharpened and straight in lateral view; dorsal plate larger and longer in dorsal view; length 2.93-3.68 mm; distributed only in Turkey...***Hydrothassa anatolica* sp. nov.**

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We are sincerely grateful to Prof. Dr. Zekiye Suludere for SEM studies.

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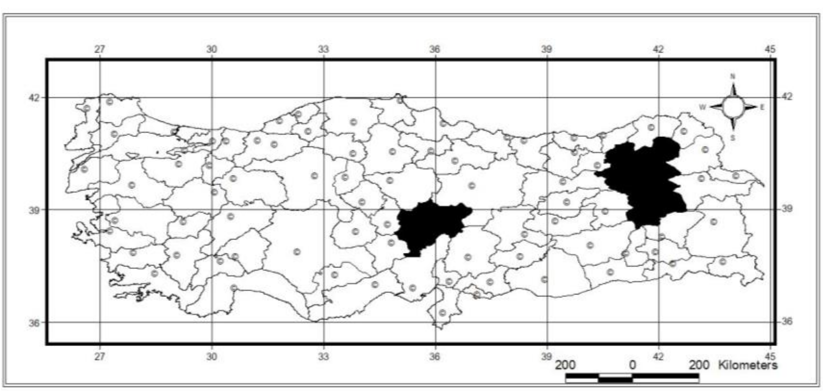

Map 1. Estimated distribution pattern of *Hydrothassa anatolica* sp. nov. in Turkey (Kayseri, Muş and ?Erzurum provinces).

A B
Figure 1. Habitus of holotype (male) of *Hydrothassa anatolica* sp. nov. A. Dorsal, B. Ventral.

A B
Figure 2. Aedeagus of *Hydrothassa anatolica* sp. nov. in streo microscope. A. ateral view, B. Dorsal view.

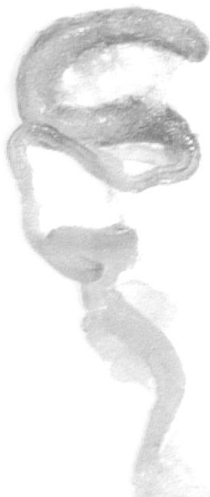

Figure 3. Spermatheca of *Hydrothassa anatolica* sp. nov. in streo microscope, lateral view.

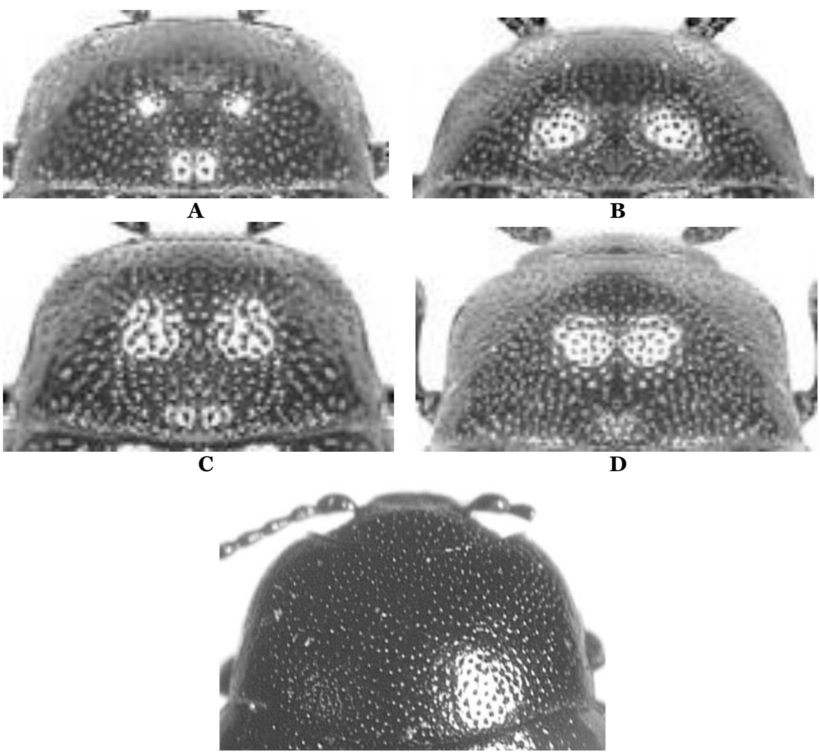

Figure 4. Punctures on pronotum. A. *Hydrothassa suffriani* (Küster, 1852), B. *Hydrothassa flavocincta* (Brullé, 1832), C. *Hydrothassa glabra* (Herbst, 1783), D. *Hydrothassa oblongiuscula* Weise, 1900, E. *Hydrothassa anatolica* sp. nov.

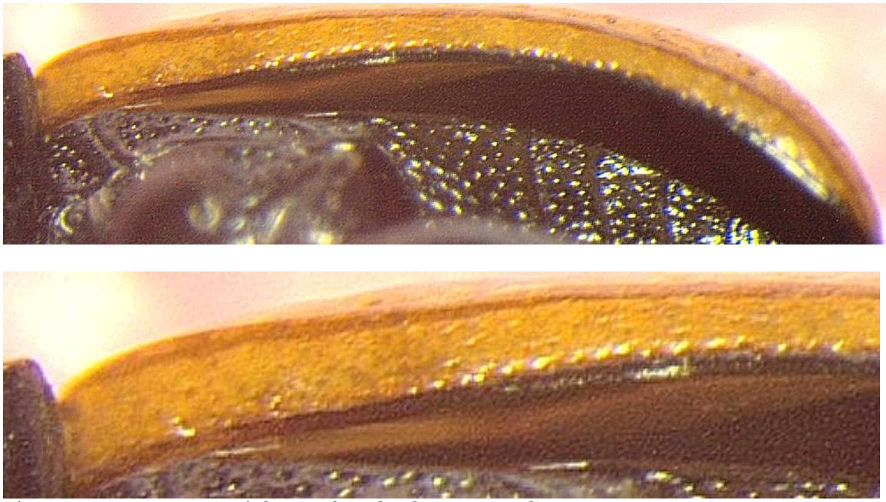

Figure 5. Punctures on epipleura of *Hydrothassa anatolica* sp. nov.

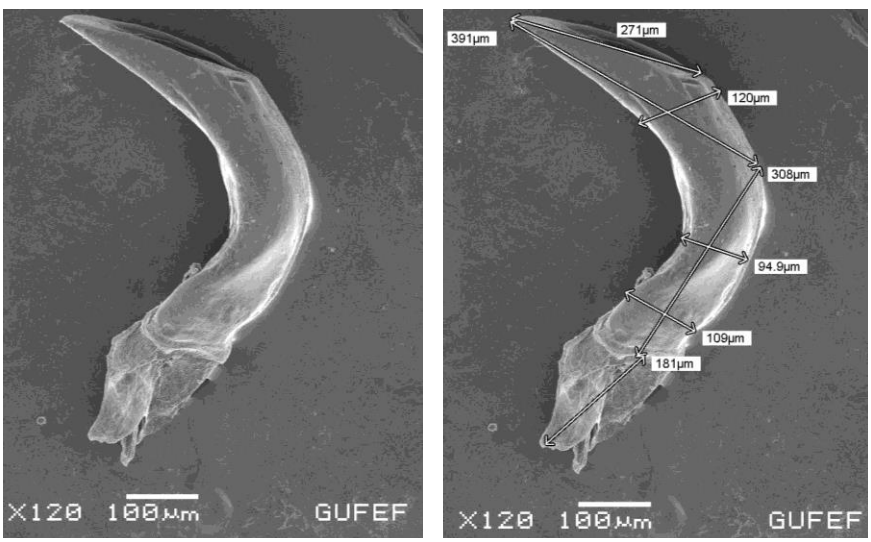

Figure 6. Aedeagus, lateral view.

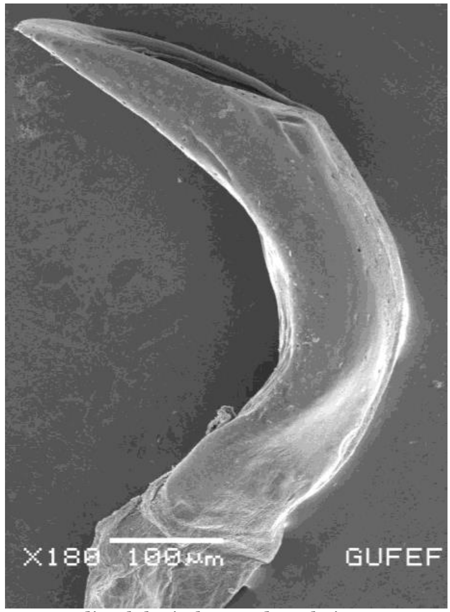

Figure 7. Aedeagus, pits on median lobe in latero-dorsal view.

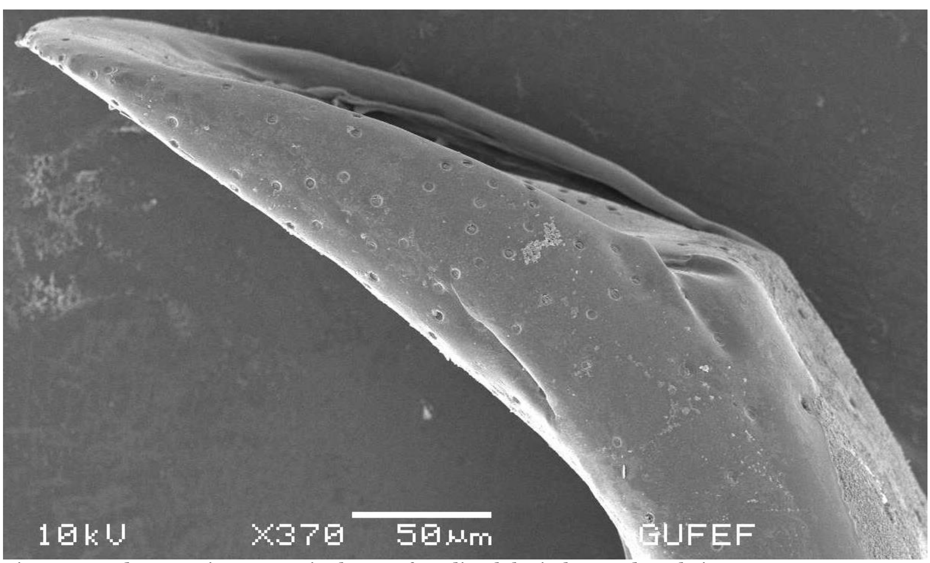

Figure 8. Aedeagus, pits on terminal part of median lobe in latero-dorsal view.

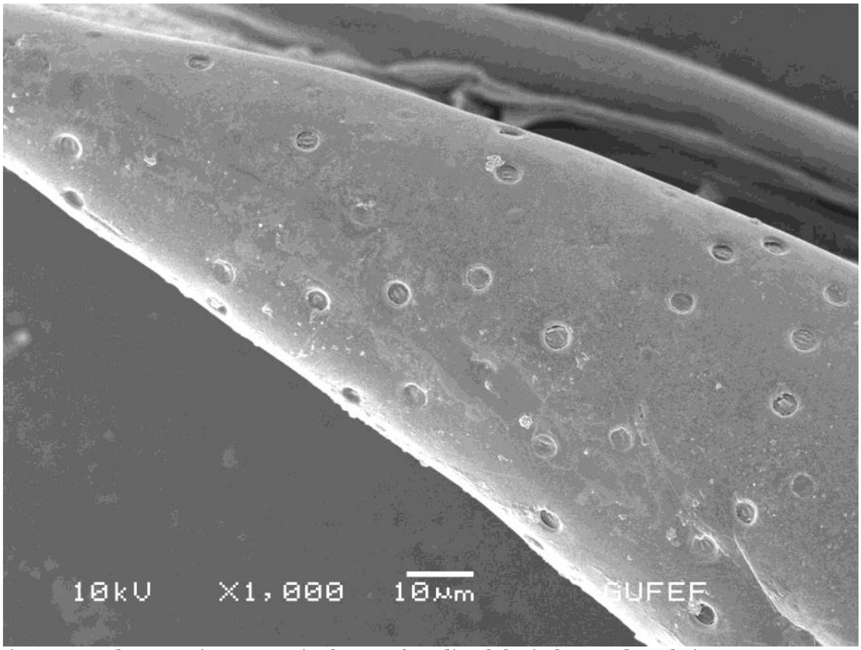

Figure 9. Aedeagus, pits on terminal part of median lobe in latero-dorsal view.

Figure 10. Aedeagus, pits on median lobe in latero-ventral view.

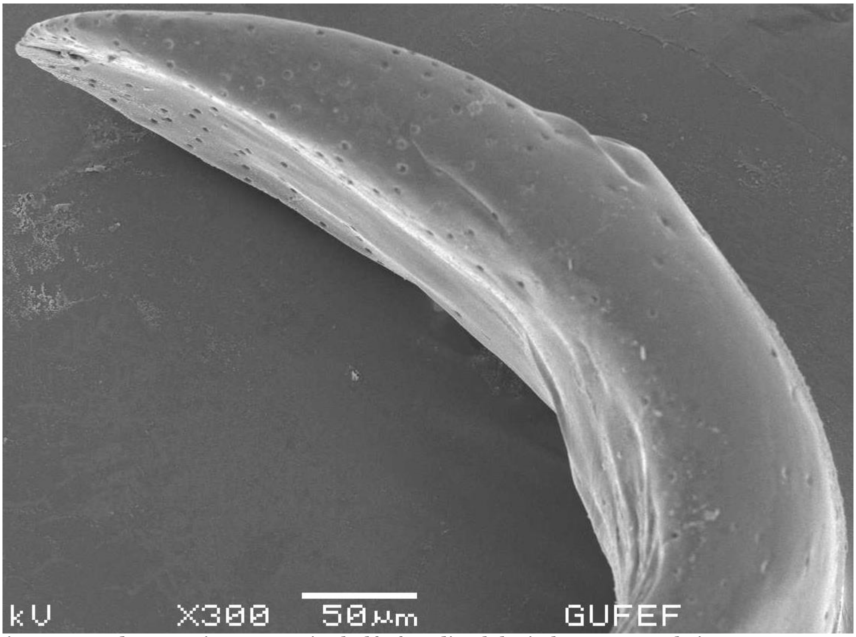

Figure 11. Aedeagus, pits on anterior half of median lobe in latero-ventral view.

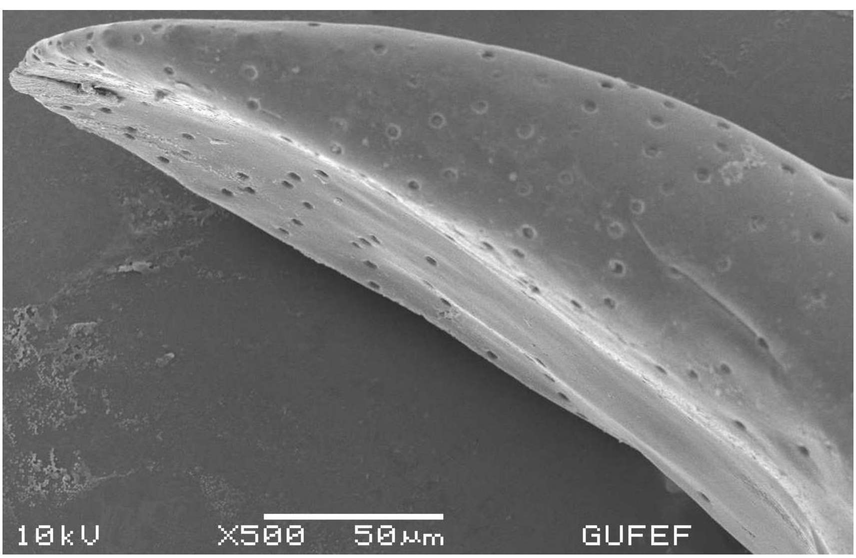

Figure 12. Aedeagus, pits on terminal part of median lobe in latero-ventral view.

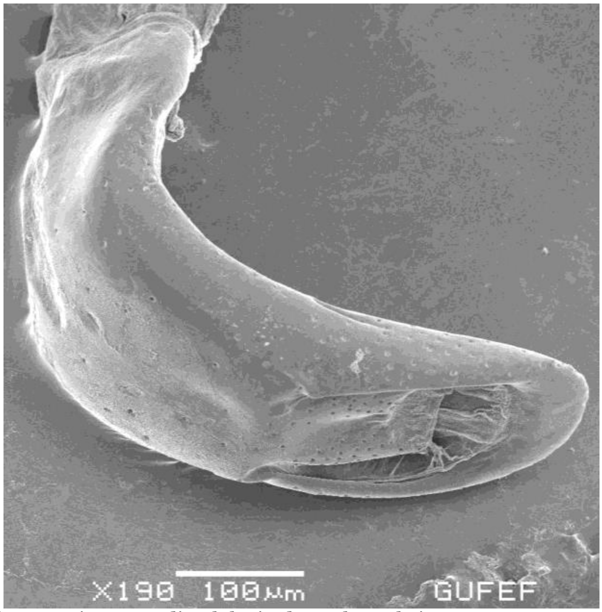

Figure 13. Aedeagus, pits on median lobe in dorso-lateral view.

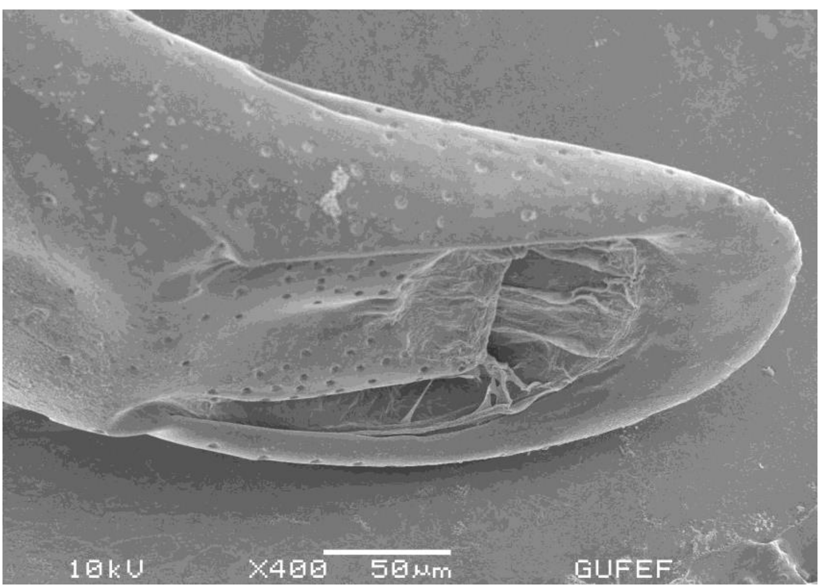

Figure 14. Aedeagus, pits on terminal part of median lobe in dorso-lateral view.

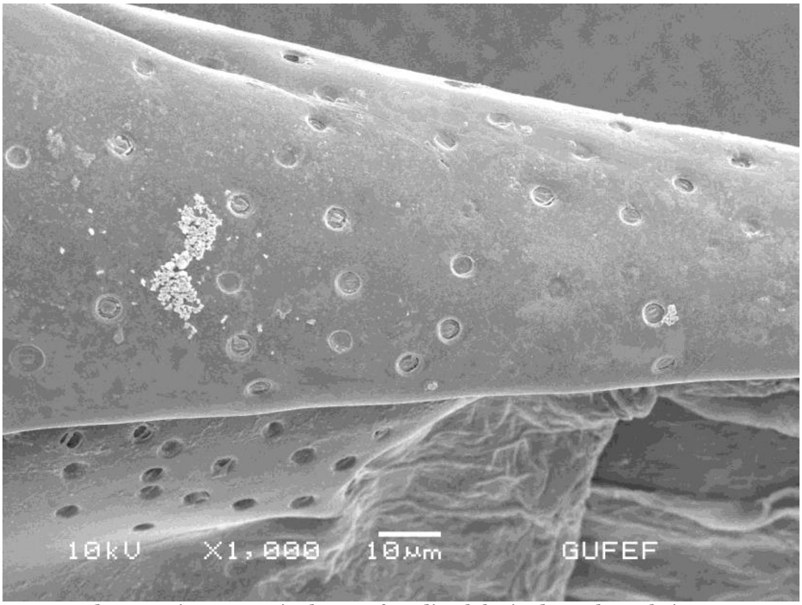

Figure 15. Aedeagus, pits on terminal part of median lobe in dorso-lateral view.

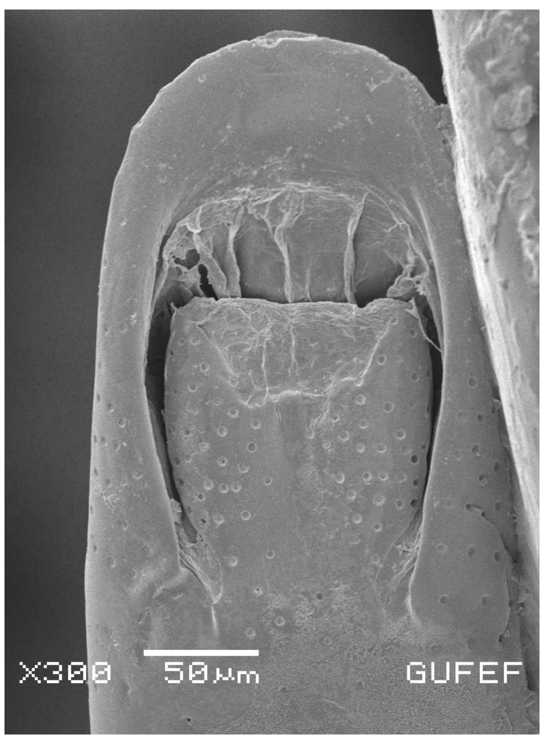

Figure 16. Aedeagus, pits on terminal part of median lobe in dorsal view.

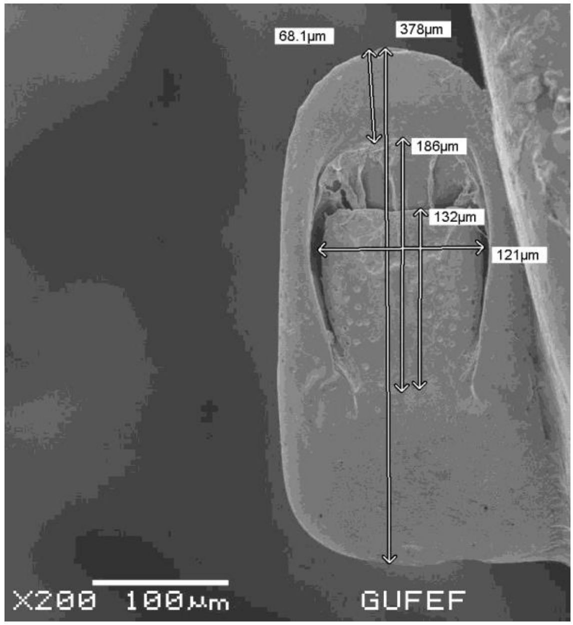

Figure 17. Aedeagus, terminal part of median lobe in dorsal view.

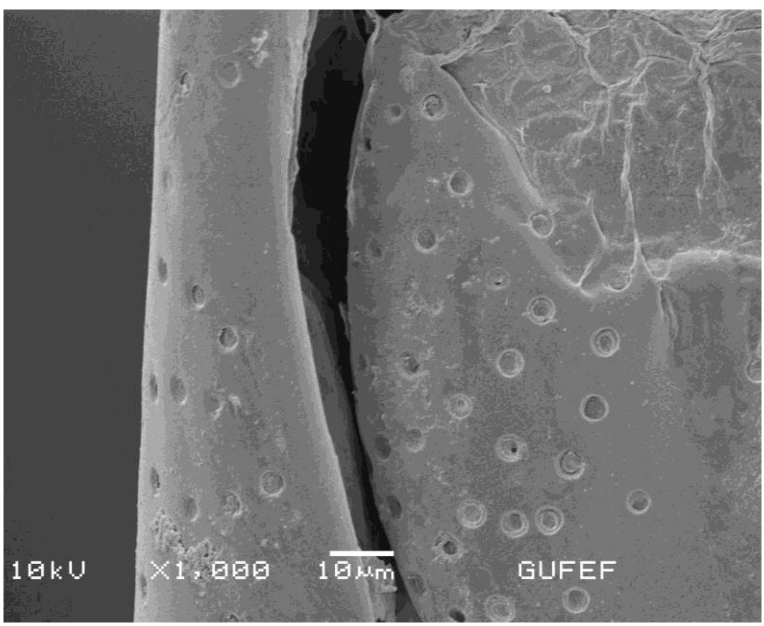

Figure 18. Aedeagus, pits on terminal part of median lobe in dorsal view.

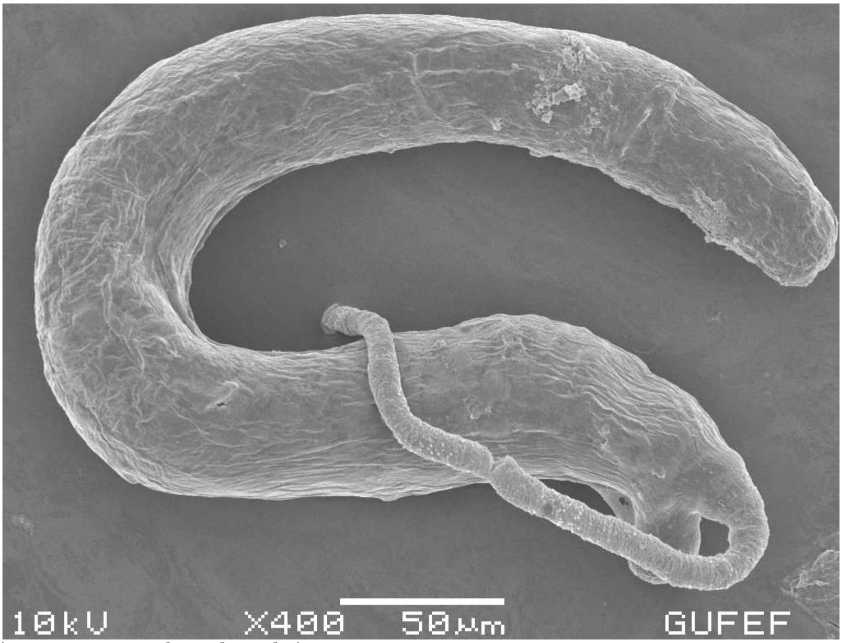

Figure 19. Spermatheca, lateral view.

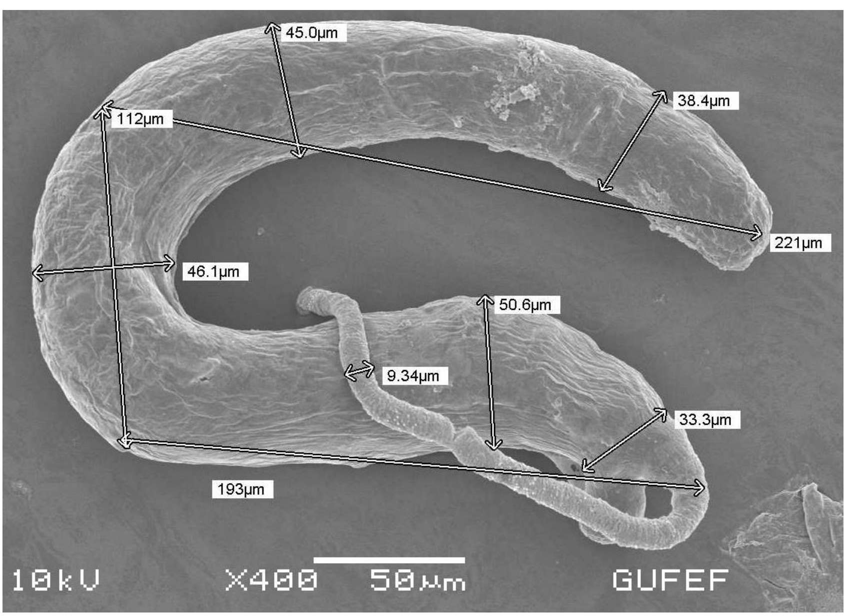

Figure 20. Spermatheca, lateral view.

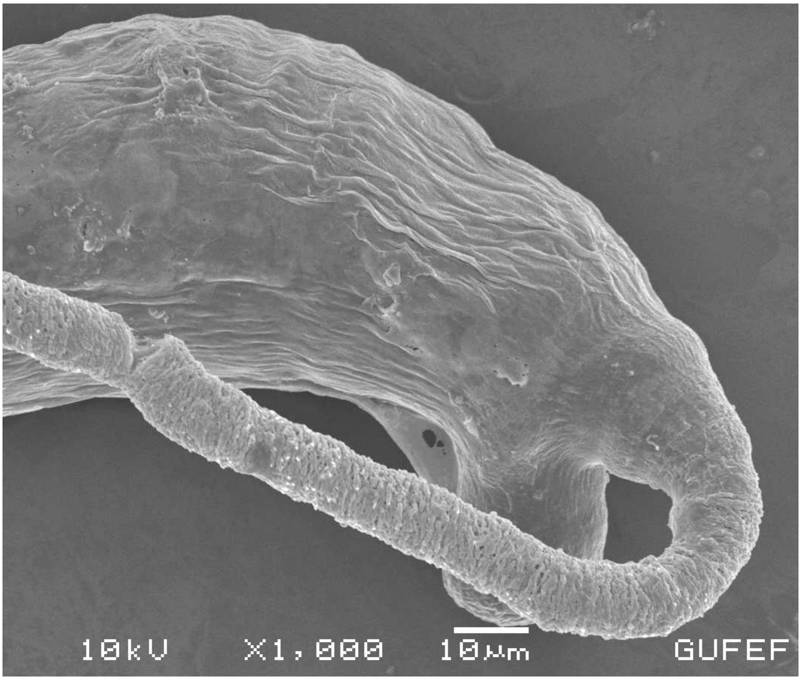

Figure 21. Spermatheca, nodulus, collum, ramus, spermathecal gland and ruptured ductus spermatheca.

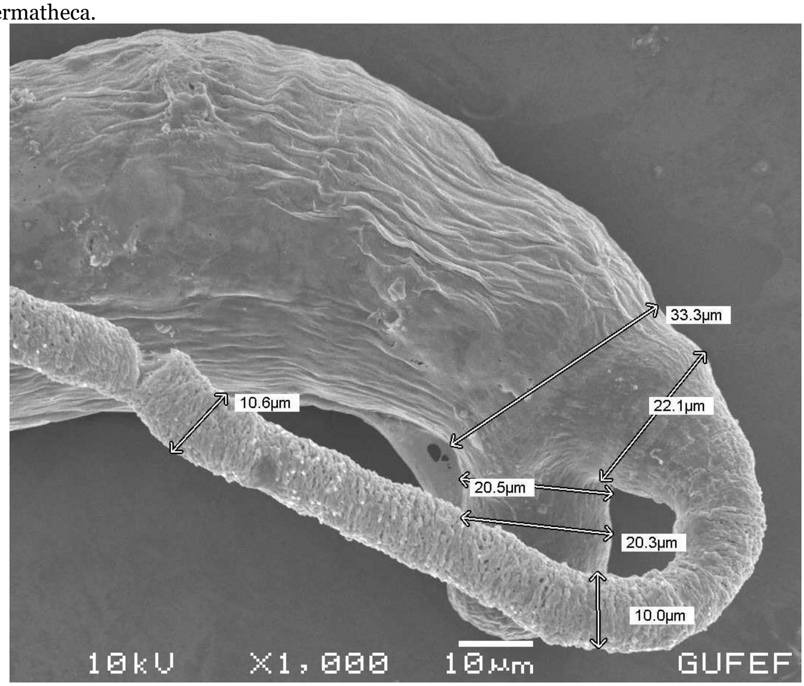

Figure 22. Spermatheca, nodulus, collum, ramus, spermathecal gland and ruptured ductus spermatheca.

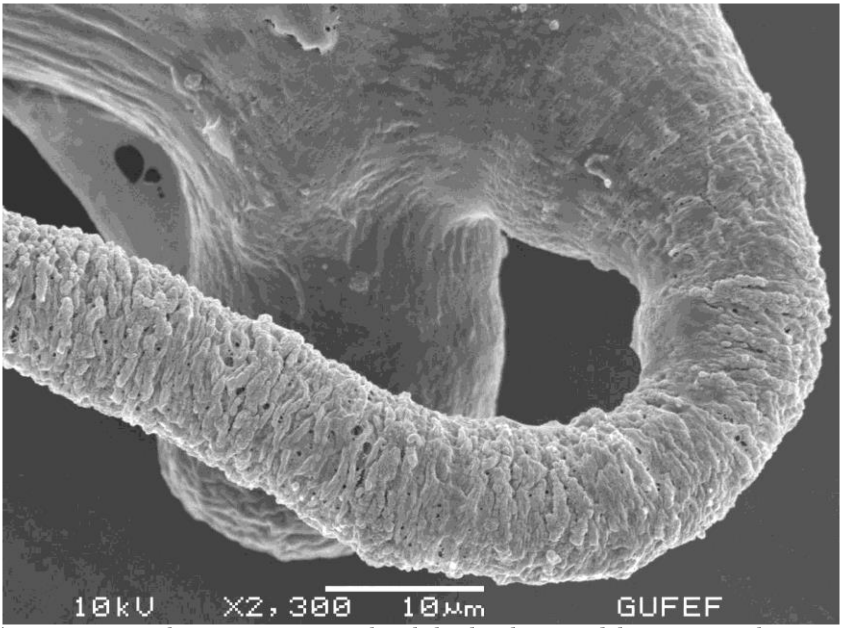

Figure 23. Spermatheca, ramus, spermathecal gland and ruptured ductus spermatheca.

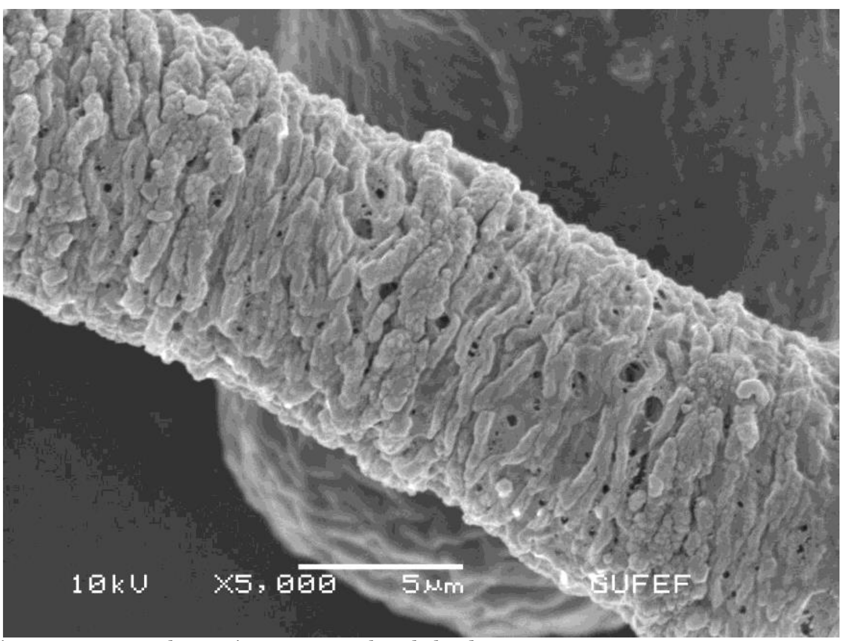

Figure 24. Spermatheca, pits on spermathecal gland.

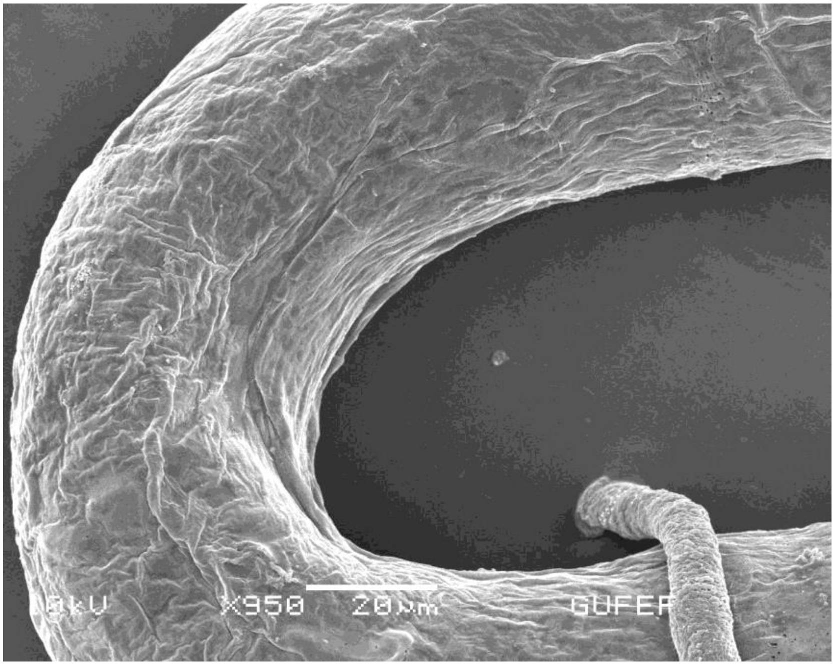

Figure 25. Spermatheca, cornu.

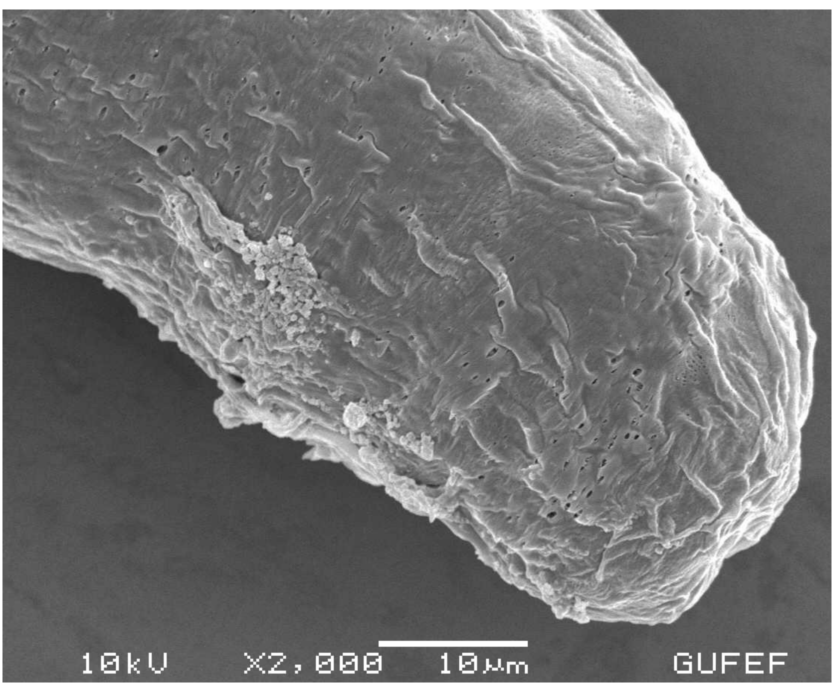

Figure 26. Spermatheca, pits on apical part of cornu.

NEOPLAGIONOTUS ANATOLICUS SP. NOV. – DESCRIPTION OF A NEW SPECIES FROM TURKEY (COLEOPTERA: CERAMBYCIDAE)

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[Vartanis, J. 2019. *Neoplagionotus anatolicus* sp. nov. - description of a new species from Turkey (Coleoptera: Cerambycidae). Munis Entomology & Zoology, 14 (1): 344-349**]**

ABSTRACT: A new species, *Neoplagionotus anatolicus* sp. nov., is described from the Turkey. For the time being, the species is endemic to the Turkey, province Antalya. *Neoplagionotus anatolicus* sp. nov., was compared to all species of the genus *Neoplagionotus* Kasatkin, 2005 and *Echinocerus* Mulsant, 1862. These are species, *Neoplagionotus andreui* (Fuente, 1908) / *Neoplagionotus bobelayei bobelayei* (Brulle, 1832) / *Neoplagionotus bobelayei huseyini* Lazarev, 2016 / *Neoplagionotus bobelayei mouzafferi* (Pic, 1905) / *Neoplagionotus scalaris* (Brulle, 1832) and *Echinocerus floralis* (Pallas, 1773).

KEY WORDS: Coleoptera, Cerambycidae, Cerambycinae, Clytini, *Neoplagionotus*, new species, Turkey, Palearctic region

Neoplagionotus anatolicus sp. nov.

(Figs. 1a,b,c,d,e)

The new species *Neoplagionotus anatolicus* sp. nov., comes from southwest Turkey, Antalya region, 30km west of the town Alanya. Until now, it is a species endemic to Turkey, which was compared with all the species of the genera *Neoplagionotus* Kasatkin, 2005 and *Echinocerus* Mulsant, 1862 all of them being represented in my collection. It can be distinctively differentiated from these species based on its morphological characters.

HOLOTYPUS: Male – Turkey (prov. Antalya), Okurcalar- 30 km W of Alanya, 2.VI.2013, lgt. Wrzecionko (coll. J. Vartanis).
PARATYPUS: 6 x males / 6 x females – Turkey (prov. Antalya), Okurcalar- 30 km W of Alanya, 2.VI.2013, lgt. Wrzecionko (coll. J. Vartanis).

Length: Males: 16 – 19 mm, females: 16 – 18 mm.
Body: Red to reddish yellow including all legs and antennae. Abdominal ventrites red, partially covered with yellow pubescence (see the photo). The whole body relatively long and narrow.
Head: More or less distinctly pubescent behind base of antennae.
Antennae: Reddish yellow, with sparse, yellow, pubescence throughout their surfaces. Antennomeres rather short, particularly antennomere 3 very short compared to species of genus *Echinocerus* Mulsant, 1862.
Pronotum: With very dense and wide yellow pubescence. Traces of black pattern only very slightly shown through on very small lateral areas pronotum (about 10% - 40% of whole pronotum area). Remaining proportion (about 60% - 90% of pronotum surface area) covered with yellow decumbent pubescence without any erect setae. Pronotum almost as wide as long.
Scutellum: Rounded, without acute angles, covered with dense, decumbent pubescence throughout.

Elytra: Black, with yellowy pubescent basal spot and three stripes, and also with a subhumeral spot and apical spot. Yellow stripes narrow, intervals between them being quite clear and wider than stripes themselves. Elytra very long, 2.8 times longer than wide at humeri. Pubescence decumbent throughout elytra surface, without any erect setae.
Legs: Reddish yellow, including femora, tibiae and tarsi. Their surfaces with sparse, yellow, pubescence throughout their surfaces.

Differential diagnosis. The new species *Neoplagionotus anatolicus* sp. nov., exerts considerable morphological features differentiation it from other species of the genus and from the species of the genus *Echinocerus* Mulsant, 1862. First of all, it should be compared with the species *Echinocerus floralis* (Pallas, 1773) which has abdominal ventrites black and completely covered with yellow pubescence and is free of reddish-yellow colour (see the photo). In addition, the species *Echinocerus floralis* (Pallas, 1773) has very long erect setae throughout the pronotum surface and humeri; these setae are very dense and perpendicular to the surface, which is well observable in lateral view; the yellow pattern on the pronotum surface is very reduced and there is a large black spot on the pronotum top surface. The black colour of thepronotum prevails over the yellow one throughout the surface; the elytra are shorter, only 2.35 times longer than wide at humeri; the antennae are longer, all the antennomeres are longer than respective antennomeres of the new species and particularly antennomere 3 of the species *Echinocerus floralis* (Pallas, 1773) is three times longer than wide at apex. The new species *Neoplagionotus anatolicus* sp. nov., has shorter antennomere 3 and its pubescence on the pronotum and elytra is free of any erect setae – all the pubescence is decumbent; the pronotum is completely covered with yellow decumbent pubescence and exerts no distinct black patter; the elytra are relatively longer – 2.8 times longer than wide at humeri, this morphological feature being very distinctive among all the species of both genera *Neoplagionotus* Kasatkin, 2005 and *Echinocerus* Mulsant, 1862, whose members have the elytra only 2-2.35 times longer than wide at humeri. Further very distinctive differences can be found in the pronotum, where the new species has its pronotum as long as wide, whereas all the members of the genus *Neoplagionotus* Kasatkin, 2005 have their pronota wider than long – in average 1.2-1.3 times wider than long. In addition, the black pattern of the pronotum is quite considerable and prevails over the yellow pattern.

The top surface is always black. Within the framework of the whole genus, the elytra width at humeri is always larger than the pronotum width, and in the new species *Neoplagionotus anatolicus* sp. nov., the elytra width at humeri equals to the pronotum width. In the new species, the yellow pattern of the elytra is considerably reduced in the new species compared to species of the genus *Neoplagionotus* Kasatkin, 2005 which particularly concerns the species *Neoplagionotus bobelayei bobelayei* (Brullé, 1832) / *Neoplagionotus bobelayei huseyini* Lazarev, 2016 / *Neoplagionotus bobelayei mouzafferi* (Pic, 1905) and *Neoplagionotus andreui* (Fuente, 1908) which has a very remarkable pattern occupying a considerable proportion of the elytral surface.

The new species is rather elongate and narrow compared to other species, which are relatively stouter and wider as to the length-towidths ratios for the pronotum, elytra and whole body. The new species is characteristic due to its morphological characters making possible its differentiation from all the above considered species of the genera *Neoplagionotus* Kasatkin, 2005 and *Echinocerus* Mulsant, 1862 these characters are observable even with the naked eye.

Extension of *Neoplagionotus* and *Echinocerus* species.

1 –*Neoplagionotus anatolicus* sp. nov. – Turkey – (Figs. 1(a,b,c,d,e))
2 – *Neoplagionotus andreui* (Fuente, 1908) – Spain, Portugal - (Fig. 6)
3 – *Neoplagionotus bobelayei bobelayei* (Brulle, 1832) – Balkan (Albania, Bulgaria, Greece, Macedonia, Romania, European Turkey) - (Fig. 5)
4 – *Neoplagionotus bobelayei huseyini* Lazarev, 2016 – Armenia, Azerbaijan, Georgia, Iran, European Russia, Turkmenistan, Turkey, Ukraina - (Fig. 4)
5 – *Neoplagionotus bobelayei mouzafferi* (Pic, 1905) – Iran, Iraq, Israel, Jordan, Syria, Turkey - (Fig. 3)
6 – *Neoplagionotus scalaris* (Brulle, 1832) – Albania, Bulgaria, Greece, Italy, Macedonia, Turkey, Algeria, Morocco, Tunisia - (Fig. 7)
7 – *Echinocerus floralis* (Pallas, 1773) – Most parts of Europe, European Russia, European and Asian Turkey, Armenia, Azerbaijan, Georgia, Iran, Iraq, Israel, Jordan, Lebanon, Siberia, Kirgizia, Kazakhstan, Tadzikistan, Turkmenia, Uzbekistan, China – (Figs. 2(a,b,c,d))

Etymology: The specific name of the new species *Neoplagionotus anatolicus sp. n.,* is based on Anatolia, synonym of Asia Minor. The name comes from the period of the Roman empire and was derived from ancient Greek „ Ανατολή“ – East, nowadays Turkey.

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I would like to thank M. Danilevsky (Moscow, Russia), M. Slama (Praha, Czechia), A. Wrzecionko (Horni Sucha, Czechia) for important data. My thanks are extended to Prof. Ing. Miloslav Rakovič (Dobřichovice, Czechia) for professional translation into English language.

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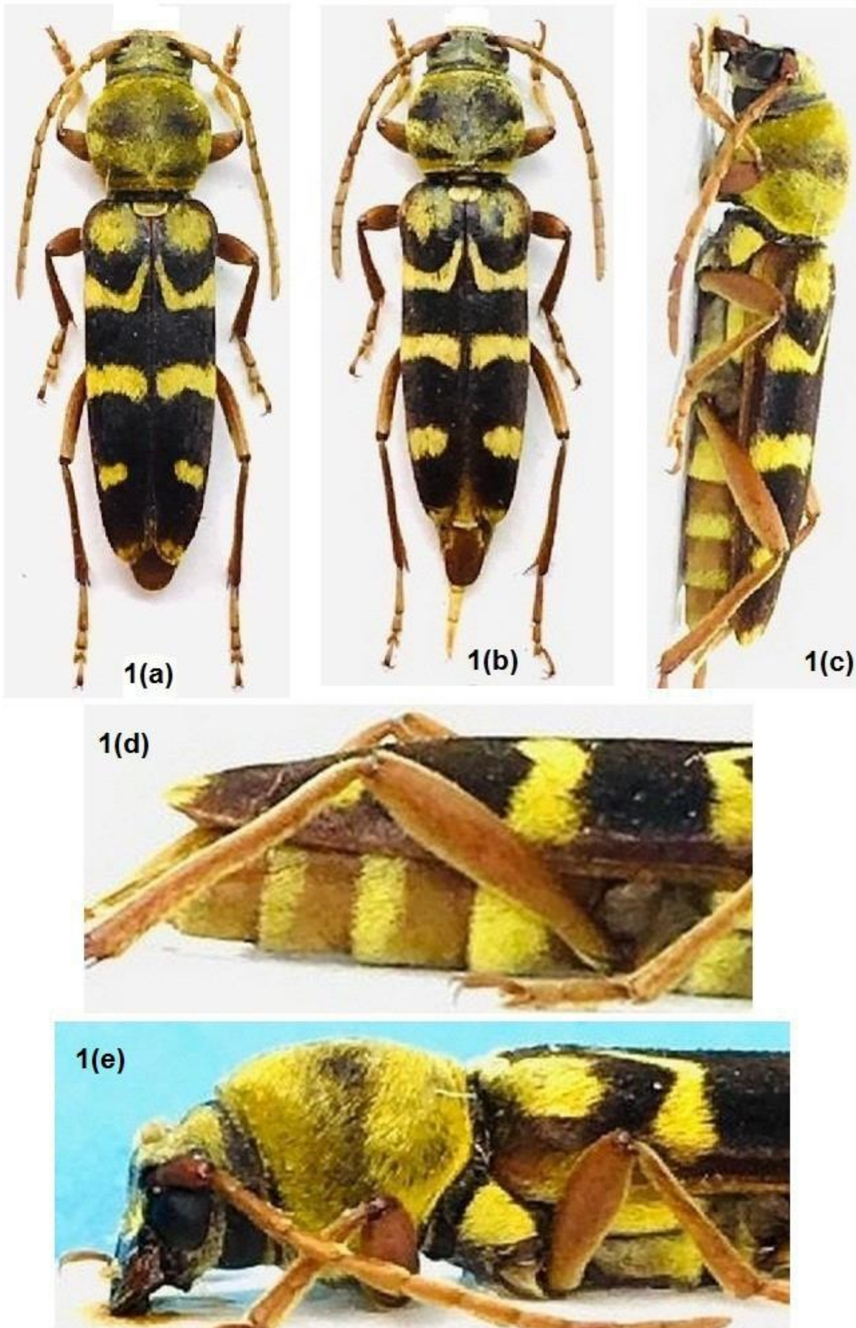

Figure 1. *Neoplagionotus anatolicus* sp. nov., (a). Male, (b). Female, (c, d). Abdominal sternites, (e). Adjacent hairs on the entire surface of pronotum and elytra.

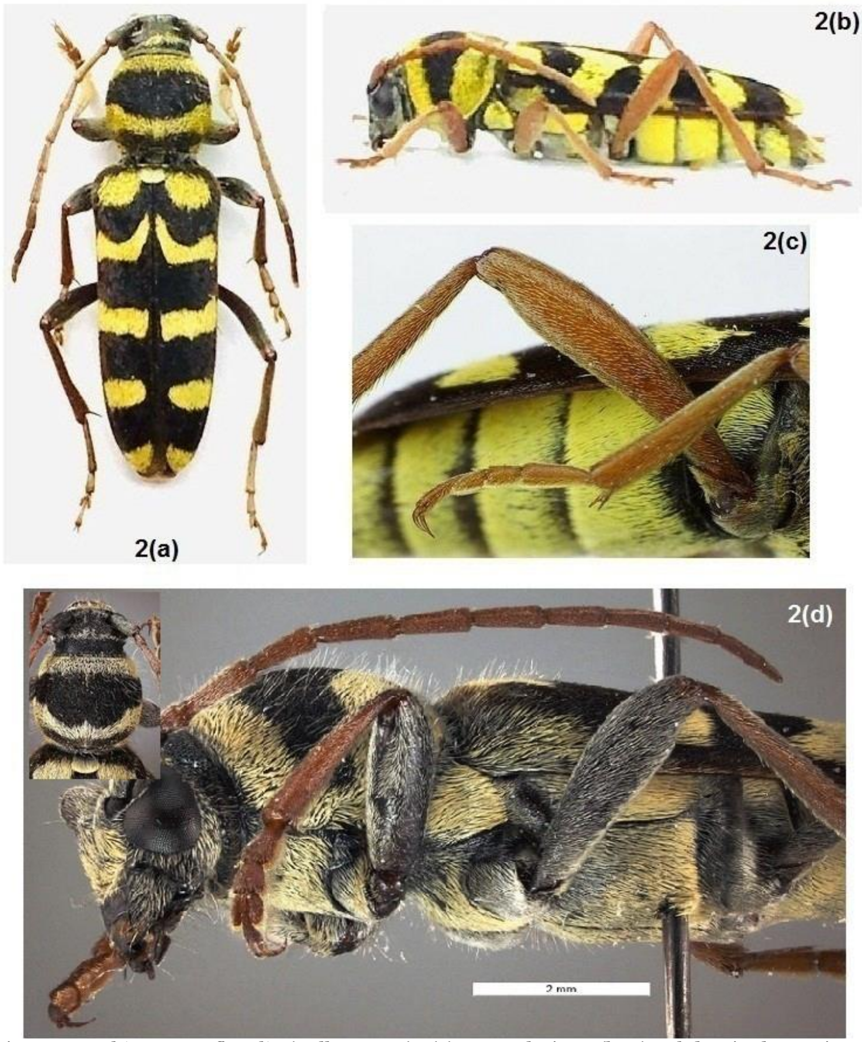

Figure 1. *Echinocerus floralis* (Pallas, 1773), (a). Dorsal view, (b, c). Abdominal sternites, (d). Very perpendicular long erect hairs of pronotum and elytra.

Figures 3-7. 3. *Neoplagionotus bobelayei mouzafferi* (Pic, 1905), 4. *Neoplagionotus bobelayei huseyini* Lazarev, 2016, 5. *Neoplagionotus bobelayei bobelayei* (Brullé, 1832), 6. *Neoplagionotus andreui* (Fuente, 1908), 7. *Neoplagionotus scalaris* (Brullé, 1832).

ON THE SUBGENUS *ALLEDOYA* HINCKS, 1950 (COLEOPTERA: CHRYSOMELIDAE: CASSIDINAE)

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[**Özdikmen, H. & Bal, N.** 2019. On the subgenus *Alledoya* Hincks, 1950 (Coleoptera: Chrysomelidae: Cassidinae). Munis Entomology & Zoology, 14 (2): 350-357]

ABSTRACT: The paper presents remarks on the validity of the subgenus *Alledoya* Hicks, 1950 of the genus *Cassida* Linnaeus, 1758 (Coleoptera: Chrysomelidae: Cassidinae). The subgenus *Alledoya* Hicks, 1950 is redefined and reviewed. Some diagnostic characters for the species of *Alledoya* Hicks, 1950 are introduced. The subgenus is distributed in the western part of Palaearctic Region. Accordingly, a key for identification of the species of subgenus *Alledoya* Hincks, 1950 and the closely related subgenus *Lasiocassis* Gressitt, 1952 is also given.

KEY WORDS: *Cassida, Alledoya, Lasiocasis*, Cassidinae, Chrysomelidae, Turkey

The genus *Cassida* Linnaeus, 1758 includes a large number of species distributed whole world (Palaearctic, Nearctic, Oriental, Afro-tropical, Madagascar and Australian Regions). The genus is divided into many subgenera for the species distributed in Palaearctic and Oriental Regions. According to Borowiec (2007), almost one half of the described species, especially from Africa, Madagascar and Australia, have never been classified in any proposed subgenera.

Hitherto, proposed and valid subgenera within the genus *Cassida* Linnaeus, 1758 are chronologically summarized on the base of Borowiec (2007) as follows:

Genus *Cassida* Linnaeus, 1758
Subgenus *Cassida* (*Cassida*) Linnaeus, 1758
Type sp.: *Cassida nebulosa* Linnaeus, 1758
  = Subgenus *Cassida* (*Pseudocassis*) Steinhausen, 2002
  Type sp.: *Cassida flaveola* Thunberg, 1794
  = Subgenus *Cassida* (*Betacassida*) Steinhausen, 2002
  Type sp.: *Cassida nebulosa* Linnaeus, 1758
Subgenus *Cassida* (*Alledoya*) Hincks, 1950
Type sp.: *Cassida seraphina* Ménétries, 1836
Subgenus *Cassida* (*Lasiocassis*) Gressitt, 1952
Type sp.: *Cassida vespertina* Boheman, 1862
Subgenus *Cassida* (*Cassidulella*) Strand, 1928
Type sp.: *Cassida nobilis* Linnaeus, 1758
Subgenus *Cassida* (*Pseudocassida*) Desbrochers, 1891
Type sp.: *Cassida murraea* Linnaeus, 1768
Subgenus *Cassida* (*Mionycha*) Weise, 1891
Type sp.: *Cassida azurea* Fabricius, 1801
Subgenus *Cassida* (*Odontionycha*) Weise, 1891
Type sp.: *Cassida viridis* Linnaeus, 1758
Subgenus *Cassida* (*Crepidaspis*) Spaeth, 1912
Type sp.: *Crepidaspis varicornis* Spaeth, 1912
  = Subgenus *Cassida* (*Taiwania*) Spaeth, 1913
  Type sp.: *Taiwania sauteri* Spaeth, 1913

= Subgenus *Cassida* (*Cyclocassida*) Spaeth, 1913
Type sp.: *Taiwania variabilis* Chen and Zia, 1961
= Subgenus *Cassida* (*Yunocassis*) Spaeth, 1913
Type sp.: *Cassida appluda* Spaeth, 1926
Subgenus *Cassida* (*Tylocentra*) Reitter in Spaeth & Reitter, 1926
Type sp.: *Cassida turcmenica* Weise, 1892
= Subgenus *Cassida* (*Eremocassis*) Spaeth in Spaeth & Reitter, 1926
Type sp.: *Eremocassis transcaspia* Spaeth, 1926 = *Cassida weisei* Jacobson, 1894
Subgenus *Cassida* (*Lordicassis*) Reitter in Spaeth & Reitter, 1926
Type sp.: *Cassida undecimnotata* Gebler, 1833
Subgenus *Cassida* (*Lordiconia*) Reitter in Spaeth & Reitter, 1926
Type sp.: *Cassida canaliculata* Gebler, 1833
Subgenus *Cassida* (*Onychocassis*) Spaeth in Spaeth & Reitter, 1926
Type sp.: *Cassida brevis* Weise, 1884 and *Cassida bella* Faldermann, 1837
Subgenus *Cassida* (*Mionychella*) Spaeth in Hincks, 1952
Type sp.: *Cassida hemisphaerica* Herbst, 1799
Subgenus *Cassida* (*Cyrtonocassis*) Chen and Zia, 1961
Type sp.: *Cassida tumidicollis* Chen et Zia, 1961
Subgenus *Cassida* (*Dolichocassida*) Günther, 1958
Type sp.: *Cassida veselyi* Günther, 1958

Consequently, the subgenus *Cassida* (*Lasiocassis*) Gressitt, 1952 for two Eastern Palaearctic species as *Cassida vespertina* Boheman, 1862 and *Cassida koreana* Borowiec & Cho, 2011, and the subgenus *Cassida* (*Alledoya*) Hincks, 1950 for two Western Palaearctic species as *Cassida seraphina* Ménétries, 1836 and *Cassida hablitziae* Motschulsky, 1838 was firstly accepted by Borowiec & Cho (2011) as separate subgenera. We agree with the acception of Borowiec & Cho (2011).

Genus *Cassida* Linnaeus, 1758

The Cassidinae fauna of Turkey includes 51 species of 6 genera. The genus *Cassida* Linnaeus, 1758 numbers 41 species (Ekiz et al., 2013; Özdikmen et al., 2014; Özdikmen & Kaya, 2014).

Subgenus *Alledoya* Hincks, 1950

The Western Palaearctic subgenus *Alledoya* Hincks, 1950 numbers only two species. It includes both species in Turkey as *Cassida seraphina* Ménétries, 1836 and *Cassida hablitziae* Motschulsky, 1838 (Ekiz et al., 2013; Özdikmen et al., 2014; Özdikmen & Kaya, 2014). We had the opportunity to study some material of both species from north-western part of Anatolia of Turkey (a total of 125 specimens). Below we redefine the subgenus *Alledoya* Hincks, 1950 on the base of the material from Turkey. Distribution patterns of the species for the provinces in Turkey are given in figures 5 and 6.

Remarks on the validity of the subgenus *Alledoya* Hincks, 1950:

A new subgenus name *Deloyala* of the genus *Cassida* L. was proposed by Redtenbacher (1858) for two western Palaearctic species as *Cassida seraphina*

Ménétries, 1836 and *Cassida hablitziae* Motschulsky, 1838, but did not designated the type species.

However, the subgeneric name *Deloyala* Redtenbacher, 1858 was a junior homonym of *Deloyala* Dejean, 1837. As a consequence, Hincks (1950) proposed a new name *Alledoya* for *Deloyala* Redtenbacher (1858) not Dejean (1837) with the type species *C. seraphina* Ménétries, 1836 (Western Palaearctic species).

Also, a new subgenus *Lasiocassis* for *Deloyala* Redtenbacher (1858) not Dejean (1837) was proposed by Gressitt (1952) with the type species *Cassida vespertina* Boheman, 1862 (Eastern Palaearctic species). The new subgenus included also two Western Palaearctic species as *Cassida seraphina* Ménétries, 1836 and *Cassida hablitziae* Motschulsky, 1838. Finaly, a new Eastern Palaearctic species, *Cassida koreana* Borowiec & Cho, 2011 was also placed in the subgenus *Lasiocassis* Gressitt, 1952 by Borowiec & Cho (2011).

Subgeneric classification of the genus *Cassida* Linnaeus was reviewed and discussed by Borowiec (2007). He concluded and suggested that most of subgeneric names proposed in the genus *Cassida* Linnaeus are artificial.

However, Borowiec (2007) and Borowiec & Cho (2011) also suggested that both Western Palaearctic species (*C. seraphina* and *C. hablitziae*) form a distinct lineage from two Eastern Palearctic species (*C. vespertina* and *C. koreana*).

Both groups differ in the morphology as well as the host preferences. According to Borowiec & Cho (2011), members of the subgenus *Lasiocassis* are at first glance very similar to members of the subgenus *Alledoya*, especially in coloration of elytra with spots on explanate margin, distinct elytral hump and irregular elytral surface. *Alledoya* differs in body more circular in outline, pronotum distinctly wider with narrowly rounded sides, clypeal plate flat and shorter antennae with segments 9 and 10 slightly wider than long. *Lasiocassis* feeds on Ranunculaceae (genus *Clematis* L.) and Convolvulaceae (genus *Calystegia* R. Br.) whereas *Alledoya* feeds on Chenopodiaceae (genera *Beta* L., *Chenopodium* L., *Hablitzia* M. Bieb., *Niedzwedzkia* B. Fedsch., *Spinacia* L.). Both groups were firstly treated by Borowiec & Cho (2011) as valid subgenera. Accordingly, the subgenus *Lasiocassis* Gressitt, 1952 including *Cassida vespertina* Boheman, 1862 and *Cassida koreana* Borowiec & Cho, 2011 and *Alledoya* Hincks, 1950 including *Cassida seraphina* Ménétries, 1836 and *Cassida hablitziae* Motschulsky, 1838.

Diagnosis of *Alledoya* Hincks, 1950

Small cassids with length 4.50–6.00 mm, body almost circular with sides more or less converging posterad. Dorsal coloration with distinct humeral, posterolateral and sutural spots on explanate margin, ventrites partly black or rusty-brown. Pronotum elliptical with more or less narrowly rounded sides, no basal corners, dorsal surface partly dull with sparse punctures. Elytra with large dorsal hump, surface of elytra irregular, with large folds and tubercles. Clypeus flat, clypeal lines indistinct, clypeal plate with coarse, moderately dense punctures. Prosternal process moderately broad between coxae, approximately as wide as 3/5 width of mid coxa, in mid part forms a shallow gutter, strongly expanded apically in rhomboidal plate. Expanded apex of prosternum coarsely punctate. Claws simple, last segment of tarsi not expanded apically. Antennae moderately short, segment 3 approximately 1.5 times as long as segment 2 and slightly longer than segment 4. Segment 9 and 10 slightly wider than long.

Members of the subgenus *Alledoya* are at first glance very similar to members of the subgenus *Lasiocassis*, especially in coloration of elytra with spots on explanate margin, distinct elytral hump and irregular elytral surface.

Alledoya differs in body more circular in outline; pronotum distinctly wider with narrowly rounded sides; prosternal process narrower between coxae, approximately as wide as 3/5 width of mid coxa; clypeal lines indistinct, clypeal plate flat and shorter antennae with segments 9 and 10 slightly wider than long.

As mentioned above, the subgenus *Alledoya* Hincks, 1950 includes only two species as *Cassida seraphina* Ménétries, 1836 and *Cassida hablitziae* Motschulsky, 1838. *Cassida seraphina* Ménétries, 1836 morphologically differs from closely related species *Cassida hablitziae* Motschulsky, 1838 with regard to rusty-brown ground color of upper side (groud color of upper side black in *C. hablitziae*), more sharpened humeral angles (humeral angles more obtuse in *C. hablitziae*) and more or less reddish-yellow clypeal plate (clypeal plate completely black in *C. hablitziae*) chiefly (Figs. 1-4).

A key to identification for the species of the subgenera *Alledoya* Hincks, 1950 and *Lasiocassis* Gressitt, 1952

1. Body subpentagonal in outline; pronotum elliptical with broadly rounded sides; prosternal process moderately broad between coxae, approximately as wide as 2/3 width of mid coxa; clypeal lines distinct, clypeal plate slightly convex and antennae moderately long with segments 9 and 10 slightly longer than wide........... ....**Subgenus *Lasiocassis* Gressitt, 1952**........................**2**

- Body more circular in outline; pronotum distinctly wider with narrowly rounded sides; prosternal process narrower between coxae, approximately as wide as 3/5 width of mid coxa; clypeal lines indistinct, clypeal plate flat and shorter antennae with segments 9 and 10 slightly wider than long... ....**Subgenus *Alledoya* Hincks, 1950**...........................**3**

2. Elytral disc mostly dark brown to almost black, humeral area sometimes slightly paler, brown but not in contrast with darkest part of disc; head almost completely reddish (except for black mouthparts); prosternal process completely black; body length 5.35-7.20 mm; distributed in Eastern Palaearctic region (China, Japan, Korea, Mongolia, Russian Far East and Taiwan).............................. ....***Cassida vespertina* Boheman, 1862**

- Elytral disc in postscutellar area, and sides and top of elytral hump yellowish-red to reddish-brown in other parts of disc from reddish-brown to almost black; head completely reddish; prosternal process completely reddish to reddish-brown; body length 4.80-5.35 mm; distributed in Eastern Palaearctic region (Korea)......... ....***Cassida koreana* Borowiec & Cho, 2011**

3. Ground color of upper side rusty-brown; clypeal plate more or less reddish-yellow, not completely black; pronotum more narrowly rounded sides; humeral angles more sharpened; body length 4.5-5.5 mm; distributed in Western Palaearctic region (Armenia, Greece, South European Russia and Turkey)............ ....***Cassida seraphina* Ménétries, 1836**

- Ground color of upper side black; clypeal plate completely black; pronotum narrowly rounded sides; humeral angles more obtuse; body length 5.0-6.0 mm; distributed in Western Palaearctic region (Armenia, Georgia, South European Russia, Kazakhstan and Turkey).........***Cassida hablitziae* Motschulsky, 1838**

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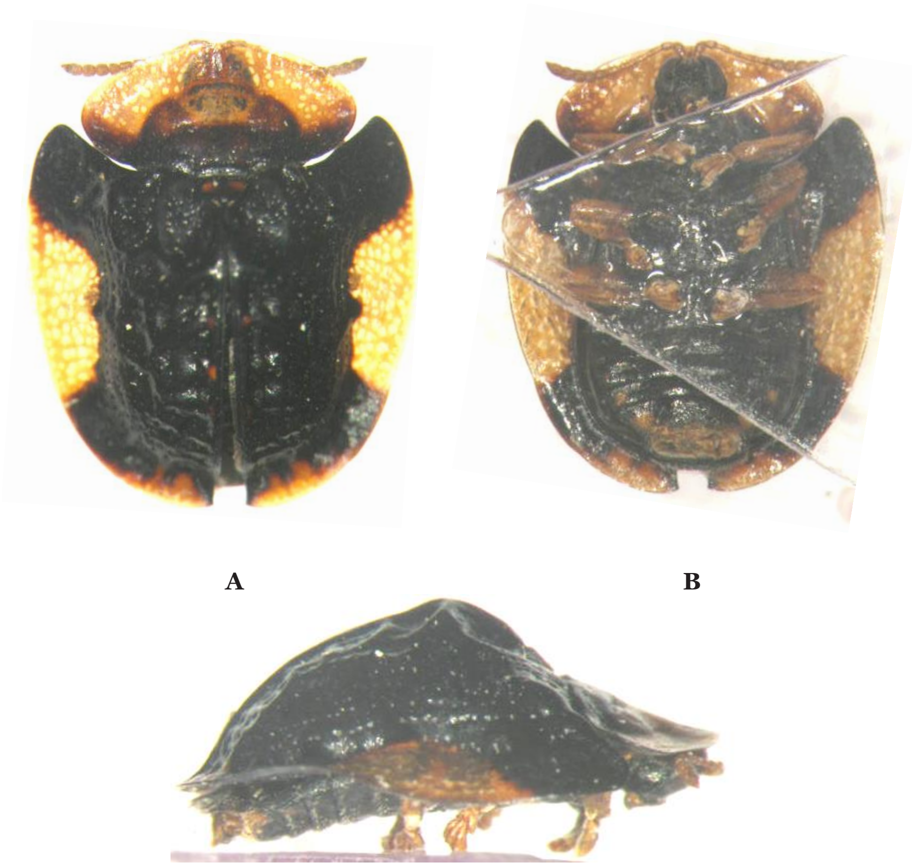


A **B**

C

Figure 1. *Cassida hablitziae* Motschulsky, 1838 (A) habitus dorsal; (B) habitus ventral; (C) habitus lateral.

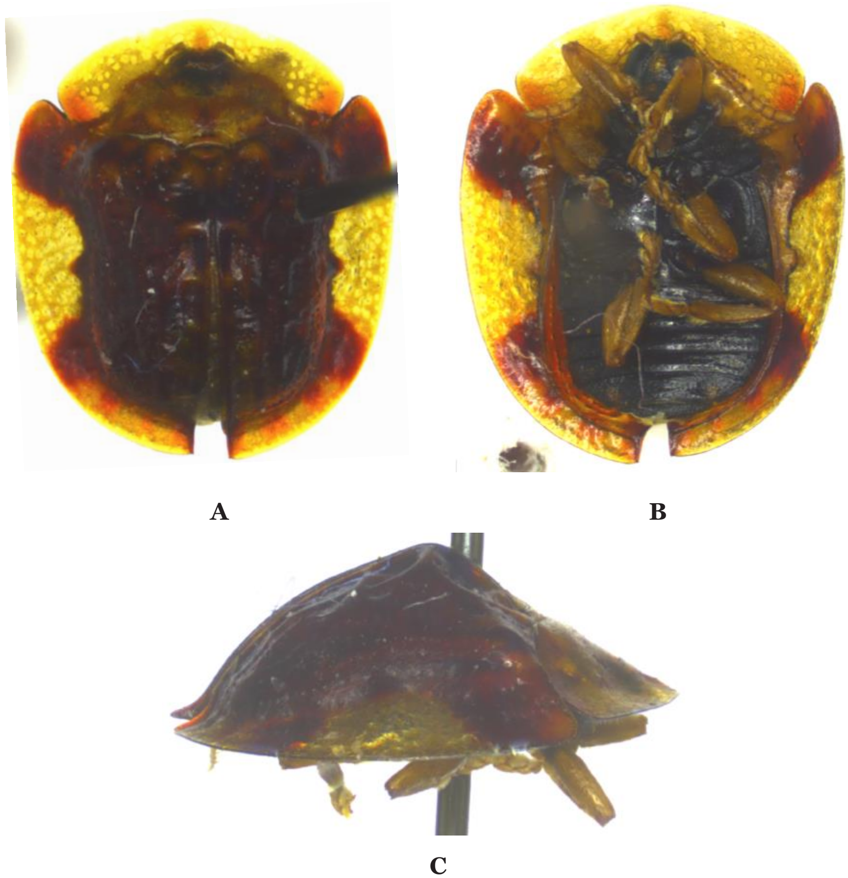
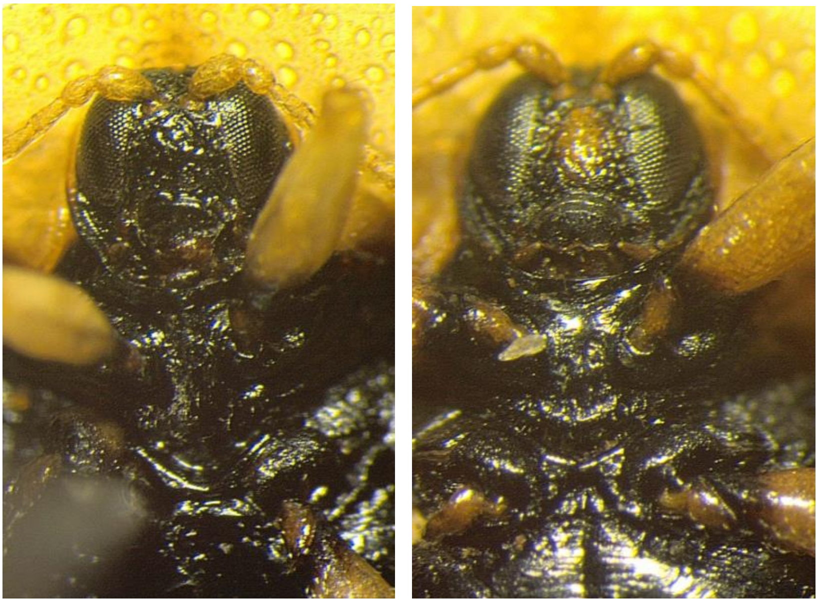


Figure 2. *Cassida seraphina* Ménétries, 1836 (A) habitus dorsal; (B) habitus ventral; (C) habitus lateral.



A **B**

Figure 3. Head and prosternum. (A) *Cassida hablitziae* Motschulsky, 1838; (B) *Cassida seraphina* Ménétries, 1836.

Figure 4. Head and prosternum of *Cassida seraphina* Ménétries, 1836.

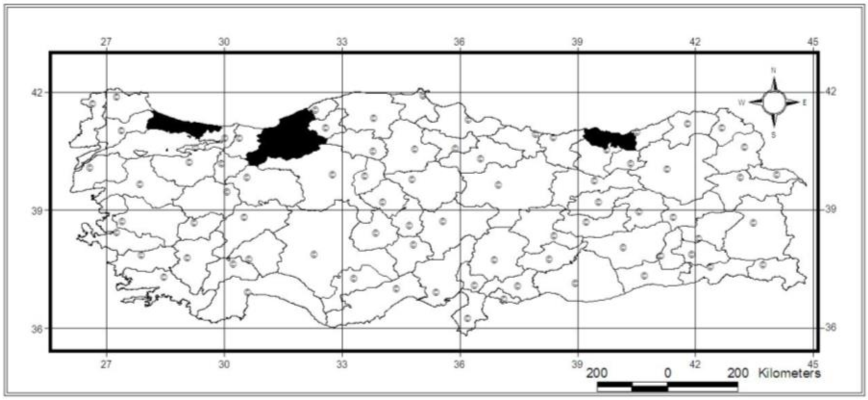


Figure 4. Distribution patterns of *Cassida hablitziae* Motschulsky, 1838 in Turkey (Bolu, Düzce, İstanbul, Trabzon and Zonguldak provinces).

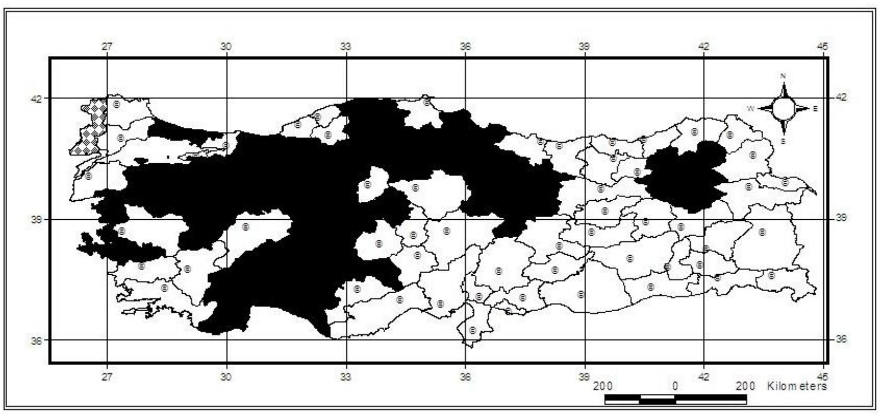


Figure 5. Distribution patterns of *Cassida seraphina* Ménétries, 1836 in Turkey (Amasya, Ankara, Antalya, Balıkesir, Bilecik, Bolu, Burdur, Bursa, Çankırı, Çorum, Düzce, Erzurum, Eskişehir, Isparta, İstanbul, İzmir, Kastamonu, Kırşehir, Konya, Kütahya, Sakarya, Samsun, Sivas, Tokat and Uşak provinces).

ODONATA FAUNA IN ADJOINING COASTAL AREAS OF PURBA MEDINIPUR DISTRICT, WEST BENGAL, INDIA

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ABSTRACT: The Present study was carried out to reveal the odonate diversity in adjoining coastal areas of Purba Medinipur District, West Bengal, India. Study was carried out from January 2014 to January 2018. During the study period a total of 49 species belonging to 35 genera and 7 families were recorded, including addition of 24 species representing 20 genera and 6 families for the district. The maximum number of odonates were found in Libellulidae (n=27), followed by Coenagrionidae (n=12 species), Aeshnidae (n=4 species), Lestidae (n=2 species), Platycnemididae (n=2 species), Gomphidae (n=1 species) and Macromiidae (n=1 species). Among the 4 selected study sites, the highest number of odonate species was observed in S3 (n= 39) and lowest in S1 (n= 21). Out of the 49 Odonates recorded from the district, 48 species come under the IUCN Red List of Threatened Category. Among them 45 species come under Least Concern (LC) Category, three species under Data Deficient (DD) and One species Not evaluated.

KEY WORDS: Dragonfly, Damselfly, Diversity, Coastal area, Purba Medinipur

In biological studies insects occupy a vital position due to their rich diversity and significant role in ecological courses (Hölldobler & Wilson, 1990; Groombridge, 1992). Among the insect's, order Odonata (dragonflies and damselflies) regarded as ideal taxonomic group for the investigation of the environmental health and climate change (Subramanian et al., 2008; Hassall & Thomoson, 2008). Odonates can be found in almost all kinds of freshwater habitats, from permanent running waters, lakes to small temporary rain pools. Their amphibious nature makes them well studied group of insects for assessing environmental changes in both the long term and short-term monitoring (Corbet, 1999). Odonata larvae reside in aquatic habitats, require very specific environmental condition to survive as they have a narrow range for temperature, oxygen levels, vegetation cover, microhabitats and water quality (Clausnitzer et al., 2009). While adult odonates shows high sensitivity with respects to the structure of their terrestrial habitats (Sheldon & Walker, 1998; Orr, 2006). As a consequence, odonates play vital role to bridge multiple trophic levels and act as a major linkage between freshwater and terrestrial food webs (Burkle et al., 2012; Hall et al., 2014).

Globally 6256 species in 686 genera of odonates have been reported, of which India known to represent 487 species, 27 Subspecies in 152 genera under 18 families. (Subramanian & Babu, 2017). Studies on the Odonata fauna of Southern parts of West Bengal were mainly carried out by Selys (1891); Laidlaw (1914); Fraser (1933, 1934, 1936); Ram et al. (1982); Srivastava & Das (1987); Prasad & Ghosh (1988); Mitra (1983, 2002); Srivastava & Sinha (1993); Gupta et al. (1995); Dawn (2014); Jana et al. (2014); Payra & Tiple (2016); Payra et al. (2017); Dwari et al. (2017). However, knowledge on the Odonata fauna of Purba Medinipur District is very fewer. Henceforth, to provide baseline data and to upgrade the known Odonata fauna, present study was carried out in adjoining coastal areas of Purba Medinipur district.

STUDY AREA

Purba Medinipur is the Southernmost district of West Bengal, is part of the Lower Gangetic Plain and Eastern Coastal Plains.With an area of about 4151.64 km^2, the district is surrounded by Bay of Bengal in the south and the state Odisha is at the Southwest border. Hooghly River and South 24 Parganas to the East and Howrah to the North-East, and at its Northwest border placed Paschim Medinipur. Except the Coastal Plains of the Southern part of the district, rest of the area almost entirely flat plains. The elevation of the district lies within 10 m a.s.l.

The climate of this area is tropical. During summer days (March-June) temperature of this region ranges from 30^0-38^0 C and in winter (November-February) temperature ranges from 15^0-25^0 C. Average annual rainfall is about 1700 mm. The coastal tract of Purba Medinipur is about 60 km in length, representing 27% coastal environment of West Bengal (Chakraborty, 2010).

MATERIALS AND METHODS

Opportunistic sampling and photo documentation were conducted in selected areas of Purba Medinipur district. Four adjacent coastal areas were sampled, viz., Digha- Site 1, Shankarpur- Site 2, Ramnagar- Site 3 and Junput- Site 4 (Details concerning all the selected four sites were presented in Table 1). Samplings were carried out from January 2014 to January 2017. Most of the sampling were done between 10 am to 2 pm, when odonates activities found in top most to control their body temperature in sunlight (Subramanian, 2009; Koli et al., 2014). Identification of the Odonates was primarily made directly in the field. In critical condition specimens were collected only with handheld aerial sweep nets and subsequently released without harm. Photographs of the specimens were taken in the field from various angles and identified with the help of field identification guide (Andrew et al., 2008; Nair, 2011; Subramanian, 2009). Those specimens are difficult to identify in the field, were collected and preserved in 70% alcohol or Acetone and carried them to the laboratory for further identification with the help of taxonomic keys (Fraser 1933, 1934, 1936; Mitra 2002). Systematic arrangement and Scientific name of the species follows Subramanian & Babu (2017).

RESULTS

A total of 49 species belonging to 35 genera and 7 families viz. Lestidae, Platycnemididae, Coenagrionidae (under suborder Zygoptera) and Aeshnidae, Gomphidae, Macromiidae, Libellulidae (under suborder Anisozygoptera) were recorded (Table 2). The maximum number of odonates were found in Libellulidae (n=27), followed by Coenagrionidae (n=12 species), Aeshnidae (n=4 species), Lestidae (n=2 species), Platycnemididae (n=2 species), Gomphidae (n=1 species) and Macromiidae (n=1 species).

Among which 24 species viz. *Lestes umbrinus* Selys,1891; *Copera marginipes* (Rambur, 1842); *Agriocnemis kalinga* Nair & Subramanian, 2015; *Onychargia atrocyana* (Selys, 1865); *Paracercion malayanum* (Selys, 1876); *Pseudagrion microcephalum* (Rambur, 1842); *Pseudagrion rubriceps* Selys, 1876; *Anaciaeschna jaspidea* (Burmeister, 1839); *Anax guttatus* (Burmeister, 1839);

Gynacantha dravida Lieftinck,1960; *Epophthalmia vittata* Burmeister,1839; *Brachydiplax chalybea* Brauer, 1868; *Brachydiplax farinosa* Krüger, 1902; *Bradinopyga geminata* (Rambur, 1842); *Lathrecista asiatica* (Fabricius, 1798); *Macrodiplax cora* (Brauer,1867); *Neurothemis fulvia* (Drury, 1773); *Neurothemis intermedia* (Rambur, 1842); *Orthetrum pruinosum* (Burmeister,1839); *Rhodothemis rufa* (Rambur,1842); *Tramea basilaris* (Palisot de Beauvois, 1805); *Tramea limbata* (Desjardins,1832) and *Zyxomma petiolatum* Rambur, 1842 representing 20 genera were newly reported for the district.

Out of the 4 selected study sites, the highest number of Odonate species (39) was recorded in S3. S2 ranked second with 34 species. Species richness was comparatively low in the remaining Study sites: S4 with 26 species and S1 with 22 species. (Table 3). The result of high species richness in the particular study sites (S3 and S2) may be due to the intensity and duration of longer surveys, rather than true ecological species richness. During the study period we also found, some of the species were mainly restricted to particular sites, species like, *Mortonagrion aborense* (Laidlaw, 1914); *Anaciaeschna jaspidea* (Burmeister, 1839); *Gynacantha khasiaca* MacLachlan,1896 were only recorded in S3. *Lestes umbrinus* Selys, 1891 and *Lestes viridulus* Rambur, 1842 only found in S4, *Onychargia atrocyana* (Selys, 1865), *Paracercion calamorum* (Ris,1916) were only found in S2.

Amid the 49 odonates, recorded from Purba Medinipur district 48 species comes under the IUCN Red List of Threatened Category. Among them 45 species come under Least Concern (LC) Category, three species under Data Deficient (DD) and One species is Not evaluated.

DISCUSSION

In Purba Medinipur district first faunistic study on odonates was carried out by Prasad & Ghosh (1988) while conducting the survey of the Estuarine Odonata of East India and recorded 22 species of odonates belonging to 19 genera and 6 families. Later Jana et al. (2014), reported 13 species of Odonates belonging to 12 genera 3 families from eight contrasting coastal areas of the District. Respectively Payra & Tiple (2016) and Payra et al. (2017) reported *Mortonagrion aborense* Laidlaw, 1914 and *Gynacantha khasiaca* Maclachlan, 1896 for the first time from district as well as from southern parts of West Bengal. As a result, during the present study 49 species were recorded and with the addition of 24 species the number of known odonates from the Purba Medinipur is increased to a total of 50 species (33 in the suborder Anisoptera and 17 in the suborder Zygoptera). Only *Agriocnemis lacteola* Selys, 1877 has not been recorded in the present study from our respective study area. This species previously been reported by Prasad & Ghosh (1988) from Nandakumar.

Expansion of urbanization in such adjacent coastal areas is a matter of concern. As expansion of urbanization causing loss of natural and semi natural habitats of Odonates, as well as the residual habitat quality may have adversely affected by various forms of pollutants (Tiple et al., 2013; Tiple & Koparde, 2015). Consequently, the necessity of increase the number of surveys from this area of West Bengal, should be emphasized, considering that coastal habitats are in the state of fragmentation and degradation. Result of the present study shows, adjoining coastal areas seems to have rich odonate diversity (49 species) and highlight the significance of the adjoining Coastal areas for Odonates conservation in southern parts of West Bengal, India. The study also provides baseline information for future quantitative work on the diversity of odonates in this particular study area.

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Table 1. Selected study sites with habitat description.

Sl.No.	Name	Latitude	Longitude	Altitude	Habitat types
1.	Digha	21°37'33.54"N	87°30'28.21"E	7m	Coastal Forest, Permanent and temporary water bodies, Agriculture fields
2.	Shankarpur	21°38'24.43"N	87°34'43.35"E	10m	Coastal Forest, Permanent and temporary water bodies, Agriculture fields, Aquaculture lands, Mangroves
3.	Ramnagar	21°40'48.75"N	87°33'33.24"E	4m	Agriculture field, Permanent and temporary water bodies, Village woodlands
4.	Juneput	21°43'29.85"N	87°48'43.53"E	7m	Coastal Forest, Permanent and temporary water bodies, Agriculture fields, Aquaculture lands, Mangroves

Table 2. Checklist of Odonata fauna (Dragonflies and damselflies) in Purba Medinipur District.

Sl. No	**Scientific Name**	**Study Sites (Present study)**	**IUCN STATUS**	**Previous Studies in Purba Medinipur**
Suborder Zygoptera Selys, 1854				
Family: LestidaeCalvert, 1907				
1.	*Lestes umbrinus* Selys,1891	S4	DD	*
2.	*Lestes viridulus* Rambur, 1842	S4	LC	Prasad & Ghosh (1988)
Family: Platycnemididae Yakobson & Bainchi, 1905				
3.	*Pseudocopera ciliata* (Selys, 1863)	S2, S3	LC	Prasad & Ghosh (1988)
4.	*Copera marginipes* (Rambur, 1842)	S1, S2, S3, S4	LC	*
Family: Coenagrionidae Kirby, 1890				
5.	*Agriocnemis pygmaea* (Rambur, 1842)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988)
6.	*Agriocnemis kalinga* Nair and Subramanian, 2015	S3, S4	NE	*
7.	*Agriocnemis lacteola* Selys, 1877			Prasad & Ghosh (1988)
8.	*Ceriagrion cerinorubellum*	S1, S2, S3,	LC	Prasad & Ghosh

	(Brauer, 1865)	S4		(1988), Jana et al. (2014)
9.	*Ceriagrion coromandelianum* (Fabricius, 1798)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
10.	*Ischnura aurora* (Brauer, 1865)	S1, S2, S3, S4	LC	*
11.	*Ischnura senegalensis* (Rambur, 1842)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
12.	*Mortonagrion aborense* (Laidlaw, 1914)	S3	LC	Payra & Tiple (2016)
13.	*Onychargia atrocyana* (Selys, 1865)	S2	LC	*
14.	*Paracercion malayanum* (Selys, 1876)	S2	LC	*
15.	*Pseudagrion decorum* (Rambur, 1842)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988)
16.	*Pseudagrion microcephalum* (Rambur, 1842)	S1, S2, S3, S4	LC	*
17.	*Pseudagrion rubriceps* Selys, 1876	S1, S2, S3, S4	LC	*
Suborder Anisozygoptera Hanlirsch, 1906				
Family: Aeshnidae Leach, 1815				
18.	*Anaciaeschna jaspidea* (Burmeister, 1839)	S3	LC	*
19.	*Anax guttatus* (Burmeister, 1839)	S3, S4	LC	*
20.	*Gynacantha dravida* Lieftinck,1960	S2	DD	*
21.	*Gynacantha khasiaca* MacLachlan,1896	S3	DD	Payra et al. (2017)
Family: Gomphidae Rambur, 1842				
22.	*Ictinogomphus rapax* (Rambur, 1842)	S1, S2, S3, S4	LC	Jana et al. (2014)
Family: MacromiidaeNeedham, 1903				
23.	*Epophthalmia vittata* Burmeister,1839	S3	LC	*
Family: Libellulidae Leach, 1815				
24.	*Acisoma panorpoides* Rambur, 1842	S1, S2, S3, S4	LC	Prasad & Ghosh (1988)
25.	*Aethriamanta brevipennis* (Rambur, 1842)	S3	LC	Prasad & Ghosh (1988)
26.	*Brachydiplax chalybea* Brauer, 1868	S2, S3	LC	*
27.	*Brachydiplax farinosa* Krüger, 1902	S3	LC	*
28.	*Brachydiplax sobrina* (Rambur, 1842)	S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
29.	*Brachythemis contaminata* (Fabricius,1793)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
30.	*Bradinopyga geminata* (Rambur, 1842)	S3	LC	*

31.	*Crocothemis servilia* (Drury, 1770)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
32.	*Diplacodes nebulosa* (Fabricius, 1793)	S2, S3	LC	Prasad & Ghosh (1988)
33.	*Diplacode strivialis* (Rambur,1842)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
34.	*Lathrecista asiatica* (Fabricius, 1798)	S2	LC	*
35.	*Macrodiplax cora* (Brauer,1867)	S1, S2	LC	*
36.	*Neurothemis fulvia* (Drury, 1773)	S1, S2, S3, S4	LC	*
37.	*Neurothemis intermedia* (Rambur, 1842)	S3, S4	LC	*
38.	*Neurothemis tullia* (Drury, 1773)	S3	LC	Prasad & Ghosh (1988)
39.	*Orthetrum sabina* (Drury, 1770)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
40.	*Orthetrum pruinosum* (Burmeister,1839)	S4	LC	*
41.	*Pantala flavescens* (Fabricius, 1798)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
42.	*Potamarcha congener* (Rambur, 1842)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988)
43.	*Rhodothemis rufa* (Rambur,1842)	S2, S3	LC	*
44.	*Rhyothemis variegata* (Linnaeus, 1763)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988), Jana et al. (2014)
45.	*Tholymis tillarga* (Fabricius, 1798)	S2, S3	LC	Jana et al. (2014)
46.	*Tramea basilaris* (Palisot de Beauvois, 1805)	S2	LC	*
47.	*Tramea limbata* (Desjardins,1832)	S2	LC	*
48.	*Trithemis pallidinervis* (Kirby, 1889)	S1, S2, S3, S4	LC	Prasad & Ghosh (1988)
49.	*Urothemis signata* (Rambur, 1842)	S2, S3	LC	Prasad & Ghosh (1988), Jana et al. (2014)
50.	*Zyxomma petiolatum* Rambur, 1842	S1, S2, S3	LC	*

*= first time reported from district


Fig. 1. *Lestes viridulus* Rambur


Fig. 2. *Lestes umbrinus* Selys


Fig. 3. *Copera marginipes* (Rambur)


Fig. 4. *Pseudagrion pruinosum* (Burmeister)


Fig. 5. *Agriocnemis kalinga* Nair & Subram.


Fig. 6. *Paracercion malayanum* (Selys)


Fig. 7. *Mortonagrion aborense* (Laidlaw)


Fig. 8. *Anax guttatus* (Burmeister)

Fig. 9. *Anaciaeschna jaspidea* (Burmeister)

Fig. 10. *Gynacantha dravida* Lieftinck

Fig. 11. *Gynacantha khasiaca* McLachlan

Fig 12. *Ictinogomphus rapax* (Rambur)

Fig. 13. *Trithemis pallidinervis* (Kirby)

Fig. 14. *Brachydiplax farinosa* Krüger

Fig. 15. *Diplacodes nebulosa* (Fabricius)

Fig. 16. *Lathrecista asiatica* (Fabricius)

Fig. 17. *Neurothemis fulvia* (Drury)

Fig. 18. *Macrodiplax cora* (Brauer)

Fig. 19. *Rhodothemis rufa* (Rambur)

Fig. 20.*Tramea basilaris (*Palisot de Beauvois)

Fig. 21. *Tramea limbata* (Desjardins)

Fig. 22. *Neurothemis intermedia* (Rambur)

CONTRIBUTIONS TO THE CERAMBYCIDAE (COLEOPTERA) FAUNA OF ÇANKIRI PROVINCE, TURKEY

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ABSTRACT: This paper provides information about the Cerambycidae (Coleoptera) species collected from Çankırı province (Turkey) in 2013, 2014 and 2015. All known taxa from Çankırı province are given with some new faunistical data in the present text. As a result of this study, a total of 42 species of Cerambycidae have been recorded. Among them, 14 species are recorded for the first time for fauna of Çankırı province and its many counties.

KEY WORDS: Cerambycidae, Coleoptera, fauna, new records, Çankırı, Turkey

Çankırı is a province in the North of Central Anatolian region of Turkey. Northern counties of the province are in Western Black Sea region. It is bordered by Karabük and Kastamonu provinces in the North, Çorum province in the East, Kırıkkale province in the South-east, Ankara province in the South and Bolu province in the West. It is situated about 800 m above sea level. It has a total of 12 counties (incl. Center county) (Map 1). The counties of Çankırı province are Center, Atkaracalar, Bayramören, Çerkeş, Eldivan, Ilgaz, Kızılırmak, Korgun, Kurşunlu, Orta, Şabanözü and Yapraklı. Eldivan, Kızılırmak, Şabanözü, Yapraklı and Center counties are placed in Central Anatolian region of Turkey. The remaining 7 counties of Çankırı province are located in Western Black Sea region of Turkey.

The data on this fauna has accumulated in a piecemeal fashion over the twentieth century and this century especially. Various authors have reported some partial data on the fauna in their different works. However, most of works were completed in a short time and their works did not focus on fauna of Çankırı generally. The first attempt on longhorned beetles fauna of Çankırı province was carried out by Al-Hamadani & Özdikmen (2014). As a result of their work, they were determined 58 species for the longhorned beetles fauna of Çankırı province.

According to Özdikmen (2016), *Dorcadion cinerarium* (Fabricius, 1787) is absent in Turkey and *Dorcadion subsericatum subsericatum* Pic, 1901 is known only in Kastamonu province in Turkey. In fact, number of species is 56. However, *D. boluense imitator* Pesarini & Sabbadini, 1998 and *D. sabanoezueense* Bernhauer & Peks, 2013 which mentioned for Çankırı province in Özdikmen (2016) were overlooked by Al-Hamadani & Özdikmen (2014). Thus, number of species is 58.

In this work, some new faunistical data are presented. Besides, according to cited literatures, all known taxa from Çankırı province are also given. Thus, the longhorned beetles fauna of Çankırı province with this work is rised up 58 to 72 species.

The complete list of longhorned beetles fauna for Çankırı province is given in appendix 1.

FAMILY CERAMBYCIDAE Latreille, 1802: 211

SUBFAMILY LEPTURINAE Latreille, 1802: 218
TRIBE RHAGIINI Kirby, 1837: 178
GENUS *DINOPTERA* Mulsant, 1863: 494
SUBGENUS *DINOPTERA* Mulsant, 1863: 494
SPECIES *D. collaris* (Linnaeus, 1758: 398)
Material examined: Çankırı prov.: Şabanözü, Entry of Kamış village, 40˚33'45" N 33˚20'13" E, 1221 m, 23.V.2014, 3 specimens; Yapraklı, Bugay, 40˚42'00" N 33˚46'18" E, 897 m, 25.V.2015, 1 specimen; Ilgaz, Between Yaylaören-Eskice, 40˚54'36" N 33˚29'45" E, 1008 m, 29.V.2015, 1 specimen; Ilgaz, Eskice-Aşıklar return, 40˚55'20" N 33˚29'44", 1014 m, 29.V.2015, 1 specimen; Ilgaz, Between Kırşlar-Gökçeyazı, 40˚56'9" N 33˚29'8" E, 1012 m, 29.V.2015, 2 specimens; Ilgaz, Entry of Güneyköy, 40˚55'15" N 33˚28'42" E, 1248 m, 17.VI.2015, 1 specimen; Ilgaz, Candere-Sazak-Hacı Hasan return, 40˚55'29" N 33˚39'29" E, 885 m, 18.VI.2015, 1 specimen; Çerkeş, Between Cedine-Kabakköy, 40˚53'12" N 32˚55'2" E, 1355 m, 20.VI.2015, 1 specimen.

GENUS *CORTODERA* Mulsant, 1863: 572
SPECIES *C. discolor* Fairmaire, 1866: 277
Material examined: Çankırı prov.: Center, Between Ovacık-Kuzuköy, 40˚32'4" N 33˚53'24" E, 919 m, 15.V.2015, 1 specimen.
SPECIES *C. flavimana* (Waltl, 1838: 471)
SUBSPECIES *C. f. flavimana* (Waltl, 1838: 471)
Material examined: Çankırı prov.: Orta, Exit of Doğanlar village, 40˚39'09" N 33˚10'18" E, 1315 m, 20.V.2014, 1 specimen; Orta, Entry of Kısaç, 40˚38'25" N 33˚02'13" E, 1316 m, 21.V.2014, 1 specimen; Orta, Exit of Buğören village, 40˚38'47" N 32˚59'42" E, 1390 m, 21.V.2014, 2 specimens; Orta, Elden village 40˚39'22" N 32˚58'21" E, 1446 m, 21.V.2014, 7 specimens; Orta, Elden plateau, 40˚39'13" N 32˚57'07" E, 1487 m, 21.V.2014, 8 specimens; Orta, Entry of Dodurga, 40˚36'11" N 33˚00'18" E, 1351 m, 22.V.2014, 1 specimen; Orta, Between Bulduk-Yenice, 40˚33'21" N 33˚12'03" E, 1400 m, 24.V.2014, 1 specimen; Orta, Özlü, 40˚29'29" N 33˚03'24" E, 1484 m, 24.V.2014, 2 specimens; Orta, Exit of Sancar village, 40˚39'1" N 33˚10'23" E, 1279 m, 11.V.2015, 3 specimens; Ilgaz, Between Kayı-Kırşlar villages, 40˚56'16" N 33˚27'24" E, 1158 m, 17.VI.2015, 2 specimens; Ilgaz, Kırkpınar plateau road, 41˚00'20" N 33˚41'5" E, 1230 m, 19.VI.2015, 1 specimen; Çerkeş, İnceğiz village, 40˚55'00" N 32˚58'54" E, 1133 m, 20.VI.2015, 1 specimen.
SPECIES *C. rufipes* (Kraatz, 1876: 344)
Material examined: Çankırı prov.: Orta, Exit of Buğören village, 40˚38'47" N 32˚59'42" E, 1390 m, 21.V.2014, 1 specimen; Orta, Elden village, 40˚39'22" N 32˚58'21" E, 1446 m, 21.V.2014, 2 specimens; Orta, Elden plateau, 40˚39'13" N 32˚57'07" E, 1487 m, 21.V.2014, 3 specimens.

TRIBE LEPTURINI Latreille, 1802: 218
GENUS *VADONIA* Mulsant, 1863: 559
SPECIES *V. unipunctata* (Fabricius, 1787: 157)
SUBSPECIES *V. u. unipunctata* (Fabricius, 1787: 157)
Material examined: Çankırı prov.: Yapraklı, Bugay, 40˚42'00" N 33˚46'18" E, 897 m, 25.V.2015, 1 specimen; Ilgaz, Between Belören-Şeyhyunus, 40˚52'3" N 33˚31'33" E, 889 m, 27.V.2015, 1 specimen; Bayramören, Between Feriz-Dereköy, 41˚2'5" N 33˚14'32" E, 954 m, 21.VI.2015, 1 specimen.

GENUS *PSEUDOVADONIA* Lobanov et al., 1981: 787
SPECIES *P. livida* (Fabricius, 1777: 233)
SUBSPECIES *P. l. livida* (Fabricius, 1777: 233)
Material examined: Çankırı prov.: Ilgaz, Arpayeri village, 40˚57'51" N 33˚44'55" E, 1323 m, 26.VII.2013, 1 specimen; Orta, Entry of Dodurga, 40˚36'11" N 33˚00'18" E, 1351 m, 22.V.2014, 2 specimens; Orta, Exit of Kırsakal village, 40˚39'30" N 33˚08'58" E, 1228 m,

10.VII.2014, 5 specimens; Çerkeş, Coroğlu village return, 40˚52'10,7" N 32˚56'58,8" E, 1434 m, 20.VII.2014, 4 specimens; Şabanözü, Between Mart-Şabanözü, 40˚25'36" N 33˚20'40" E, 899 m, 12.V.2015, 1 specimen; Kızılırmak, Korçullu, 40˚19'5" N 34˚2'1" E, 645 m, 17.V.0215, 2 specimens; Ilgaz, Between Belören-Şeyhyunus, 40˚52'3" N 33˚31'33" E, 889 m, 27.V.2015, 4 specimens; Ilgaz, Between Eskice-Süleymancılar, 40˚54'56" N 33˚29'48" E, 1006 m, 17.VI.2015, 1 specimen; Ilgaz, Entry of Şeyhyunus village, 40˚50'16" N 33˚31'33" E, 1421 m, 18.VI.2015, 1 specimen; Ilgaz, Between Şeyhyunus-Ericek, 40˚49'51" N 33˚31'19" E, 1438 m, 18.VI.2015, 1 specimen; Ilgaz, Onat, 40˚58'12" N 33˚41'26" E, 1024 m, 19.VI.2015, 3 specimens; Ilgaz, Between Beyköy-Saraycık, 40˚59'24" N 33˚44'10" E, 1195 m, 19.VI.2015, 5 specimens; Ilgaz, Kazancı village-Kırkpınar-Yayla return, 40˚59'34" N 33˚41'55" E, 1110 m, 19.VI.2015, 1 specimen; Ilgaz, Kırkpınar plateau road, 41˚00'20" N 33˚41'5" E, 1230 m, 19.VI.2015, 1 specimen; Bayramören, Exit of Karataş village, 40˚59'8" N 33˚15'21" E, 1068 m, 21.VI.2015, 1 specimen; Bayramören, Boğazkaya village, 40˚59'12" N 33˚16'37" E, 1085 m, 21.VI.2015, 3 specimens; Bayramören, Koçlu-Feriz return, 41˚1'9" N 33˚17'58" E, 758 m, 21.VI.2015, 2 specimens; Bayramören, Harmancık road, 41˚2'32" N 33˚13'45" E, 861 m, 21.VI.2015, 3 specimens; Bayramören, Yaylatepesi road, 41˚3'26" N 33˚12'34" E, 651 m, 21.VI.2015, 5 specimens; Yapraklı, Between Yuvasaray-Yukarıöz, 40˚52'6" N 33˚46'32" E, 1077 m, 25.VI.2015, 26 specimens; Eldivan, Bülbül stream road, 40˚30'26" N 33˚30'32" E, 1091 m, 28.VI.2015, 3 specimens; Şabanözü, Exit of Kamış village (Maruf road), 40˚33'50" N 33˚20'17" E, 1217 m, 28.VI.2015, 1 specimen.

GENUS *STICTOLEPTURA* Casey, 1924: 280

SUBGENUS *STICTOLEPTURA* Casey, 1924: 280

SPECIES *S. fulva* (DeGeer, 1775: 137)

Material examined: Çankırı prov.: Ilgaz, Kırkpınar plateau 3rd km, 41˚0'25" N 33˚42'28" E, 1252 m, 26.VII.2013, 1 specimen.

GENUS *ANASTRANGALIA* Casey, 1924: 280

SPECIES *A. dubia* (Scopoli, 1763: 47)

SUBSPECIES *A. d. dubia* (Scopoli, 1763: 47)

Material examined: Çankırı prov.: Orta, Entry of Derebayındır, 40˚34'56" N 32˚59'50" E, 1389 m, 22.V.2014, 1 specimen; Ilgaz, Kırpınar plateau road, 41˚00'18,0" N 33˚39'03,9" E, 1493 m, 17.VII.2014, 1 specimen.

SPECIES *A. sanguinolenta* (Linnaeus, 1760: 196)

Material examined: Çankırı prov.: Ilgaz, Between exit of Yuvasaray-Yukarıöz, 40˚52'8" N 33˚46'27" E, 1101 m, 25.VII.2013, 1 specimen; Yapraklı, Between Yuvasaray-Yukarıöz, 40˚52'6" N 33˚46'32" E, 1077 m, 25.VI.2015, 1 specimen; Eldivan, Bülbül stream road, 40˚30'26" N 33˚30'32" E, 1091 m, 28.VI.2015, 1 specimen.

GENUS *PEDOSTRANGALIA* Sokolov, 1897: 461

SUBGENUS *NEOSPHENALIA* Löbl, 2010: 60

SPECIES *P. verticenigra* (Pic, 1892: 416)

Material examined: Çankırı prov.: Bayramören, Yaylatepesi road, 41˚3'26" N 33˚12'34" E, 651 m, 21.VI.2015, 1 specimen.

Remarks: New to Çankırı province.

GENUS *JUDOLIA* Mulsant, 1863: 496

SPECIES *J. erratica* (Dalman, 1817: 490)

Material examined: Çankırı prov.: Ilgaz, 7 km to Balcı village, 41˚02'45" N 33˚28'27" E, 1392 m, 26.VII.2013, 2 specimens; Orta, Entry of Derebayındır, 40˚34'56" N 32˚59'50" E, 1389 m, 22.V.2014, 2 specimens; Kurşunlu, Between Köpürlü-Kapaklı, 40˚46'11,5" N 33˚16'49,7" E, 1223 m, 10.VII.2014, 3 specimens; Bayramören, Entry of Feriz village, 41˚2'12" N 33˚16'23" E, 759 m, 21.VI.2015, 1 specimen; Eldivan, Bülbül stream road, 40˚30'26" N 33˚30'32" E, 1091 m, 28.VI.2015, 1 specimen.

GENUS *STENURELLA* Villiers, 1974: 217

SUBGENUS *PRISCOSTENURELLA* Özdikmen, 2013: 516

SPECIES *S. bifasciata* (Müller, 1776: 93)

SUBSPECIES *S. b. limbiventris* (Reitter, 1898: 21)

Material examined: Çankırı prov.: Ilgaz, Between exit of Yuvasaray-Yukarıöz, 40°52'8" N 33°46'27" E, 1101 m, 25.VII.2013, 2 specimens; Ilgaz, 7 km to Balcı village, 41°02'45" N 33°28'27" E, 1392 m, 26.VII.2013, 7 specimens; Ilgaz, Arpayeri village, 40°57'51" N 33°44'55" E, 1323 m, 26.VII.2013, 1 specimen; Ilgaz, Entry of Eskikıymık village, 41°0'19" N 33°41'15" E, 1230 m, 26.VII.2013, 1 specimen; Ilgaz, Kırkpınar plateau 3rd km, 41°0'25" N 33°42'28" E, 1252 m, 26.VII.2013, 7 specimens; Atkaracalar, Höyük village, 40°48'28" N 33°3'47" E, 1239 m, 27.VII.2013, 2 specimens; Orta, Exit of Buğören village, 40°38'47" N 32°59'42" E, 1390 m, 21.V.2014, 3 specimens; Orta, Elden plateau, 40°39'13" N 32°57'07" E, 1487 m, 21.V.2014, 1 specimen; Orta, Between Elden plateau-Hacılar, 40°39'42" N 32°55'43" E, 1618 m, 21.V.2014, 3 specimens; Orta, Exit of Yuva village, 40°36'57" N 33°01'36" E, 1306 m, 22.V.2014, 1 specimen; Orta, Entry of Derebayındır, 40°34'56" N 32°59'50" E, 1389 m, 22.V.2014, 14 specimens; Orta, Entry of İncecik village, 40°35'33" N 32°55'59" E, 1600 m, 22.V.2014, 2 specimens; Kurşunlu, Between Köpürlü-Kapaklı, 40°46'11,5" N 33°16'49,7" E, 1223 m, 10.VII.2014, 1 specimen; Ilgaz, Between Sarmaşık village-Işılıklı, 40°52'18,7 " N 33°40'49" E, 859 m, 16.VII.2014, 1 specimen; Yapraklı, Forest of plateau, 40°49'38,7" N 33°43'37,4" E, 1517 m, 16.VII.2014, 1 specimen; Bayramören, Exit of Harmancık village, 41°03'17,6" N 33°12'31,0" E, 639 m, 19.VII.2014, 1 specimen; Çerkeş, Bıldırcın plateau, 40°40'38,6" N 32°50'47,7" E, 1650 m, 20.VIII.2014, 1 specimen; Ilgaz, Kazancı village-Kırkpınar-Yayla return, 40°59'34" N 33°41'55" E, 1110 m, 19.VI.2015, 1 specimen; Bayramören, Harmancık road, 41°2'32" N 33°13'45" E, 861 m, 21.VI.2015, 1 specimen; Yapraklı, Between Yuvasaray-Yukarıöz, 40°52'6" N 33°46'32" E, 1077 m, 25.VI.2015, 3 specimens; Eldivan, Bülbül stream road, 40°30'26" N 33°30'32" E, 1091 m, 28.VI.2015, 9 specimens.

SPECIES *S. septempunctata* (Fabricius, 1792: 346)

SUBSPECIES *S. s. latenigra* (Pic, 1915: 5)

Material examined: Çankırı prov.: Ilgaz, 7 km to Balcı village, 41°02'45" N 33°28'27" E, 1392 m, 26.VII.2013, 3 specimens; Ilgaz, Kırkpınar plateau 3rd km, 41°0'25" N 33°42'28" E, 1252 m, 26.VII.2013, 1 specimen; Orta, Entry of Derebayındır, 40°34'56" N 32°59'50" E, 1389 m, 22.V.2014, 4 specimens; Ilgaz, Kırpınar plateau road, 41°00'18,0" N 33°39'03,9" E, 1493 m, 17.VII.2014, 2 specimens; Bayramören, Exit of Harmancık village, 41°03'17,6" N 33°12'31,0" E, 639 m, 19.VII.2014, 1 specimen.

SUBFAMILY CERAMBYCINAE Latreille, 1802: 211

TRIBE CERTALLINI Fairmaire, 1864: 149

GENUS *CERTALLUM* Dejean, 1821: 111

SPECIES *C. ebulinum* (Linnaeus, 1767: 637)

Material examined: Çankırı prov.: Korgun, Akören-Çankırı 20th km, 40°30'24" N 33°37'41" E, 666 m, 21.IV.2013, 1 specimen; Kızılırmak, Karamürsel village return, 40°26'18" N 34°01'19" E, 550 m, 24.IV.2014, 1 specimen; Kızılırmak, Exit of Karamürsel village, Halimintepe, 40°24'06" N 34°02'26" E, 550 m, 24.IV.2014, 5 specimens; Kızılırmak, 4 km to Cacıklar village, 40°23'43" N 34°04'18" E, 597 m, 24.IV.2014, 11 specimens; Kızılırmak, Entry of Kuzeykışla village, 40°22'14" N 34°03'00" E, 600 m, 24.IV.2014, 6 specimens; Kızılırmak, Between Korçullu-Kemalli villages, 40°18'37" N 34°02'09" E, 646 m, 24.IV.2014, 1 specimen; Kızılırmak, Entry of Kemalli village, 40°18'6" N 34°02'37" E, 686 m, 24.IV.2014, 1 specimen; Kızılırmak, Between Kemalli-Halaçlı villages, 40°18'7" N 33°58'33" E, 608 m, 24.IV.2014, 2 specimens; Kızılırmak, Aşağıalagöz village, 40°21'42" N 33°55'25" E, 556 m, 25.IV.2014, 1 specimen; Kızılırmak, Center, 40°21'49" N 34°00'56" E, 557 m, 25.IV.2014, 3 specimens; Kızılırmak, Saraycık village return, 40°20'01" N 33°58'29" E, 565 m, 25.IV.2014, 2 specimens; Kızılırmak, Karallı village return 2nd km, 40°18'30" N 33°56'36" E, 606 m, 25.IV.2014, 6 specimens; Kızılırmak, Between Bostancı-Hacılar villages, 40°19'58" N 33°51'51" E, 565 m, 25.IV.2014, 1 specimen; Kızılırmak, Entry of Aşağıovacık village, 40°26'29" N 33°53'27" E, 576 m, 25.IV.2014, 1 specimen; Center, Tuz cave env., 40°31'38" N 33°45'55" E, 699 m, 26.IV.2014, 2 specimens; Center, Haydarköy return, Alaçat village, 40°31'25" N 33°54'55" E, 704 m, 26.IV.2014, 2 specimens; Center, Danabaşı village, 40°31'33" N 34°02'46" E, 724 m, 26.IV.2014, 1 specimen; Eldivan, Between Akçalı-Çiftlik villages, 40°36'01" N 33°29'07" E, 1036 m, 20.V.2014, 2 specimens; Korgun, Between Bugay-Ildızım, 40°42'27" N 33°29'23" E, 909 m, 23.V.2014, 2 specimens; Center, Aşağıçavuş return, 40°41'02" N 33°35'56" E, 826 m, 15.VII.2014, 1 specimen; Center, Between Ova-Kuzuköy, 40°31'24" N 33°54'56" E, 703 m, 29.IV.2015, 3 specimens; Center, Exit of Kuzuköy, 40°30'41" N 33°56'56" E, 637 m, 29.IV.2015, 1 specimen; Center, Between Kuzuköy-Çırçır villages, 40°30'14" N 33°57'54" E, 615 m, 29.IV.2015, 1 specimen; Center, Beşdut village, 40°36'40" N 34°3'55" E, 730 m, 29.IV.2015, 2 specimens; Kızılırmak, Exit of Tepealagöz, 40°23'2" N 33°58'32" E, 595 m, 01.V.2015, 2 specimens; Kızılırmak, entry of Büyükbahçeli village, 40°25'21" N 34°00'15" E, 608 m, 01.V.2015, 1 specimen; Kızılırmak, Cacıklar village return (2nd km), 40°23'28" N 34°2'41" E, 563 m, 01.V.2015, 1 specimen; Kızılırmak, Between Çullu-Kevalli villages, 40°18'50" N 34°1'9" E, 589 m, 01.V.2015, 4 specimens; Center, Aşağıçavuş-Yukarıçavuş return, 40°40'9" N 33°35'8" E, 837 m, 09.V.2015, 11 specimens; Center, Alanpınar-Başeğmez return, 40°41'00" N 33°35'9" E, 822 m, 09.V.2015, 6 specimens; Şabanözü, Bakırlı, 40°28'00" N 33°22'23" E, 1012 m, 12.V.2015, 2 specimens; Şabanözü, Between Mart-Şabanözü, 40°25'36" N 33°20'40" E, 899 m, 12.V.2015, 1 specimen; Şabanözü, Between Gündoğmuş-Karahacı villages, 40°21'53" N 33°17'17" E, 975 m, 12.V.2015, 7 specimens; Center, Kılıççarkı, 40°33'10" N 33°34'50" E, 737 m, 13.V.2015, 4 specimens; Eldivan, Oğlaklı village, 40°32'10" N 33°33'12" E, 1027 m, 13.V.2015, 2 specimens; Eldivan, Between Gölezkayı-Gölez, 40°30'6" N 33°33'17" E, 922 m, 13.V.2015, 2 specimens; Eldivan, Between Gölez-Elmacı, 40°29'13" N 33°33'53" E, 1015 m, 13.V.2015, 1 specimen; Eldivan, entry of Eldivan, 40°32'18" N 33°30'10" E, 909 m, 14.V.2015, 1 specimen; Eldivan, entry of Çiftlik village, 40°34'42" N 33°30'20" E, 844 m, 14.V.2015, 13 specimens; Eldivan, Sarıtarla village, 40°36'7" N 33°30'40" E, 1014 m, 14.V.2015, 1 specimen; Center, Between Ovacık-Kuzuköy, 40°32'4" N 33°53'24" E, 919 m, 15.V.2015, 2 specimens; Center, Kuzuköy, 40°31'1" N 33°56'39" E, 645 m, 15.V.2015, 3 specimens; Center, Between Külburun-Karadayı, 40°26'20" N 33°44'57" E, 614 m, 16.V.2015, 3 specimens; Center, entry of Karadayı, 40°24'38" N 33°45'29" E, 856 m, 16.V.2015, 3 specimens; Kızılırmak, Karallı-Kahyalı return, 40°18'30" N 33°56'50" E, 556 m, 17.V.2015, 2 specimens; Yapraklı, Bugay, 40°42'00" N 33°46'18" E, 897 m, 25.V.2015, 1 specimen; Yapraklı, Between Yüklü-Çevrecik, 40°40'5" N 33°49'22" E, 983 m, 25.V.2015, 3 specimens; Yapraklı, Kirliakça, 40°37'40" N 33°54'38" E, 914 m, 26.V.2015, 1 specimen; Ilgaz, exit of Belören, 40°51'46" N 33°30'7" E, 903 m, 27.V.2015, 2 specimens; Ilgaz, Between Belören-Şeyhyunus, 40°52'3" N 33°31'33" E, 889 m, 27.V.2015, 1 specimen; Ilgaz, Yaylaören, 40°53'7" N 33°30'28" E, 999 m, 29.V.2015, 3 specimens; Ilgaz, Eskice-Aşıklar return, 40°55'20" N 33°29'44" E, 1014 m, 29.V.2015, 1 specimen; Ilgaz, Between Eskice-Süleymancılar, 40°54'56" N 33°29'48" E, 1006 m, 17.VI.2015, 1 specimen; Ilgaz, Entry of Şeyhyunus village, 40°50'16" N 33°31'33" E, 1421 m, 18.VI.2015, 1 specimen.

TRIBE CLYTINI Mulsant, 1839: 70

GENUS *ECHINOCERUS* Mulsant, 1862: 143

SPECIES *E. floralis* (Pallas, 1773: 724)

Material examined: Çankırı prov.: Şabanözü, entry of Çerçi, 40°31'07" N 33°13'40" E, 1275 m, 08.VII.2014, 1 specimen; Şabanözü, Demirsahan, 40°25'22" N 33°17'35" E, 1004 m, 11.VII.2014, 1 specimen; Atkaracalar, Ilıksu, 40°48'6,8" N 33°05'48,4" E, 1207 m, 20.VII.2014, 2 specimens; Bayramören, Between Dalkoz-Aşağı, 40°57'16" N 33°13'30" E, 800 m, 21.VI.2015, 1 specimen; Bayramören, Between Feriz-Dereköy, 41°2' 5" N 33°14'32" E, 954 m, 21.VI.2015, 1 specimen; Bayramören, Harmancık road, 41°2'32" N 33°13'45" E, 861 m, 21.VI.2015, 1 specimen; Çerkeş, entry of Ahırlar village, 40°52'51" N 32°46'26" E, 1270 m, 22.VI.2015, 1 specimen; Eldivan, Bülbül stream road, 40°30'26" N 33°30'32" E, 1091 m, 28.VI.2015, 1 specimen; Yapraklı, Tatlıpınar road, 40°43'53" N 33°52'58" E, 955 m, 29.VI.2015, 1 specimen.

GENUS *CHLOROPHORUS* Chevrolat, 186: 290

SUBGENUS *CRASSOFASCIATUS* Özdikmen, 2011: 538

SPECIES *C. hungaricus* Seidlitz, 1891: 828

Material examined: Çankırı prov.: Ilgaz, Kırkpınar plateau road, 41˚00'20" N 33˚41'5" E, 1230 m, 19.VI.2015, 1 specimen; Bayramören, Boğazkaya village, 40˚59'12" N 33˚16'37" E, 1085 m, 21.VI.2015, 2 specimens; Bayramören, Koçlu-Feriz return, 41˚1'9" N 33˚17'58" E, 758 m, 21.VI.2015, 2 specimens; Bayramören, Between Feriz-Dereköy, 41˚2'5" N 33˚14'32" E, 954 m, 21.VI.2015, 8 specimens.

Remarks: New to Çankırı province.

SUBGENUS *PERDEROMACULATUS* Özdikmen, 2011: 537

SPECIES *C. sartor* (Müller, 1766: 188)

Material examined: Çankırı prov.: Kurşunlu, Between Madenli village-Çaylıca, 40˚56'23" N 33˚12'24" E, 900 m, 27.VII.2013, 1 specimen; Bayramören, Karakışla village road, 40˚57'01" N 33˚09'27" E, 916 m, 27.VII.2013, 3 specimens.

GENUS *CLYTUS* Laicharting, 1784: 88

SUBGENUS *CLYTUS* Laicharting, 1784: 88

SPECIES *C. rhamni* Germar, 1817: 223

SUBSPECIES *C. r. temesiensis* (Germar, 1824: 519)

Material examined: Çankırı prov.: Bayramören, Between Dere-Hacılar villages, 41˚01'14,2" N 33˚13'53,9" E, 1081 m, 19.VII.2014, 2 specimens.

SPECIES *C. schurmanni* Sama, 1996: 108

Material examined: Çankırı prov.: Şabanözü, Çaparkayı, 40˚31'22,3" N 33˚21'12,3" E, 1229 m, 11.VII.2014, 1 specimen; Ilgaz, Sazak village, 40˚56'56" N 33˚43'9" E, 1144 m, 18.VI.2015, 1 specimen; Eldivan, Bülbül stream road, 40˚30'26" N 33˚30'32" E, 1091 m, 28.VI.2015, 1 specimen.

SUBFAMILY STENOPTERINAE Gistel, 1848: [9] (unnumbered section)

TRIBE STENOPTERINI Gistel, 1848: [9]

GENUS *STENOPTERUS* Illiger, 1804: 120

SPECIES *S. rufus* (Linnaeus, 1767: 642)

SUBSPECIES *S. r. geniculatus* Kraatz, 1863: 104

Material examined: Çankırı prov.: Bayramören, Between Dalkoz-Aşağı, 40˚57'16" N 33˚13'30" E, 800 m, 21.VI.2015, 1 specimen; Bayramören, Boğazkaya village, 40˚59'12" N 33˚16'37" E, 1085 m, 21.VI.2015, 1 specimen; Bayramören, Yaylatepesi road, 41˚3'26" N 33˚12'34" E, 651 m, 21.VI.2015, 1 specimen.

GENUS *CALLIMUS* Mulsant, 1846: [5]

SUBGENUS *LAMPROPTERUS* Mulsant, 1862: 214

SPECIES *C. femoratus* (Germar, 1824: 519)

Material examined: Çankırı prov.: Eldivan, Bülbül stream road, 40˚30'26" N33˚30'32" E, 1091 m, 28.VI.2015, 1 specimen.

Remarks: New to Çankırı province.

SUBFAMILY DORCADIONINAE Swainson, 1840: 290

TRIBE DORCADIONINI Swainson, 1840: 290

GENUS *DORCADION* Dalman, 1817: 397

SUBGENUS *CRIBRIDORCADION* Pic, 1901: 12

SPECIES *D. subsericatum* Pic, 1901: 12

SUBSPECIES *D. s. rufipenne* Breuning, 1946: 118

Material examined: Çankırı prov.: Çerkeş, Türbaşı village return, 40˚47'09" N 34˚51'43" E, 626 m, 27.IV.2014, 1 specimen.

SUBFAMILY LAMIINAE Latreille, 1825: 401

TRIBE POGONOCHERINI Mulsant, 1839: 151

GENUS *POGONOCHERUS* Dejean, 1821: 107

SUBGENUS *PITYPHILUS* Mulsant, 1862: 302

SPECIES *P. decoratus* Fairmaire, 1855: 320
Material examined: Çankırı prov.: Orta, exit of Sancar village, 40˚39'14,9" N 33˚09'49,3" E, 1257 m, 10.VII.2014, 1 specimen.
Remarks: New to Çankırı province.

TRIBE TETROPINI Portevin, 1927
GENUS *TETROPS* Kirby, 1826 (in Kirby & Spence 1826: 498)
SUBGENUS *TETROPS* Kirby, 1826 (in Kirby & Spence 1826: 498)
SPECIES *T. praeustus* (Linnaeus, 1758: 399)
SUBSPECIES *T. p. angorensis* Pic, 1918: 11
Material examined: Çankırı prov.: Yapraklı, entry of Çevrecik, 40˚39'36" N 33˚49'52" E, 953 m, 25.V.2015, 1 specimen; Ilgaz, Between Şeyhyunus-Ericek, 40˚49'54" N 33˚33'16" E, 1361 m, 27.V.2015, 1 specimen; Çerkeş, entry of Gelik, 40˚50'29" N 32˚55'32" E, 1318 m, 20.VI.2015, 1 specimen.
Remarks: New to Çankırı province.

TRIBE PHYTOECIINI Mulsant, 1839: 191
GENUS *OXYLIA* Mulsant, 1862: 398
SPECIES *O. duponcheli* (Brullé, 1832: 260)
Material examined: Çankırı prov.: Korgun, exit of Maruf village, 40˚38'19,1" N 33˚24'14,5" E, 1193 m, 08.VII.2014, 1 specimen.
Remarks: New to Çankırı province.

GENUS *PHYTOECIA* Dejean, 1835: 351
SUBGENUS *HELLADIA* Fairmaire, 1864: 176
SPECIES *P. humeralis* (Waltl, 1838: 471)
SUBSPECIES *P. h. humeralis* (Waltl, 1838: 471)
Material examined: Çankırı prov.: Kızılırmak, Between Korçullu-Kemalli villages, 40˚18'37" N 34˚02'09" E, 646 m, 24.IV.2014, 1 specimen; Kızılırmak, Entry of Kemalli village, 40˚18'6" N 34˚02'37" E, 686 m, 24.IV.2014, 1 specimen; Kızılırmak, Saraycık village return, 40˚20'01" N 33˚58'29" E, 565 m, 25.IV.2014, 1 specimen; Center, Between Pehlivanlı-Alaçatı villages, 40˚34'19" N 33˚52'18" E, 925 m, 26.IV.2014, 1 specimen; Kızılırmak, entry of Karamirsel village, 40˚26'12" N 34˚1'34" E, 569 m, 01.V.2015, 2 specimens; Kızılırmak, Cacıklar village return (2nd km), 40˚23'28" N 34˚2'41" E, 563 m, 01.V.2015, 2 specimens; Kızılırmak, Between Çullu-Kevalli villages, 40˚18'50" N 34˚1'9" E, 589 m, 01.V.2015, 1 specimen; Şabanözü, Bakırlı, 40˚28'00" N 33˚22'23" E, 1012 m, 12.V.2015, 2 specimens; Şabanözü, Between Gündoğmuş-Karahacı villages, 40˚21'53" N 33˚17'17" E, 975 m, 12.V.2015, 1 specimen; Eldivan, entry of Çiftlik village, 40˚34'42" N 33˚30'20" E, 844 m, 14.V.2015, 1 specimen; Center, Çiviköy, 40˚34'52" N 33˚45'20" E, 1018 m, 15.V.2015, 1 specimen; Center, Kuzuköy, 40˚31'1" N 33˚56'39" E, 645 m, 15.V.2015, 1 specimen; Center, Between Külburun-Karadayı, 40˚26'20" N 33˚44'57" E, 614 m, 16.V.2015, 1 specimen; Yapraklı, Balıbıdık, 40˚40'22" N 33˚44'25" E, 877 m, 25.V.2015, 1 specimen.
SPECIES *P. praetextata* (Steven, 1817: 184)
SUBSPECIES *P. p. praetextata* (Steven, 1817: 184)
Material examined: Çankırı prov.: Ilgaz, Gökçeyazı village, 40˚57'27" N 33˚29'42" E, 1020 m, 29.V.2015, 1 specimen; Ilgaz, exit of Kırşlar village, 40˚56'5" N 33˚29'9" E, 914 m, 17.VI.2015, 1 specimen; Ilgaz, Candere-Sazak-Hacı Hasan return, 40˚55'29" N 33˚39'29" E, 885 m, 18.VI.2015, 1 specimen.
Remarks: New to Çankırı province.
SUBGENUS *MUSARIA* Thomson, 1864: 121
SPECIES *P. affinis* (Harrer, 1784: 209)
SUBSPECIES *P. a. tuerki* Ganglbauer, 1884: 575
Material examined: Çankırı prov.: Orta, Elden plateau, 40˚39'13" N 32˚57'07" E, 1487 m, 21.V.2014, 2 specimens.
Remarks: New to Çankırı province.

SUBGENUS *PHYTOECIA* Dejean, 1835: 351

SPECIES *P. baccueti* (Brullé, 1832: 262)

Material examined: Çankırı prov.: Border of Kalecik-Çankırı province, D-765 road, 40˚21'28" N 33˚31'0" E, 701 m, 21.IV.2013, 1 specimen; Korgun, Akören-Çankırı 20th km, 40˚30'24" N 33˚37'41" E, 666 m, 21.IV.2013, 1 specimen; Kızılırmak, exit of Tepealagöz village, 40˚21'49" N 34˚00'56" E, 557 m, 24.IV.2014, 2 specimens; Kızılırmak, Karamürsel village return, 40˚26'18" N 34˚01'19" E, 550 m, 24.IV.2014, 6 specimens; Kızılırmak, Between Boyacıoğlu- Karamürsel, 40˚25'36" N 34˚02'19" E, 543 m, 24.IV.2014, 1 specimen; Kızılırmak, Entry of Kuzeykışla village, 40˚22'14" N 34˚03'00" E, 600 m, 24.IV.2014, 2 specimens; Kızılırmak, Between Kemalli-Halaçlı villages, 40˚18'7" N 33˚58'33" E, 608 m, 24.IV.2014, 3 specimens; Kızılırmak, Aşağıalagöz village, 40˚21'42" N 33˚55'25" E, 556 m, 25.IV.2014, 1 specimen; Kızılırmak, Center, 40˚21'49" N 34˚00'56" E, 557 m, 25.IV.2014, 3 specimens; Kızılırmak, Karallı village return 2nd km, 40˚18'30" N 33˚56'36" E, 606 m, 25.IV.2014, 1 specimen; Kızılırmak, Entry of Aşağıovacık village, 40˚26'29" N 33˚53'27" E, 576 m, 25.IV.2014, 2 specimens; Center, Balıbağı plateau, 40˚29'50" N 33˚52'42" E, 774 m, 25.IV.2014, 2 specimens; Center, Between Kuzuköy-Ağzıbüyük villages, 40˚30'25" N 33˚59'01" E, 617 m, 26.IV.2014, 1 specimen; Center, Danabaşı village, 40˚31'33" N 34˚02'46" E, 724 m, 26.IV.2014, 4 specimens; Orta, entry of Sakarcaören village, 40˚37'16" N 33˚08'46" E, 1305 m, 20.V.2014, 1 specimen; Korgun, exit of Maruf village, 40˚38'18" N 33˚26'22" E, 1181 m, 20.V.2014, 1 specimen; Orta, exit of Sakaeli, 40˚40'19" N 33˚09'48" E, 1227 m, 21.V.2014, 1 specimen; Korgun, Between Bugay-Ildızım, 40˚42'27" N 33˚29'23" E, 909 m, 23.V.2014, 1 specimen; Korgun, exit of Maruf, 40˚38'25" N 33˚26'02" E, 1200 m, 23.V.2014, 1 specimen; Orta, Between Yaylakent-İnkılap, 40˚35'23" N 33˚05'15" E, 1273 m, 24.V.2014, 2 specimens; Kızılırmak, entry of Büyükbahçeli village, 40˚25'21" N 34˚00'15" E, 608 m, 01.V.2015, 1 specimen; Eldivan, entry of Çiftlik village, 40˚34'42" N 33˚30'20" E, 844 m, 14.V.2015, 1 specimen; Yapraklı, entry of Çevrecik, 40˚39'36" N 33˚49'52" E, 953 m, 25.V.2015, 1 specimen; Ilgaz, entry of Güneyköy, 40˚55'14" N 33˚28'44" E, 1226 m, 29.V.2015, 1 specimen; Ilgaz, Between Güneyköy-Aşıklar villages, 40˚55'19" N 33˚27'30" E, 1294 m, 17.VI.2015, 1 specimen; Ilgaz, Aşıklar village, 40˚55'54" N 33˚26'23" E, 1260 m, 17.VI.2015, 1 specimen; Ilgaz, exit of Kırşlar village, 40˚56'5" N 33˚29'9" E, 914 m, 17.VI.2015, 1 specimen; Ilgaz, Belören, 40˚51'45" N 33˚30'6" E, 914 m, 18.VI.2015, 3 specimens; Ilgaz, Entry of Şeyhyunus village, 40˚50'16" N 33˚31'33" E, 1421 m, 18.VI.2015, 3 specimens; Ilgaz, Onat, 40˚58'12" N 33˚41'26" E, 1024 m, 19.VI.2015, 1 specimen; Ilgaz, Between Beyköy-Saraycık, 40˚59'24" N 33˚44'10" E, 1195 m, 19.VI.2015, 1 specimen; Ilgaz, Kırkpınar plateau road, 41˚00'20" N 33˚41'5" E, 1230 m, 19.VI.2015, 1 specimen; Ilgaz, exit of Yukarıbozan, 40˚57'26" N 33˚35'58" E, 1047 m, 19.VI.2015, 1 specimen; Çerkeş, Gelikköy road, 40˚49'36" N 32˚54'43" E, 1195 m, 20.VI.2015, 1 specimen; Çerkeş, Between Gelikova-Çorapoğlu return, 40˚51'47" N 32˚56'47" E, 1361 m, 20.VI.2015, 2 specimens; Çerkeş, Between Cedine-Kabakköy, 40˚53'12" N 32˚55'2" E, 1355 m, 20.VI.2015, 4 specimens; Çerkeş, Between İnceğiz-Avşar, 40˚54'52" N 32˚59'58" E, 1113 m, 20.VI.2015, 1 specimen; Atkaracalar, Kükürt village, Between Demirciler-Yazıören, 40˚55'25" N 33˚4'46" E, 924 m, 20.VI.2015, 1 specimen; Atkaracalar, Budak source, 40˚51'40" N 33˚8'32" E, 1096 m, 22.VI.2015, 1 specimen; Çerkeş, Kuzuören road, 40˚54'4" N 32˚49'13" E, 963 m, 22.VI.2015, 1 specimen; Çerkeş, Yeşilören road, 40˚49'26" N 32˚37'51" E, 1122 m, 23.VI.2015, 3 specimens; Yapraklı, Between Yuvasaray-Yukarıöz, 40˚52'6" N 33˚46'32" E, 1077 m, 25.VI.2015, 1 specimen; Yapraklı, Yukarıöz, 40˚51'27" N 33˚44'54" E, 1380 m, 25.VI.2015, 2 specimens; Eldivan, Bülbül stream road, 40˚30'26" N 33˚30'32" E, 1091 m, 28.VI.2015, 3 specimens.

Remarks: New to Çankırı province.

SPECIES *P. caerulea* (Scopoli, 1772: 102)

SUBSPECIES *P. c. caerulea* (Scopoli, 1772: 102)

Material examined: Çankırı prov.: Kızılırmak, Karamürsel village return, 40˚26'18" N 34˚01'19" E, 550 m, 24.IV.2014, 4 specimens; Kızılırmak, Between Boyacıoğlu-Karamürsel, 40˚25'36" N 34˚02'19" E, 543 m, 24.IV.2014, 1 specimen; Kızılırmak, Exit of Karamürsel village, Halimintepe, 40˚24'06" N 34˚02'26" E, 550 m, 24.IV.2014, 3 specimens; Kızılırmak, Entry of Kuzeykışla village, 40˚22'14" N 34˚03'00" E, 600 m, 24.IV.2014, 3 specimens; Kızılırmak, Aşağıalagöz village, 40˚21'42" N 33˚55'25" E, 556 m, 25.IV.2014, 1 specimen; Kızılırmak, Center, 40˚21'49" N 34˚00'56" E, 557 m, 25.IV.2014, 6 specimens;

Kızılırmak, Entry of Aşağıovacık village, 40˚26'29" N 33˚53'27" E, 576 m, 25.IV.2014, 1 specimen; Center, Çayırpınar plateau, 40˚28'34" N 33˚54'09" E, 726 m, 25.IV.2014, 2 specimens; Center, Haydarköy return, Alaçat village, 40˚31'25" N 33˚54'55" E, 704 m, 26.IV.2014, 1 specimen; Center, Between Kuzuköy-Ağzıbüyük villages, 40˚30'25" N 33˚59'01" E, 617 m, 26.IV.2014, 1 specimen; Center, Danabaşı village, 40˚31'33" N 34˚02'46" E, 724 m, 26.IV.2014, 1 specimen; Kurşunlu, Between Köprülü-Kapaklı, 40˚45'11" N 33˚16'31" E, 1329 m, 20.V.2014, 1 specimen; Korgun, Sanı plateau, 40˚37'00" N 33˚24'10" E, 1363 m, 20.V.2014, 1 specimen; Eldivan, Between Akçalı-Çiftlik villages, 40˚36'01" N 33˚29'07" E, 1036 m, 20.V.2014, 1 specimen; Kurşunlu, Between Sünürlü-Sakaeli, 40˚42'01" N 33˚08'53" E, 1415 m, 21.V.2014, 1 specimen; Orta, exit of Sakaeli, 40˚40'19" N 33˚09'48" E, 1227 m, 21.V.2014, 3 specimens; Orta, Exit of Yuva village, 40˚36'57" N 33˚01'36" E, 1306 m, 22.V.2014, 1 specimen; Center, Balıbağı return, 40˚34'3" N 33˚46'35" E, 1068 m, 29.IV.2015, 1 specimen; Yapraklı, Bademçay village return, 40˚46'16" N 33˚55'51" E, 1059 m, 30.IV.2015, 1 specimen; Center, Aşağıçavuş, 40˚41'13" N 33˚36'6" E, 847 m, 09.V.2015, 1 specimen; Korgun, exit of Bugay village, 40˚42'7" N 33˚29'6" E, 886 m, 09.V.2015, 1 specimen; Kurşunlu, 4 km to Dağören, 40˚48'21" N 33˚16'24" E, 1110 m, 10.V.2015, 1 specimen; Orta, exit of Kısaç village, 40˚37'57" N 33˚3'11" E, 1283 m, 10.V.2015, 1 specimen; Orta, Exit of Sancar village, 40˚39'1" N 33˚10'23" E, 1279 m, 11.V.2015, 1 specimen; Center, Kılıççarkı, 40˚33'10" N 33˚34'50" E, 737 m, 13.V.2015, 1 specimen; Eldivan, Between Gölezkayı-Gölez, 40˚30'6" N 33˚33'17" E, 922 m, 13.V.2015, 1 specimen; Eldivan, entry of Çiftlik village, 40˚34'42" N 33˚30'20" E, 844 m, 14.V.2015, 1 specimen; Kızılırmak, Tepealagöz return, 40˚21'58" N 33˚57'34" E, 557 m, 16.V.2015, 1 specimen; Kızılırmak, Between Küçükbahçeli-Büyükbahçeli, 40˚23'53" N 33˚58'59" E, 560 m, 16.V.2015, 1 specimen; Kızılırmak, Karallı village, 40˚17'31" N 33˚56'00" E, 665 m, 17.V.2015, 1 specimen; Ilgaz, entry of Aşıklar village, 40˚55'24" N 33˚27'19" E, 1359 m, 29.V.2015, 2 specimens; Ilgaz, Between Eskice-Süleymancılar, 40˚54'56" N 33˚29'48" E, 1006 m, 17.VI.2015, 1 specimen; Ilgaz, Entry of Şeyhyunus village, 40˚50'16" N 33˚31'33" E, 1421 m, 18.VI.2015, 1 specimen.

SPECIES *P. croceipes* Reiche & Saulcy, 1858: 17

Material examined: Çankırı prov.: Center, Çiviköy, 40˚34'52" N 33˚45'20" E, 1018 m, 15.V.2015, 1 specimen.

Remarks: New to Çankırı province.

SPECIES *P. cylindrica* (Linnaeus, 1758: 394)

Material examined: Çankırı prov.: Center, Danabaşı village, 40˚31'33" N 34˚02'46" E, 724 m, 26.IV.2014, 1 specimen; Korgun, exit of Maruf, 40˚38'25" N 33˚26'02" E, 1200 m, 23.V.2014, 1 specimen; Şabanözü, entry of Çerçi, 40˚31'07" N 33˚13'40" E, 1275 m, 08.VII.2014, 1 specimen; Kurşunlu, Between Köpürlü-Kapaklı, Devrez, 40˚46'43,1" N 33˚17'10,7" E, 1010 m, 10.VII.2014, 1 specimen; Ilgaz, Kaleköyü, 40˚57'12,3" N 33˚39'12,2" E, 980 m, 17.VII.2014, 1 specimen; Ilgaz, Bükcük, 40˚55'59" N 33˚39'53" E, 917 m, 18.VI.2015, 1 specimen.

Remarks: New to Çankırı province.

SPECIES *P. gamzeae* Özdikmen, 2017: 23

Material examined: Çankırı prov.: Şabanözü, entry of Büyükyakalı village, 40˚28'38" N 33˚14'25" E, 1091 m, 23.V.2014, 1 specimen; Kızılırmak, Kavaklı, 40˚22'44" N 34˚1'46" E, 542 m, 16.V.2015, 1 specimen; Ilgaz, Eskice-Aşıklar return, 40˚55'20" N 33˚29'44" E, 1014 m, 29.V.2015, 1 specimen; Ilgaz, Belören, 40˚51'45" N 33˚30'6" E, 914 m, 18.VI.2015, 1 specimen; Yapraklı, Tatlıpınar road, 40˚43'53" N 33˚52'58" E, 955 m, 29.VI.2015, 1 specimen.

Remarks: New to Çankırı province.

SPECIES *P. geniculata* Mulsant, 1863: 420

SUBSPECIES *P. g. geniculata* Mulsant, 1863: 420

Material examined: Çankırı prov.: Kızılırmak, Karamürsel village return, 40˚26'18" N 34˚01'19" E, 550 m, 24.IV.2014, 1 specimen; Kızılırmak, Entry of Kuzeykışla village, 40˚22'14" N 34˚03'00" E, 600 m, 24.IV.2014, 1 specimen; Kızılırmak, Center, 40˚21'49" N 34˚00'56" E, 557 m, 25.IV.2014, 1 specimen; Center, Between Pehlivanlı-Alaçatı villages, 40˚34'19" N 33˚52'18" E, 925 m, 26.IV.2014, 1 specimen.

Remarks: New to Çankırı province.

SPECIES *P. pubescens* Pic, 1895: 64

Material examined: Çankırı prov.: Ilgaz, Between Belören-Şeyhyunus, 40˚52'3" N 33˚31'33" E, 889 m, 27.V.2015, 1 specimen; Bayramören, Yaylatepesi road, 41˚3'26" N 33˚12'34" E, 651 m, 21.VI.2015, 1 specimen.

SPECIES *P. pustulata* (Schrank, 1776: 66)

SUBSPECIES *P. p. pustulata* (Schrank, 1776: 66)

Material examined: Çankırı prov.: Center, Alaçatı, 40˚32'16" N 33˚33'13" E, 870 m, 15.V.2015, 1 specimen.

Remarks: New to Çankırı province.

SPECIES *P. virgula* (Charpentier, 1825: 225)

Material examined: Çankırı prov.: Şabanözü- Orta road, 24 km to Orta, 40˚28'51" N 33˚16'3" E, 1300 m, 08.VI.2013, 1 specimen; Çankırı-Ankara road, 60 km to Kalecik, 40˚29'52" N 33˚38'35" E, 09.VI.2013, 1 specimen; Kızılırmak, Entry of Kemalli village, 40˚18'6" N 34˚02'37" E, 686 m, 24.IV.2014, 1 specimen; Kızılırmak, Between Bostancı-Hacılar villages, 40˚19'58" N 33˚51'51" E, 565 m, 25.IV.2014, 1 specimen; Korgun, Between Bugay-Ildızım, 40˚42'27" N 33˚29'23" E, 909 m, 23.V.2014, 1 specimen.

SUBGENUS *OPSILIA* Mulsant, 1862: 387

SPECIES *P. coerulescens* (Scopoli, 1763: 49)

Material examined: Çankırı prov.: Orta, Exit of Yuva village, 40˚36'57" N 33˚01'36" E, 1306 m, 22.V.2014, 1 specimen; Orta, Entry of Dodurga, 40˚36'11" N 33˚00'18" E, 1351 m, 22.V.2014, 2 specimens; Şabanözü, entry of Çerçi, 40˚31'07" N 33˚13'40" E, 1275 m, 08.VII.2014, 1 specimen; Ilgaz, entry of Belsöğüt village, 40˚56'51,6" N 33˚36'13" E, 1019 m, 17.VII.2014, 1 specimen; Ilgaz, Kırpınar plateau road, 41˚00'18,0" N 33˚39'03,9" E, 1493 m, 17.VII.2014, 1 specimen.

TRIBE AGAPANTHIINI Mulsant, 1839: 172

GENUS *AGAPANTHIA* Audinet-Serville, 1835: 35

SUBGENUS *EPOPTES* Gistel, 1857: 93

SPECIES *A. lateralis* Ganglbauer, 1884: 541

Material examined: Çankırı prov.: Ilgaz, Yaylaören, 40˚53'7" N 33˚30'28" E, 999 m, 29.V.2015, 1 specimen; Ilgaz, Between Yaylaören-Eskice, 40˚54'36" N 33˚29'45" E, 1008 m, 29.V.2015, 1 specimen; Ilgaz, entry of Aşıklar village, 40˚55'24" N 33˚27'19" E, 1359 m, 29.V.2015, 1 specimen; Bayramören, exit of Oynaağaç village, 40˚58'19" N 33˚14'58" E, 811 m, 21.VI.2015, 2 specimens; Çerkeş, Yürükköyü, 40˚54'52" N 32˚52'45" E, 970 m, 22.VI.2015, 1 specimen; Eldivan, Bülbül stream road, 40˚30'26" N 33˚30'32" E, 1091 m, 28.VI.2015, 1 specimen.

SUBGENUS *AGAPANTHIA* Audinet-Serville, 1835: 35

SPECIES *A. cardui* (Linnaeus, 1767: 632)

Material examined: Çankırı prov.: Orta, Akçaören village, 40˚30'56" N 33˚12'39" E, 1200 m, 23.V.2014, 1 specimen; Eldivan, Çiftlikköy, 40˚34'33" N 33˚28'08" E, 921 m, 09.VII.2014, 1 specimen;.Kızılırmak, Tepealagöz return, 40˚21'58" N 33˚57'34" E, 557 m, 16.V.2015, 2 specimens; Kızılırmak, Kahyalı village, 40˚16'44" N 33˚55'22" E, 634 m, 17.V.2015, 1 specimen; Center, Değim, 40˚41'8" N 33˚41'27" E, 916 m, 25.V.2015, 1 specimen; Yapraklı, Balıbıdık, 40˚40'22" N 33˚44'25" E, 877 m, 25.V.2015, 1 specimen; Yapraklı, Bugay, 40˚42'00" N 33˚46'18" E, 897 m, 25.V.2015, 3 specimens; Yapraklı, Between Yüklü-Çevrecik, 40˚40'5" N 33˚49'22" E, 983 m, 25.V.2015, 10 specimens; Yapraklı, entry of Çevrecik, 40˚39'36" N 33˚49'52" E, 953 m, 25.V.2015, 2 specimens; Ilgaz, Eskice-Aşıklar return, 40˚55'20" N 33˚29'44" E, 1014 m, 29.V.2015, 1 specimen; Ilgaz, entry of Yaylaören village, 40˚52'44" N 33˚30'32" E, 914 m, 17.VI.2015, 1 specimen.

SPECIES *A. suturalis* (Fabricius, 1787: 149)

Material examined: Çankırı prov.: Center, Between Ovacık-Kuzuköy, 40˚32'28" N 33˚52'12" E, 920 m, 26.IV.2014, 1 specimen; Şabanözü, entry of Büyükyakalı village, 40˚28'38" N 33˚14'25" E, 1091 m, 23.V.2014, 1 specimen;.Orta, Akçaören village, 40˚30'56" N 33˚12'39" E, 1200 m, 23.V.2014, 1 specimen; Yapraklı, Balıbıdık, 40˚40'22" N 33˚44'25" E, 877 m, 25.V.2015, 1 specimen; Yapraklı, Bugay, 40˚42'00" N 33˚46'18" E, 897 m, 25.V.2015, 1 specimen; Yapraklı, Kirliakça, 40˚37'40" N 33˚54'38" E, 914 m, 26.V.2015, 3 specimens; Ilgaz, Yaylaören, 40˚53'7" N 33˚30'28" E, 999 m, 29.V.2015, 1 specimen; Ilgaz, Eskice-

Aşıklar return, 40°55'20" N 33°29'44" E, 1014 m, 29.V.2015, 1 specimen; Ilgaz, Between Kırşlar-Gökçeyazı, 40°56'9" N 33°29'8" E, 1012 m, 29.V.2015, 1 specimen; Ilgaz, Between Güneyköy-Aşıklar, 40°55'19" N 33°27'30" E, 1294 m, 17.VI.2015, 1 specimen; Ilgaz, Candere-Sazak-Hacı Hasan return, 40°55'29" N 33°39'29" E, 885 m, 18.VI.2015, 1 specimen; Ilgaz, entry of Beyköy, 40°59'20" N 33°43'56" E, 1120 m, 19.VI.2015, 1 specimen; Ilgaz, exit of Yukarıbozan, 40°57'26" N 33°35'58" E, 1047 m, 19.VI.2015, 1 specimen; Yapraklı, Tatlıpınar road, 40°43'53" N 33°52'58" E, 955 m, 29.VI.2015, 1 specimen; Yapraklı, Yüklü-Çevrecik return, 40°40'17" N 33°45'29" E, 926 m, 29.VI.2015, 6 specimens; Korgun, Öz, 40°42'57" N 33°31'26" E, 758 m, 30.VI.2015, 1 specimen.

SUBGENUS *SMARAGDULA* Pesarini & Sabbadini, 2004: 128

SPECIES *A. violacea* (Fabricius, 1775: 187)

Material examined: Çankırı prov.: Yapraklı, Bugay, 40°42'00" N 33°46'18" E, 897 m, 25.V.2015, 2 specimens; Yapraklı, Between Yüklü-Çevrecik, 40°40'5" N 33°49'22" E, 983 m, 25.V.2015, 1 specimen; Yapraklı, entry of Çevrecik, 40°39'36" N 33°49'52" E, 953 m, 25.V.2015, 3 specimens; Yapraklı, entry of Topuzsaray, 40°38'28" N 33°53'11" E, 1169 m, 26.V.2015, 2 specimens; Yapraklı, Kirliakça, 40°37'40" N 33°54'38" E, 914 m, 26.V.2015, 4 specimens; Yapraklı, Söğütlü, 40°41'31" N 33°59'16" E, 1112 m, 26.V.2015, 1 specimen; Ilgaz, entry of Belören, 40°51'53" N 33°29'44" E, 919 m, 27.V.2015, 1 specimen; Ilgaz, exit of Belören, 40°51'46" N 33°30'7" E, 903 m, 27.V.2015, 1 specimen; Ilgaz, entry of Güneyköy, 40°55'14" N 33°28'44" E, 1226 m, 29.V.2015, 1 specimen; Ilgaz, Betweeen Kayı village return-Kırşlar village, 40°56'22" N 33°28'37" E, 1137 m, 29.IX.2015, 3 specimens; Ilgaz, Gökçeyazı village, 40°57'27" N 33°29'42" E, 1020 m, 29.V.2015, 1 specimen; Ilgaz, Belören, Between Şeyhyunus-Sapgöl villages, 40°52'4" N 33°31'37" E, 893 m, 18.VI.2015, 1 specimen; Ilgaz, 7 km to Şeyhyunus village, 40°51'49" N 33°32'7" E, 1015 m, 18.VI.2015, 1 specimen; Ilgaz, Candere-Sazak-Hacı Hasan return, 40°55'29" N 33°39'29" E, 885 m, 18.VI.2015, 1 specimen; Ilgaz, Between Beyköy-Saraycık, 40°59'24" N 33°44'10" E, 1195 m, 19.VI.2015, 1 specimen; Ilgaz, exit of Yukarıbozan, 40°57'26" N 33°35'58" E, 1047 m, 19.VI.2015, 1 specimen; Çerkeş, Between Cedine-Kabakköy, 40°53'12" N 32°55'2" E, 1355 m, 20.VI.2015, 3 specimens; Çerkeş, Between Avşar-Kükürt, 40°54'56" N 33°1'10" E, 1205 m, 20.VI.2015, 1 specimen; Bayramören, Harmancık road, 41°2'32" N 33°13'45" E, 861 m, 21.VI.2015, 1 specimen; Bayramören, Yaylatepesi road, 41°3'26" N 33°12'34" E, 651 m, 21.VI.2015, 2 specimens; Çerkeş, Yürükköyü, 40°54'52" N 32°52'45" E, 970 m, 22.VI.2015, 1 specimen; Ilgaz, entry of Yuvasaray, 40°53'11" N 33°44'6" E, 781 m, 25.VI.2015, 2 specimens; Eldivan, Bülbül stream road, 40°30'26" N 33°30'32" E, 1091 m, 28.VI.2015, 1 specimen.

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Appendix 1. The complete list of longhorned beetles fauna for Çankırı province in Turkey.

FAMILY CERAMBYCIDAE Latreille, 1802: 211

SUBFAMILY LEPTURINAE Latreille, 1802: 218
TRIBE RHAGIINI Kirby, 1837: 178
GENUS *RHAGIUM* Fabricius, 1775: 182
SUBGENUS *RHAGIUM* Fabricius, 1775: 182
SPECIES *R. inquisitor* (Linnaeus, 1758: 393)
SUBSPECIES *R. i. inquisitor* (Linnaeus, 1758: 393)
GENUS *DINOPTERA* Mulsant, 1863: 494
SUBGENUS *DINOPTERA* Mulsant, 1863: 494
SPECIES *D. collaris* (Linnaeus, 1758: 398)
GENUS *CORTODERA* Mulsant, 1863: 572
SPECIES *C. discolor* Fairmaire, 1866: 277
SPECIES *C. flavimana* (Waltl, 1838: 471)
SUBSPECIES *C. f. flavimana* (Waltl, 1838: 471)
SPECIES *C. rufipes* (Kraatz, 1876: 344)
TRIBE LEPTURINI Latreille, 1802: 218
GENUS *VADONIA* Mulsant, 1863: 559
SPECIES *V. moesiaca* (Daniel & Daniel, 1891: 6)
SPECIES *V. unipunctata* (Fabricius, 1787: 157)
SUBSPECIES *V. u. unipunctata* (Fabricius, 1787: 157)
GENUS *PSEUDOVADONIA* Lobanov et al., 1981: 787
SPECIES *P. livida* (Fabricius, 1777: 233)
SUBSPECIES *P. l. livida* (Fabricius, 1777: 233)
GENUS *STICTOLEPTURA* Casey, 1924: 280
SUBGENUS *STICTOLEPTURA* Casey, 1924: 280
SPECIES *S. fulva* (DeGeer, 1775: 137)
GENUS *ANASTRANGALIA* Casey, 1924: 280
SPECIES *A. dubia* (Scopoli, 1763: 47)
SUBSPECIES *A. d. dubia* (Scopoli, 1763: 47)
SPECIES *A. sanguinolenta* (Linnaeus, 1760: 196)
GENUS *PEDOSTRANGALIA* Sokolov, 1897: 461
SUBGENUS *NEOSPHENALIA* Löbl, 2010: 60
SPECIES *P. verticenigra* (Pic, 1892: 416)
GENUS *JUDOLIA* Mulsant, 1863: 496
SPECIES *J. erratica* (Dalman, 1817: 490)
GENUS *RUTPELA* Nakani & Ohbayashi, 1957: 242
SPECIES *R. maculata* (Poda, 1761: 37)
SUBSPECIES *R. m. maculata* (Poda, 1761: 37)
GENUS *STENURELLA* Villiers, 1974: 217
SUBGENUS *PRISCOSTENURELLA* Özdikmen, 2013: 516
SPECIES *S. bifasciata* (Müller, 1776: 93)
SUBSPECIES *S. b. limbiventris* (Reitter, 1898: 21)
SPECIES *S. septempunctata* (Fabricius, 1792: 346)
SUBSPECIES *S. s. latenigra* (Pic, 1915: 5)

SUBFAMILY ASEMINAE Thomson, 1861: 139
TRIBE ASEMINI Thomson, 1861
GENUS *ASEMUM* Eschscholtz, 1830: 66
SPECIES *A. striatum* (Linnaeus, 1758: 396)

SUBFAMILY SPONDYLIDINAE Audinet-Serville, 1832: 123
TRIBE SPONDYLIDINI Audinet-Serville, 1832: 123
GENUS *SPONDYLIS* Fabricius, 1775: 159
SPECIES *S. buprestoides* (Linnaeus, 1758: 388)

SUBFAMILY CERAMBYCINAE Latreille, 1802: 211
TRIBE TRACHYDERINI Dupont, 1836: 1
GENUS *PURPURICENUS* Dejean, 1821: 105
SPECIES *P. budensis* (Götz, 1783: 70)
TRIBE CERTALLINI Fairmaire, 1864: 149
GENUS *CERTALLUM* Dejean, 1821: 111
SPECIES *C. ebulinum* (Linnaeus, 1767: 637)
TRIBE CALLIDIINI Kirby, 1837: 170
GENUS *ROPALOPUS* Mulsant, 1839: 40
SUBGENUS *ROPALOPUS* Mulsant, 1839: 40
SPECIES *R. clavipes* (Fabricius, 1775: 188)
GENUS *PHYMATODES* Mulsant, 1839: 47
SUBGENUS *PHYMATODES* Mulsant, 1839: 47
SPECIES *P. testaceus* (Linnaeus, 1758: 396)
TRIBE ANAGLYPTINI Lacordaire, 1868: 404
GENUS *ANAGLYPTUS* Mulsant, 1839: 91
SUBGENUS ANAGLYPTUS Mulsant, 1839: 91
SPECIES *A. arabicus* (Küster, 1847: 95)
TRIBE CLYTINI Mulsant, 1839: 70
GENUS *ECHINOCERUS* Mulsant, 1862: 143
SPECIES *E. floralis* (Pallas, 1773: 724)
GENUS *NEOPLAGIONOTUS* Kasatkin, 2005: 51
SPECIES *P. bobelayei* (Brullé, 1832: 253)
SUBSPECIES *N. b. bobelayei* (Brullé, 1832: 253)
GENUS *CHLOROPHORUS* Chevrolat, 186: 290
SUBGENUS *CHLOROPHORUS* Chevrolat, 1863: 290
SPECIES *C. varius* (Müller, 1766: 188)
SUBSPECIES *C. v. varius* (Müller, 1766: 188)
SUBGENUS *CRASSOFASCIATUS* Özdikmen, 2011: 538
SPECIES *C. aegyptiacus* (Fabricius, 1775: 194)
SPECIES *C. hungaricus* Seidlitz, 1891: 828
SUBGENUS *PERDEROMACULATUS* Özdikmen, 2011: 537
SPECIES *C. sartor* (Müller, 1766: 188)
GENUS *XYLOTRECHUS* Chevrolat, 1860: 456
SUBGENUS RUSTICOCLYTUS Vives, 1977: 130
SPECIES *X. rusticus* (Linnaeus, 1758: 398)
GENUS *CLYTUS* Laicharting, 1784: 88
SUBGENUS *CLYTUS* Laicharting, 1784: 88
SPECIES *C. arietis* (Linnaeus, 1758: 399)
SUBSPECIES *C. a. arietis* (Linnaeus, 1758: 399)
SPECIES *C. rhamni* Germar, 1817: 223
SUBSPECIES *C. r. temesiensis* (Germar, 1824: 519)
SPECIES *C. schurmanni* Sama, 1996: 108

SUBFAMILY STENOPTERINAE Gistel, 1848: [9] (unnumbered section)
TRIBE STENOPTERINI Gistel, 1848: [9]
GENUS *STENOPTERUS* Illiger, 1804: 120
SPECIES *S. rufus* (Linnaeus, 1767: 642)
SUBSPECIES *S. r. geniculatus* Kraatz, 1863: 104
GENUS *CALLIMUS* Mulsant, 1846: [5]
SUBGENUS *LAMPROPTERUS* Mulsant, 1862: 214
SPECIES *C. femoratus* (Germar, 1824: 519)

SUBFAMILY DORCADIONINAE Swainson, 1840: 290
TRIBE DORCADIONINI Swainson, 1840: 290
GENUS *DORCADION* Dalman, 1817: 397
SUBGENUS *CRIBRIDORCADION* Pic, 1901: 12
SPECIES *D. boluense* Breuning, 1962: 38
SUBSPECIES *D. b. imitator* Pesarini and Sabbadini, 1998: 53

SPECIES *D. muchei* Breuning, 1962: 38
SPECIES *D. sabanoezueense* Bernhauer and Peks, 2013: 326
SPECIES *D. scabricolle* (Dalman, 1817: 174)
SUBSPECIES *D. s. paphlagonicum* Breuning, 1962: 459
SPECIES *D. septemlineatum* Waltl, 1838: 469
SUBSPECIES *D. s. abanti* Braun, 1976: 54
SPECIES *D. subsericatum* Pic, 1901: 12
SUBSPECIES *D. s. rufipenne* Breuning, 1946: 118
SPECIES *D. yilmazi* Özdikmen & Kaya, 2016: 21

SUBFAMILY LAMIINAE Latreille, 1825: 401
TRIBE LAMIINI Latreille, 1825: 401
GENUS *MORIMUS* Brullé, 1832: 258
SPECIES *M. orientalis* Reitter, 1894: 43
TRIBE POGONOCHERINI Mulsant, 1839: 151
GENUS *POGONOCHERUS* Dejean, 1821: 107
SUBGENUS *PITYPHILUS* Mulsant, 1862: 302
SPECIES *P. decoratus* Fairmaire, 1855: 320
SPECIES *P. fasciculatus* (DeGeer, 1775: 71)
SUBSPECIES *P. f. fasciculatus* (DeGeer, 1775: 71)
TRIBE ACANTHOCININI Blanchard, 1845: 154
GENUS *ACANTHOCINUS* Dejean, 1821: 106
SPECIES *A. aedilis* (Linnaeus, 1758: 392)
GENUS *LEIOPUS* Audinet-Serville, 1835: 86
SPECIES *L. nebulosus* (Linnaeus, 1758: 391)
SUBSPECIES *L. n. nebulosus* (Linnaeus, 1758: 391)
TRIBE TETROPINI Portevin, 1927
GENUS *TETROPS* Kirby, 1826 (in Kirby & Spence 1826: 498)
SUBGENUS *TETROPS* Kirby, 1826 (in Kirby & Spence 1826: 498)
SPECIES *T. praeustus* (Linnaeus, 1758: 399)
SUBSPECIES *T. p. angorensis* Pic, 1918: 11
TRIBE PHYTOECIINI Mulsant, 1839: 191
GENUS *OBEREA* Dejean, 1835: 351
SUBGENUS *AMAUROSTOMA* Müller, 1906: 223
SPECIES *O. ressli* Demelt, 1963: 150
GENUS *OXYLIA* Mulsant, 1862: 398
SPECIES *O. argentata* (Ménétriés, 1832: 227)
SUBSPECIES *O. a. argentata* (Ménétriés, 1832: 227)
SPECIES *O. duponcheli* (Brullé, 1832: 260)
GENUS *PHYTOECIA* Dejean, 1835: 351
SUBGENUS *HELLADIA* Fairmaire, 1864: 176
SPECIES *P. humeralis* (Waltl, 1838: 471)
SUBSPECIES *P. h. humeralis* (Waltl, 1838: 471)
SPECIES *P. praetextata* (Steven, 1817: 184)
SUBSPECIES *P. p. praetextata* (Steven, 1817: 184)
SUBGENUS *MUSARIA* Thomson, 1864: 121
SPECIES *P. affinis* (Harrer, 1784: 209)
SUBSPECIES *P. a. tuerki* Ganglbauer, 1884: 575
SPECIES *P. wachanrui* Mulsant, 1851: 120
SUBGENUS *NEOMUSARIA* Plavilstshikov, 1928: 123
SPECIES *P. merkli* Ganglbauer, 1884: 560
SPECIES *P. pauliraputii* (Sama, 1993: 295)
SUBGENUS *PHYTOECIA* Dejean, 1835: 351
SPECIES *P. baccueti* (Brullé, 1832: 262)
SPECIES *P. caerulea* (Scopoli, 1772: 102)
SUBSPECIES *P. c. caerulea* (Scopoli, 1772: 102)
SPECIES *P. croceipes* Reiche & Saulcy, 1858: 17
SPECIES *P. cylindrica* (Linnaeus, 1758: 394)
SPECIES *P. gamzeae* Özdikmen, 2017: 23

SPECIES *P. geniculata* Mulsant, 1863: 420
SUBSPECIES *P. g. geniculata* Mulsant, 1863: 420
SPECIES *P. pubescens* Pic, 1895: 64
SPECIES *P. pustulata* (Schrank, 1776: 66)
SUBSPECIES *P. p. pustulata* (Schrank, 1776: 66)
SPECIES *P. rufipes* (Olivier, 1795: 25)
SUBSPECIES *P. r. rufipes* (Olivier, 1795: 25)
SPECIES *P. virgula* (Charpentier, 1825: 225)
SUBGENUS *OPSILIA* Mulsant, 1862: 387
SPECIES *P. coerulescens* (Scopoli, 1763: 49)
TRIBE AGAPANTHIINI Mulsant, 1839: 172
GENUS *AGAPANTHIA* Audinet-Serville, 1835: 35
SUBGENUS *EPOPTES* Gistel, 1857: 93
SPECIES *A. lateralis* Ganglbauer, 1884: 541
SUBGENUS *AGAPANTHIA* Audinet-Serville, 1835: 35
SPECIES *A. cardui* (Linnaeus, 1767: 632)
SPECIES *A. suturalis* (Fabricius, 1787: 149)
SUBGENUS *SMARAGDULA* Pesarini & Sabbadini, 2004: 128
SPECIES *A. violacea* (Fabricius, 1775: 187)

Map 1. Çankırı province.

NEW RECORDS FOR APHID FAUNA OF TURKEY FROM SAMSUN PROVINCE

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ABSTRACT: Twelve new aphid records had been given in this study are results of the studies performed between 2009 and 2012 in order to determine the aphid fauna of Samsun province. New records for Turkey are; *Aphis esulae* (Börner, 1940), *Aphis odinae* (van der Goot, 1917), *Aphis rubicola* Oestlund, 1887, *Aphis stachydis* Mordvilko, 1929, *Cavariella salicis* (Monell, 1879), *Cinara neubergi* (Arnhart, 1930), *Cinara occidentalis* (Davidson, 1909), *Macrosiphoniella millefolii* (De Geer, 1773), *Megoura nigra* Lee, 2002, *Myzus cornutus* Medda ve Chakrabarti, 1986, *Pterocomma rufipes* (Hartig, 1841), *Sitobion africanum* (Hille Ris Lambers, 1954). Number of the species in Turkey aphid fauna increased about to 560 with these new records.

KEY WORDS: New records, aphid, Samsun, Turkey

Aphids are an important phloem sap-sucking insect group due to their small size, high fecundity, short development time, cyclical parthenogenetic reproduction, diverse host-plant preferences and close relationship with their host plants. There are about 5100 described aphid species worldwide in about 510 presently accepted genera (Blackman & Eastop, 2018; Favret, 2018) and about 540 species are recorded from Turkey (Şenol et al., 2014; Özdemir & Barjadze, 2015; Şenol et al., 2017; Görür et al., 2017). Turkey is a geographically large country and has different types of climatic conditions, large and various agricultural lands and very rich flora which 31% of this is endemic. Therefore, Turkey is important, diverse and fascinating area for aphids, but there are still many unstudied areas. Early studies about Turkey's aphid fauna were performed by foreign researchers at the beginning of the 1900s. Many following studies were conducted in order to determine the Turkish aphid fauna and were added many new records. Çanakçıoğlu (1975) revised all previous studies and listed 258 aphid species in his book that is first revision and called "*Aphidoidae of Turkey*". New additions for the aphidofauna of Turkey which have been added from this revision to 2006 were summarized by Remaudiere et al. (2006) and have been listed 417 species. More recently, Toper Kaygın et al. (2008), Eser et al. (2009), Görür et al. (2009a,b), Akyürek et al. (2010), Toper Kaygin et al. (2010), Akyürek, et al. (2011), Tepecik et al. (2011), Barjadze et al. (2011) and Görür et al. (2011a,b) listed about 60 new records of Turkey aphid fauna. Once for all, a checklist of the Turkish aphidofauna have been published by Görür et al. (2012) and listed 480 species in 141 genera. After the checklist, Şenol et al. (2014) 9, Barjadze & Özdemir (2014) 1 (One new genus), Barjadze et al. (2014) 2 (two new species), Şenol et al. (2015a) 19, Özdemir & Barjadze (2015) 3, Şenol et al. (2015b) 7, Özdemir & Barjadze (2015) 3; Şenol et al. (2017) 15 and Görür et al. (2017) 8 new records added to the turkish aphidofauna. In recent study, we added 12 new records for Turkey aphid fauna.

MATERIAL AND METHOD

Samples were collected from Samsun Province in Middle Black Sea Region between 2009 and 2012. The samples were processed in the laboratory based on the methods offered by Martin (1983). Species were identified according to Blackman & Eastop (2018). The taxonomic status of the species was checked based on Favret (2018) The geographic distribution, general characteristcis and biology of the species were given according to Blackman & Eastop (2018) and Nieto Nafria (2018). Also, host plants and distinguishing features of each determined species were given. Voucher samples were stored at the Biology Department of Ondokuz Mayıs University.

RESULTS

As a result of identification of the samples collected from Samsun province, 12 aphid species belonging to the Aphididae family have been identified as new records for the Turkish aphid fauna. World distributions, host plants and distinguishing features are presented below.

Family: Aphididae
Subfamily: Aphidinae
Tribe: Aphidini
Subtribe: Aphidina
Genus: *Aphis* Linnaeus, 1758

Aphis esulae (Börner, 1940)

Distinguishing Features: Eyes multifaced. Head without spicules. ANT tubercules absent. ANT less than 0.9x BL and usually without rhinaria on III; ANT PT/BASE 1.5-2.4; Longest hairs on ANT III 0.2-0.5 x BD III. Dorsum membranous. MTu present only ABD TERG 1 and 7. Spiracular apertures reniform. Stridulatory apparatus absent. Cauda finger-shaped, more than its basal width and with 6-10 hairs. Dark SIPH without a subapical annular incision and 0.70-1.37 x cauda. Hind tarsi similar in length to other tarsi (Blackman & Eastop, 2018).
Material Examined: Samsun, Terme, Altunlu Village, on stem of *Euphorbia* sp., 23.V.2010.
Distribution: Austria, Bulgaria, East Siberia, Hungary, Kazakhistan, (Stekolshchikov et al., 2008; Kadyrbekov, 2011; Blackman & Eastop, 2018).

Aphis odinae (van der Goot, 1917)

Distinguishing Features: Body oval. Head without spicules. Eyes multifaced. ANT tubercules little developed; ANT PT/BASE 2.5-3.0. Dorsal abdomen smooth and without dark markings. ABD TERG 1 and 7 constantly with MTu (altough these may be very small). Stridulatory apparatus present and reniform, consisting of a pattern of ridges on ventro-lateral areas of abdominal sternites 5 and 6, and a row of short, peg-like hairs on the hind tibia. Cauda pale, tongue-shaped, tapering and usually much longer than basal width. Pale SIPH with dark apices, much shorter than (0.4-0.6x) cauda and tapering gradually over most of length and with a moderate flange; length of SIPH usually 0.5 or less than the distance between their bases (Blackman & Eastop, 2018).
Material Examined: Samsun, Atakum, İsmet İnönü Boulevard, under leaf of *Citrus* sp., 22.V.2010.

Distribution: Africa–South of Sahara East and South-east Asia (Barbagallo & Alcantara Santos, 1989; Martin, 1989; Blackman & Eastop, 2018).

Aphis rubicola Oestlund, 1887

Distinguishing Features: Smooth head without spicules. Antennal tubercules weakly developed. ANT 6-segmented; ANT I without a projection; ANT PT/BASE 2.0-2.6; Dorsal hairs all less than 1.5 x BD III. Prothorax and ABD TERG 1 and 7 with MTu. ABD TERG 8 with 3-5 hairs. Pale SIPH with dark apices tubular and tapering on distal half; more than 0.12 mm long and 0.8-2.2 x cauda. Cauda with (8-)10-12 hairs. R IV+V with (2-)3-4 accessory hairs (Blackman & Eastop, 2012).
Material Examined: Samsun, Çarşamba, Ağacabey Town, Tilkili Village, on stem of *Rubus* sp., 15.V.2010.
Distribution: North America (Blackman & Eastop, 2018).

Aphis stachydis Mordvilko, 1929

Distinguishing Features: Head without spicules. ANT tubercules undeveloped. ANT usually 6-segmented, more than 0.2 x BL and without sec. rhinaria; ANT PT/BASE more than 1.5. Rostrum longer, length of sclerotised part of stylet Groove more than 0.4 mm. Dorsum pale, without an extensive black sclerotic shield. Dorsal body hairs mostly shorter than BD III and pointed. ABD TERG 1 and 7 with MTu. Cauda finger-like, much longer than its basal width (Blackman & Eastop, 2018).
Material Examined: Samsun, Terme, Gölardı Town, on stem of *Stachys palustris*, 23.V.2010.
Distribution: South, Central and East Europea, To East of West Siberia and Transcaucasia (Jörg & Lampel, 1988; Blackman & Eastop, 2018).

Tribe: Macrosiphini
Genus: *Cavariella* Del Guercio, 1911
Cavariella salicis (Monell, 1879)

Distinguishing Features: ANT PT/BASE 0.6-2.0. Rostrum IV+V 0.85-1.04 x HT II. ABD TERG 8 with a posteriorly projecting above cauda bearing 2 hairs. SIPH clavate; swollen on distal half to at least 1.2 x narrower basal half. Supracaudal process large, conical, extending beyond and usually covering cauda (Blackman & Eastop, 2018).
Material Examined: Samsun, Çarşamba, Dikbıyık Town, on inflorescence of *Oenanthe pimpinelloides*, 15.V.2010.
Distribution: East and Central America (Blackman & Eastop, 2018).

Genus: *Macrosiphoniella* Del Guercino, 1911
Macrosiphoniella millefolii (De Geer, 1773)

Distinguishing Features: BL 2.1-4.1 mm. ANT tubercules variably developed. PT 3.3-4.3 x BASE VI and clearly longer than base of last ANT segment. Rostrum IV+V 0.9-1.2 x HT II. Dorsal hairs long, pointed apices and arising from conspicuous dark scleroites. Marginal tubercules (MTu) absent. SIPH dark, with polygonal reticulation extending over distal 0.06-0.7 and SIPH 0.6-1.0 x cauda (SIPH very evident, only shorter than cauda when it is long, dark and finger-like, and always clearly longer than HT II). Cauda finger-like, more than 2 times its basal width and with 20-32 hairs. Tibia entirely dark Brown to black (Blackman & Eastop, 2018).
Material Examined: Samsun, Asarcık, Gökçepınar Village, on stem of *Achillea* sp., 12.X.2009.
Distribution: Europe, North America, West Siberia, (Blackman & Eastop, 2018).

Genus: *Megoura* Buckton, 1876
Megoura nigra Lee, 2002

Distinguishing Features: Head smooth with well-developed antennal tubercules, their iner faces divergent. ANT III with usually more than 50 (28-64) rhinaria. Rostrum IV+V 0.88-1 x HT II. Tibia pale on basal 0.6-0.7. Dorsal abdomen onterior to SIPH with small

scattered dark markings. Scleroites at bases of dorsal hairs absent. SIPH dark, swollen on distal half and 0.8-1.33 x cauda. Cauda dark (Blackman & Eastop, 2018).
Material Examined: Samsun, Atakum, Mimar Sinan Street, on shoot and stem of *Vicia sativa,* 19.V.2010: Atakum, İsmet İnönü Boulevard, on shoot and stem of *Vicia lutea,* 21.V.2010; Çarşamba, Ağacabey Town, shoot of *Vicia* sp., 15.V.2010.
Distribution: Korea (Blackman & Eastop, 2018).

Genus: *Myzus* Passerini, 1860

***Myzus cornutus* Medda & Chakrabarti, 1986**

Distinguishing Features: Head capsule with nodulose ornamentation. Antennal tubercules well developed, iner faces are gibbous in dorsal view, withouth a finger-like projection. ANT I with iner sides scabrous or smooth. ANT III always without secondary rhinaria. Hairs on ANT III with pointed apices. ANT PT/BASE more than 0.8. Rostrum IV+V 0.85-0.95 x HT II. Tergum pale. Mesosternum without spinal processes. Longest hairs on ABD TERG 1-6 more than 20 µm long, with pointed apices, 0.8 or more x ANT BD III. Marginal tubercules absent. Tibia smooth. SIPH and antennal segments pale not contrastingly two-toned; SIPH tubular and without hairs. Spring generations curling, Rolling, twisting or blistering leaves, but not in closed galls (Blackman & Eastop, 2018).
Material Examined: Samsun, Atakum, Mimar Sinan Street, under leaf of *Prunus persica*, 21.V.2010.
Distribution: India, North-East Pakistan (Naumann-Etienne & Remaudière 1995; Blackman & Eastop, 2018).

Genus: *Sitobion* Mordvilko, 1914

***Sitobion africanum* (Hille Ris Lambers, 1954)**

Distinguishing Features: Eyes multi-facetted. ANT 6-segmented. ANT PT/BASE more than 1. Alata with 4-14 circular or oval secondary rhinaria mostly concentrated on basal half on ANT III. Rostrum IV+V 0.8-0.9 x HT II. SIPH tubular and usually uniformly dark, and dorsal abdomen often with a pattern of dark segmental marking. SIPH with a subapical zone of polygonal reticulation and without hairs (Blackman & Eastop, 2018).
Material Examined: Samsun, Ayvacık, on stalk and under leaf of *Ficus* sp., 24.V.2010. This species also determined from Adıyaman during preparation of the manuscript.
Distribution: Africa, The Island of Indian Ocean, Yemen (Blackman & Eastop, 2018).

Subfamily: Pterocommatinae Wilson, 1910
Genus: *Pterocomma* Buckton, 1879

***Pterocomma rufipes* (Hartig, 1841)**

Distinguishing Features: Antennae 6-segmented. ANT PT/BASE 1.0-2.2 and PT much narrower than BASE; ANT II with 3-7 hairs. ANT BASE VI with only 1-3 long hairs, plus 2-4 short hairs. Longest hair on ANT III 120-150 µm, 3-4 x basal diameter of segment. Alata with usually 25-30 secondary rhinaria on ANT III. Marginal tubercules present and well developed on prothorax and most of ABD TERG 1-7; conical and broad-based, much larger than adjacent hair-bases. SIPH pale, 0.16-0.54 mm long, swollen distally, 1.3-2.4 x HT II, without hairs, with at least a small flange. Cauda rounded with 20-60 hairs (Blackman & Eastop, 2018).
Material Examined: Samsun, Atakum, Balaç Village, on branch *Salix* sp., 02.V.2010; Çarşamba, Çınarlık Town, on branch of *Salix* sp., 15.V.2010.
Distribution: Canada, East and West Siberia, Iceland, Mongolia, Northwest and Central Europe (Pashtshenko, 1988; Blackman & Eastop, 2018).

Subfamily: Lachninae Herrich-Schaeffer, 1854
Tribe: Eulachnini Baker, 1920
Genus: *Cinara* Curtis, 1835

***Cinara neubergi* (Arnhart, 1930)**

Distinguishing Features: ANT V usually with one secondary rhinarium. ANT II bearing 5-10 hairs and ANT BADE VI with 2-8 hairs. Longest hairs on ANT III 110-150 µm long, on hind tibia 150-190 µm long, and on ABD TERG 5 140-180 µm long, arising from larger

scleroites of varying sizes. Rostrum IV 0.15-0.32 mm long, 2.3-2.4 x R V. R IV 1.2-1.5 x HT Iand 0.8 or less x HT II. Largest scleroites on ABD TERG 2-4 of maximum diameter 70-300 µm. HT I 0.16-0.32 mm and without any dorsal hairs. HT II 0.30-0.53 mm and 1.3-1.6 x RIV (Blackman & Eastop, 2012).
Material Examined: Samsun, Vezirköprü, Kunduz Forest, on branch of *Pinus sylvestris*, 26.V.2010.
Distribution: Europe (Blackman & Eastop, 2018).

Cinara occidentalis (Davidson, 1909)

Distinguishing Features: Adult apterae with 6-segmented antennae, at least 0.2 of body lengt. BL 2.1-3.2 mm. ANT PT/BASE less than 1.0. Rostrum much shorter than body. SIPH present as pores on hairy cones which are usually pigmented. Maximum diameter of base of SIPH cone less than 0.3 mm, or less than 3 times the diameter of the SIPH aperture. HT I less than half as long as HT II. HT II at least 4 x longer than the very short, almost triangular HT I (Blackman & Eastop, 2018).
Material Examined: Samsun, Atakum, Alparslan Boulevard, on branch of *Abies* sp., 21.V.2010; Ayvacık, on branch of *Abies* sp., 24.V.2010.
Distribution: Canada, West America (Blackman & Eastop, 2018).

DISCUSSION

Recent global changes in climate, international trade, agricultural activities around the World result in changes in aphid fauna of the countries and regions in any country. Turkey has its own characteristic climatic conditions and variability, geographical locations, agricultural crop richness - large agricultural landscape and one of the richest flora in Europe with about 31 % endemism, despite that only 2.3 % of the Turkey aphid fauna originated from Turkey (Akyıldırım et al., 2013). In addition current number of the Turkey aphid fauna do not reflect real composition compared with neighbouring countries (Görür et al., 2017). In present study, 12 new records were added to the aphid fauna of Turkey. With these new records, the number of species known in Turkey's aphidofauna was increased to about 555. There is a strong probability of a finding new record species or new species due to Turkey's particular conditions. It is expected that further studies will reveal new additional aphid species to the Turkish fauna.

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PRELIMINARY SCREENING OF SELECTED TROPICAL BOTANICALS AS COWPEA PROTECTANTS AGAINST COWPEA SEED BRUCHID, *CALLOSOBRUCHUS MACULATUS* FABRICIUS (COLEOPTREA: CHRYSOMELIDAE: BRUCHINEAE)

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[**Babarinde, S. A. & Pitan, O. O. R.** 2019. Preliminary screening of selected tropical botanicals as cowpea protectants against cowpea seed bruchid, *Callosobruchus maculatus* Fabricius (Coleoptrea: Chrysomelidae: Bruchineae). Munis Entomology & Zoology, 14 (2): 389-394]

ABSTRACT: A preliminary screening was conducted to investigate the potentials of thirteen botanical powders as cowpea seed protectant against cowpea seed bruchid, *Callosobruchus maculatus,* Fabricius using seed damage parameters. The botanicals included *Azadirachta indica, Ekebergia senegalensis, Urginea altissima, Ancistrophyllum secundiflorum, Pseudocedrela kotschyi, Lannea welwitschii, Xylopia parviflora, Usteria guineensis* and *Antiaris toxicaria.* Others were *Indigofera arrecta, Hoslundia opposita, Cleome ciliata* and *Lagerra aurita.* All the botanicals, except *L. aurita,* showed potentials for cowpea protectant ability against the seed bruchid. Using Bruchid Perforation Index (BPI) values, the most effective powders were *A. indica* (2.95), *A. toxicoria* (2.07) and *H. opposita* (2.64) which BPI values were significantly ($p<0.05$) lower than that of *L. aurita* (26.46). Percentage Seed damage (PSD) varied with the studied botanicals (2.10-41.32%) and significantly ($p<0.05$) lower in the botanical-treated seeds compared to the untreated control (98.28%). The effective botanicals are, therefore, recommended for tropical resource-poor subsistent farmers for use in their small scale cowpea postharvest storage and for further studies to elucidate other effective formulations and their active ingredients.

KEY WORDS: Botanical powders, Bruchid Perforation Index, *Callosobruchus,* grain protectant, seed damage

Cowpea, *Vigna unguiculata* (L.) Walpers, is an important food legume and an essential component of cropping systems in many developing countries. Rich in protein and carbohydrate, it is the preferred pulse in large parts of Africa, where the seeds are processed into various products for human consumption or to appease to gods among the traditional worshippers. Seeds are medicinally used as a poultice to treat skin infections and boils. Despite its various uses, the post-harvest infestation by bruchids, especially the genus *Callosobruchus* (Coleoptera: Chrysomelidae: Bruchinae) poses a serious threat to its all-year round availability (Tuda et al., 2005).

The use of plant products to protect stored products from insect pest infestation is an age-long practice in developing world and is recently receiving a renewed attention as an important component of integrated pest control scheme. The reasons for this renewed interest include their abundance and cost effectiveness. Also, the use of botanicals reduces the ecological problems and health hazards of over-dependence on synthetic pesticides. Thirdly, some botanical formulations like powder and ash could be prepared by local resource-poor farmers, because they require no skilled technicality. Although, a large array of plant species has been documented for their insecticidal properties against bruchids (Dales, 1996; Ileke & Bulus, 2012; Ashamo et al., 2013; Musa et al., 2015; Babarinde et al., 2016a,b; Chauhan et al., 2016; Vijayaraghavan & Zadda, 2016; Kosini & Nukenine, 2017; *Usman* et al., 2017), screening more botanicals for potential efficacies cannot be inappropriate in bio-rational innovations for bruchids control. This is because bioactivity of botanicals could be species-specific which necessitates the attempt to establish the spectrum of bioactivity of any chosen botanical species. Plants selected for the study were those known to possess medicinal, pesticidal or nutritional values.

In this study, powder formulation was used being a preliminary study which was designed to provide baseline information for further studies on the insecticidal properties of the selected botanical species. Interestingly, the selected species are naturally available in many tropical countries. Therefore, the aim of the study was to evaluate thirteen selected tropical botanicals for their protectant ability of cowpea seed against the seed bruchid, *Callosobruchus maculatus* using seed damage parameters due to the bruchid's infestation.

MATERIALS AND METHODS

Insect culture

C. maculatus was reared on clean seeds of "Ife Brown", a bruchid-susceptible cowpea cultivar, under ambient environmental temperature of 30±2°C and 70±5% using standard method earlier described by Babarinde and Ewete (2008).

Botanical procurement and preparation

Thirteen botanicals were collected from different towns in south western Nigeria, where they are found in abundance (Table 1). Identification of the botanicals was done with the help of local ethno-botanists and matching of the vernacular names with the scientific names contained in Gbile (2006). The root and stem bark of the woody species used for the study were exposed to sun drying for 2 days and subsequently air-dried, while the leaves were air-dried under shade until crisp to prevent destroying the thermo-labile compounds in them. Thereafter, the dried plant parts were pulverized with the aid of a hammer mill and sieved with the aid of 50 µm sieve. The plant powder were then stored in labelled plastic airtight jars until use.

Botanical screening for insecticidal potentials

The plant powders were screened according to Fatope et al. (1995) with some modifications. Cowpea seeds (30 g each) were put in a 1 L Kilner jar covered with muslin cloth into which 3 g plant powder corresponding to 10% (w/w) was added to the cowpea seeds. A Kilner jar containing 30 g cowpea seeds without botanical treatment served as control. Three pairs (sex ratio 1:1) 1- to 3-day old *C. maculatus* were introduced into each covered jar. Six replicates of the setup was maintained for seven days in order to infest the stock after which the insects were removed from the stock. At 3 months after infestation, data were collected on the number of damaged (NDS) and number of undamaged seeds (NUdS), weight of damaged and undamaged seeds from both treated and untreated grains.

Percentage seed damage (PSD) was calculated as

$$PSD = \frac{NDS \times 100}{NDS + NUdS}$$

Bruchid perforation index (BPI) was calculated to determine the seed damage level according to Fatope et al. (1995), using the formula:

$$BPI = \frac{(\%TP) \times 100}{(\%TP+\%CP)},\quad \text{where}$$

%TP = % treated cowpea seeds perforated
%CP = % control cowpea seeds perforated
BPI > 50 = negative protectant of plant material tested (i.e. enhancement of infestation of the bruchid) BPI < 50 = positive protectant (i.e. prevention of infestation of the bruchid).

Experimental design and data analysis

The experiments were laid out in completely randomized design. Data were subjected to analysis of variance and significant treatment means were separated using Tukey's HSD at 5% probability level, with the aid of SPSS Software (SPSS, 2006).

RESULTS AND DISCUSSION

The highest BPI was observed in cowpea treated with *Lagerra aurita* (26.46), which was not significantly different from the BPI observed in cowpea treated with Uriginea *altissima*, *Lannea welwitschii, Xylopia parviflora, Usteria guineensis, Indigofera arrecta* and *Cleome ciliata*. The BPI obtained from cowpea treated with *Azadirachta indica* (2.95), Antiaris *toxicoria* (2.07) and *Hoslundia. opposita* (2.64), *Ancistophyllum secundiflorum* (6.88), *Ekebergia senegalensis* (5.57), *H. opposita* (2.64) were not significantly different from one another but were significantly lower than the BPI obtained from cowpea treated with *L. aurita* (26.46) (Table II). Based on the BPI, *A. indica, A. toxicoria* and *H. opposita* were ranked to possess very strong grain protectant effect; while *E. senegalensis, U. altissima, A. secundiflorum, P. kotschyi U. guineensis* and *I. arrecta* were ranked to possess strong grain protectant effect. Three of the studied botanicals, *L. welwitschii, X. parviflora* and *C. ciliata* were ranked to possess fairly strong grain protectant effect; while only one (*Laggera aurita)* was ranked to be weak in its grain protectant potential. Seed damage varied significantly with the botanicals used (2.10 - 41.20%), but generally lower in the botanical-treated seeds compared to the untreated control (98.28%). The most effective powders were *A. toxicaria* (2.10%), *H. opposita* (2.68%) *A. indica* (3.05%), *E. senegalensis* (5.94%) and *A. secundiflorum* (7.59%). The least effective botanical was *L. aurita* (with 41.32% PSD) (Fig. I).

According to Fatope et al. (1995), of the various screening procedures available, the cowpea bruchid bioassay is the most convenient for general use in the laboratory. A BPI value of 50 shows that equal amounts of botanical-treated and untreated cowpea seeds were perforated. This bioassay procedure thus allows plant materials with strong, weak or negative grain protectant effects to be identified, irrespective of their mode of action. In this study, all the tested botanicals showed varying levels of protection potentials of cowpea seeds against *C. maculatus*. BPI value of ≤ 15 is good and considered to be a strong effect. The low BPI values obtained from the seed treated with *A. toxicaria, A. indica* and *H. opposita,* made them good candidates for further study towards establishment of their bioactivity against *C. maculatus*. Earlier studies on the insecticidal potentials of *A. indica* against *C. maculatus* were on its seeds (Lale & Mustapha, 2000; Tofel et al., 2016), known to possess azadirachtin. This work examines the insecticidal potentials of the leaves. The study of Cepeda Palacios et al. (2014) reported the bioactivity of the neem leaves against insect. Based on their results, we included the leaf to investigate its bioactivity against the cowpea seed bruchid. Of the ten species assayed at 10-30% w/w by Fatope et al. (1995), *Hyptis suaveolens* (Labiatae) and *Spenoclea zeylanica* (Sphenocleceae) were the only ones with a BPI value of < 15 when the botanical powders were assayed at 10% w/w. The result from this study where the BPI of the majority of the tested materials was < 15 suggests that the majority of the plants have cowpea protectant potentials against the bruchid. The result of this study agrees with previous authors on the efficacy of botanical powders in controlling *C. maculatus* (Ileke & Bulus, 2012; Ojo & Ogunleye, 2013; Tefsu & Amana, 2013).

Plant species with lower PSD had lower BPI. *Xylopia parviflora* had a BPI of 15.76, despite the fact that some members of its family (Annonaceae) had been reported to be insecticidal against stored product pests (Babarinde et al., 2008; Babarinde & Adeyemo, 2010; Akinyemi et al., 2016; Babarinde et al., 2017). Similar report exists for another member of Annonaceae family (*Annona senegalensis)* included in Fatope et al. (1995), that was not effective in the protection of cowpea seeds against *C. maculatus*. The insecticidal properties of Meliaceae against *C. maculatus* has been reported by Babarinde and Ewete (2008). However, this is the first report of *A. toxicaria* (Family Moraecea), for its pesticidal potentials against stored product insect. The fact that the powders showed protectant ability justifies their recommendation for local farmers who may not have the technicality of essential oil extraction or production of inorganic extracts.

CONCLUSION

Majority of the screened species showed insecticidal potentials against bruchids. Since the formulation investigated in this study was powder, it is necessary to investigate other formulations like organic and inorganic extracts and essential oil. Also, their modes of action and bioactive ingredients should be well studied as prerequisites to the understanding of their mechanism of actions and the production of synthetic products from the species.

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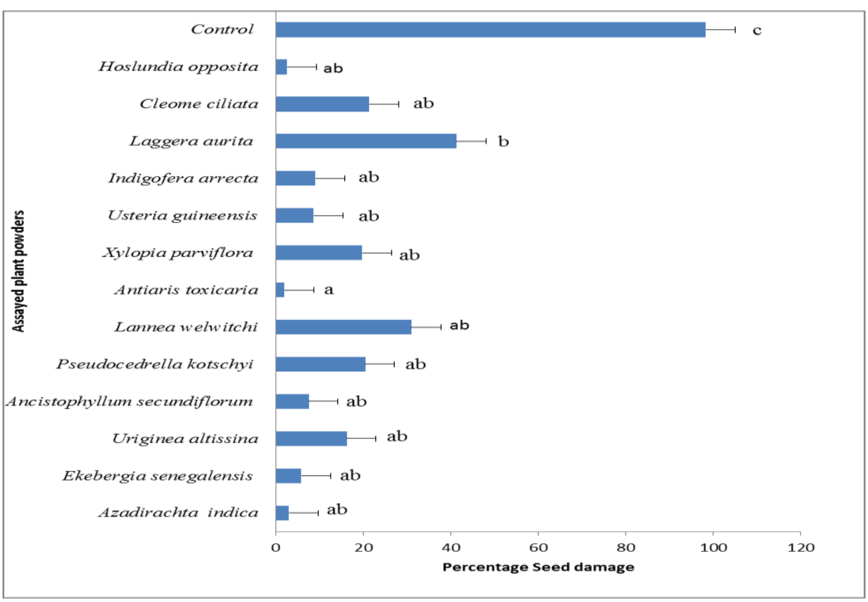

Figure I. Percentage seed damage by *Callosobruchus maculatus* of cowpea seeds treated with selected plant powder {Number of replicates = 6; ANOVA Result: F = 9.929; d f =13, 70; p<0.0001}.

Table 1. List of the thirteen plant species screened for insecticidal properties against *Callosobruchus maculatus*.

Plant species	Common name	Family	Part used	Bioactivity information	Point of collection
Azadirachta indica	Neem	Meliaceae	Leaf	Medicinal, insecticidal	Ogbomoso
Ekebergia senegalensis	Stavewood	Meliaceae	Leaf	Antibacterial	Ibadan
Urginea altissima	Tall squill	Liliaceae	Leaf	Medicinal	Ibadan
Ancistrophyllum secundiflorum	Large Benin rattan	Arecaceae	stem bark	Chewing stick	Ogbomoso
Pseudocedrela kotschyi	Cedar mahogany	Meliaceae	root bark	Antibacterial, chewing stick,	Ogbomoso
Lannea welwitschii	Kumbi	Anacardiaceae	Leaf	Antibacterial, medicinal, furniture	Ibadan
Antiaris toxicaria	False iroko	Moraceae	Stem bark	Insecticidal, medicinal	Ibadan
Xylopia parviflora	Bushveld bitterwood	Annonaceae	root bark	Medicinal, Chewing stick	Alapa-Ilorin
Usteria guineensis	-	Loganiaceae	Aerial	Medicinal	Akure
Indigofera arrecta	Indigo	Papilonaceae	Leaf	Dye production	Ogbomoso
Lagerra aurita	Laggera	Asteraceae	leaf	Antibacterial, insecticidal	Ogbomoso
Cleome ciliata	Wild mustard	Capparaceae	seed	Green manure, vegetable	Ogbomoso
Hoslundia opposita	Hoslundia	Lamiaceae	Leaf	Medicinal, insecticidal	Ilorin

Table 2. Cowpea grain protectant potentials of the selected botanicals against *Callosobruchus maculatus* using Bruchid Perforation Index.

Plant powder	Bruchid Perforation Index	Grain Protectant Potentials*
Azadirachta indica	2.95±.1.05a	Very strong
Ekebergia senegalensis	5.57±1.48ab	Strong
Uriginea altissina	13.25± 3.78ab	Strong
Ancistophyllum secundiflorum	6.88 ± 2.45ab	Strong
Pseudocedrella kotschyi	12.51 ± 7.71ab	Strong
Lannea welwitchi	16.48 ± 10.04ab	Fairly strong
Antiaris toxicaria	2.07 ±0.76a	Very strong
Xylopia parviflora	15.76 ±3.97ab	Fairly strong
Usteria guineensis	7.76 ± 2.79ab	Strong
Indigofera arrecta	7.66 ± 3.67ab	Strong
Laggera aurita	26.46 ± 6.75b	Weak
Cleome ciliata	17.30 ± 3.16ab	Fairly strong
Hoslundia opposita	2.64 ± 0.37a	Very strong
ANOVA Results	F=2.586; df=12, 65; p=0.007	

Means followed by same alphabet along a column are not significantly different from one another using Tukey's HSD test (p<0.05).
*BPI of < 15 depicts a strong grain protectant effect {Adapted with modification from Fatope et al. (1995)}

A SEM STUDY ON AEDEAGUS AND SPERMATHECA OF *CASSIDA SERAPHINA* MÉNÉTRIES, 1836 (COLEOPTERA: CHRYSOMELIDAE: CASSIDINAE) FROM TURKEY

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[Ataş, F., Özdikmen, H., Bal, N., Amutkan Mutlu, D. & Suludere, Z. 2019. A SEM study on aedeagus and spermatheca of *Cassida seraphina* Ménétries, 1836 (Coleoptera: Chrysomelidae: Cassidinae) from Turkey. Munis Entomology & Zoology, 14 (2): 395-411**]**

ABSTRACT: The paper presents ultrastructures observed by SEM of aedeagus and spermatheca of *Cassida seraphina* Ménétries, 1836 (Coleoptera: Chrysomelidae: Cassidinae) from Turkey for the first time. Male genitalia are not diagnostic, spermathecae are partly diagnostic within the genus *Cassida* Linnaeus, 1758. Accordingly, ultrastructural investigations of aedeagus and spermatheca are very important to obtain new diagnostic characters in the genus *Cassida*. Photos of aedeagus and spermatheca in SEM as weel as photos of aedeagus and spermatheca in stereo microscope are also given in the text.

KEY WORDS: *Cassida seraphina*, SEM, ultrastructures, aedeagus, spermatheca, Turkey

Cassida seraphina Ménétries, 1836 is in the subgenus *Alledoya* Hincks, 1950 of the genus *Cassida* Linnaeus, 1758 (Chrysomelidae: Cassidinae).

The Cassidinae fauna of Turkey includes 51 species of 6 genera. The genus *Cassida* Linnaeus, 1758 numbers 41 species (Ekiz et al., 2013; Özdikmen et al., 2014; Özdikmen & Kaya, 2014).

The Western Palaearctic subgenus *Alledoya* Hincks, 1950 numbers only two species. It includes both species in Turkey as *Cassida seraphina* Ménétries, 1836 and *Cassida hablitziae* Motschulsky, 1838 (Ekiz et al., 2013; Özdikmen et al., 2014; Özdikmen & Kaya, 2014).

The aim of this work, ultrastructures observed by SEM of aedeagus and spermatheca of *Cassida seraphina* Ménétries, 1836 (Coleoptera: Chrysomelidae: Cassidinae) from Turkey reveal for the first time.

MATERIAL AND METHODS

The available specimens (a total of 119 specimens) for the present work were collected from Ankara, Düzce and Çankırı provinces in Turkey in 2000, 2003, 2014, 2015. The specimens are deposited at Gazi University (Turkey, Ankara).

The spermathecae and aedeagi were dissected from abdomen, remaining tissue were removed with fine tweezers.

For light microscopic examination after cleaning, the samples were placed 70% ethanol and examined with Olympus SZX7 stereomicroscope.

For scanning electron microscopy (SEM), cleaned samples were dehydrated using an ascending series of ethanol (70%, 80%, 90%, and 100%) and then air dried. After that the specimens were mounted onto SEM stubs using a double-sided adhesive tape, coated with gold using a Polaron SC 502 Sputter Coater, and examined with a JEOL JSM 6060 Scanning Electron Microscope (SEM) at 10 kV.

RESULTS

***Cassida seraphina* Ménétries, 1836**
= *Cassida testudo* Suffrian, 1844

Cassida seraphina Ménétries, 1836 is a SW-Asiatic species. It is distributed in Armenia, Greece, South European Russia and Turkey of Western Palaearctic region (Borowiec, 2007a,b; Warchalowski, 2010; Borowiec & Sekerka in Löbl & Smetana (2010)).

The species is rather widely distributed in Turkey. It has been recorded from 25 provinces in 6 of 7 Turkish regions except for South-East Anatolian region. It is reported from Amasya, Ankara, Antalya, Balıkesir, Bilecik, Bolu, Burdur, Bursa, Çankırı, Çorum, Düzce, Erzurum, Eskişehir, Isparta, İstanbul, İzmir, Kastamonu, Kırşehir, Konya, Kütahya, Sakarya, Samsun, Sivas, Tokat and Uşak provinces in Turkey (Ekiz et al., 2013; Özdikmen & Kaya, 2014).

Material examined: Turkey, Ankara prov.: Eryaman, 01.V.2000, 850 m, 1 specimen; **Düzce prov.:** Karakaş env., to Yedigöller, 12.V.2003, 510 m, 1 specimen; **Çankırı prov.:** Kızılırmak, between Kemallı-Halaçlı villages, 40˚18' N 33˚58' E, 24.IV.2014, 608 m, 1 specimen; Kızılırmak, entry of Aşağıovacık village, 40˚26' N 33˚53' E, 25.IV.2014, 576 m, 1 specimen; Şabanözü, entry of Kamış village, 40˚33' N 33˚20' E, 23.V.2014 and 09.V.2015, 1208-1221 m, 100 specimens; Kurşunlu, 4 km to Dağören, 40˚48' N 33˚16' E, 10.V.2015, 1110 m, 1 specimen; Çerkeş, entry of Gelik district, 40˚50' N 32˚55' E, 20.VI.2015, 1318 m, 1 specimen; Çerkeş, between Cedine-Kabakköy, 40˚53' N 32˚55' E, 20.VI.2015, 1355 m, 1 specimen; Bayramören, entry of Dereköy, 41˚1' N 33˚14' E, 21.VI.2015, 1048 m, 1 specimen; Şabanözü, exit of Kamış village (Maruf road), 40˚33' N 33˚20' E, 28.VI.2015, 1217 m, 11 specimens.

According to Bordy & Doguet (1987), Borowiec & Świętojańska (2001) and Borowiec (2007a), male genitalia are not diagnostic within the genus *Cassida* Linnaeus, 1758. Spermathecae in the genus *Cassida* are partly diagnostic. With this reason, ultrastructural investigations of aedeagus and spermatheca are very important in the genus *Cassida*.

Aedeagus and spermatheca of *Cassida seraphina* Ménétries, 1836 were studied with both stereo microscope and SEM for the first time. Obtaining observations on ultrastructures of them are presented as follows:

Aedeagus: In lateral view, median lobe distinctly curved median foramen to apex. More or less sharpened towards to apex (Figs. 1, 3, 4, 15).

In dorsal view, median lobe at the apex curved to backward and so apex seems like truncated (Figs. 1, 10, 11, 15-17, 19-20). Upper and lateral margins of orifice more or less rounded (Figs. 1, 10, 15-17, 19-20). Dorsal plate distinct and largish bipartite basally (Figs. 1, 10, 15-17, 19-20). Median lobe in lateral parts and fore part of orifice thickened. Thickening in lateral parts smaller than the fore part (Figs. 1, 10, 15-20). Median lobe behind the orifice more or less flattened (Figs. 1, 15-17, 19-20). Flattened part closed V-shaped basally (Figs. 1, 15, 19).

Median lobe especially in anterior half with scattered, irregular and sparsely ultrastructural pits (Figs. 6-9, 12-14, 16-20). The pits on ventral parts of median lobe much more than on dorsal parts (Figs. 6-10, 13-14, 16-20). The pits located only in lateral parts of terminal part of median lobe in dorsal view (Figs. 7-9, 16-20). Dorsal plate and flattened area behind it without ultrastructural pits in dorsal view (Figs. 15-17, 19-20). Also the terminal area from upper margin of orifice to aedeagal apex without ultrastructural pits in dorsal view (Figs. 10-11).

Spermatheca: General view of spermatheca falcate like a fish hook (Figs. 2, 21). Cornu C-shaped. Cornu gradually narrowed towards to apex and apex of cornu strongly sharpened (Figs. 2, 21). Nodulus swollen like a thigh (Figs. 2, 21-23, 34). Collum + ramus reduced and hardly visible (Figs. 2, 21-25, 30-32). Ductus spermatheca long, thick and distinctly spiral (Figs. 2, 21-24, 26). Nodulus, cornu, collum + ramus and spermathecal gland with scattered, irregular and sparsely ultrastructural pits (Figs. 28-29, 31-33, 35-37, 39-41). Ductus spermatheca without ultrastructural pits (Figs. 26-27).

Note: This work is based on a part of the Master Thesis of the first author.

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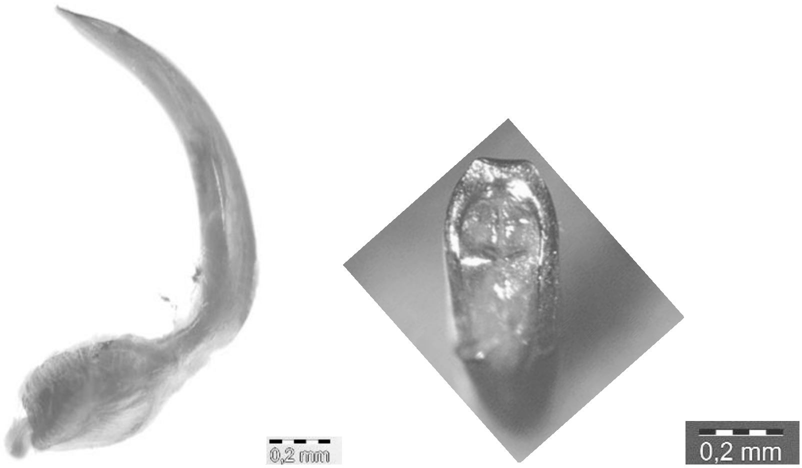

Figure 1. Aedeagus in streo microscope, Lateral view (left), Dorsal view (right).

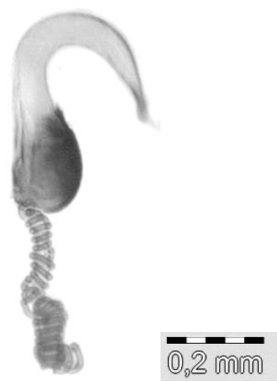

Figure 2. Spermatheca in streo microscope, Lateral view.

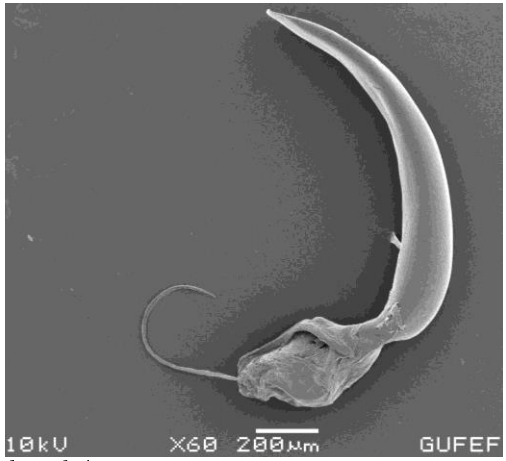

Figure 3. Aedeagus, lateral view.

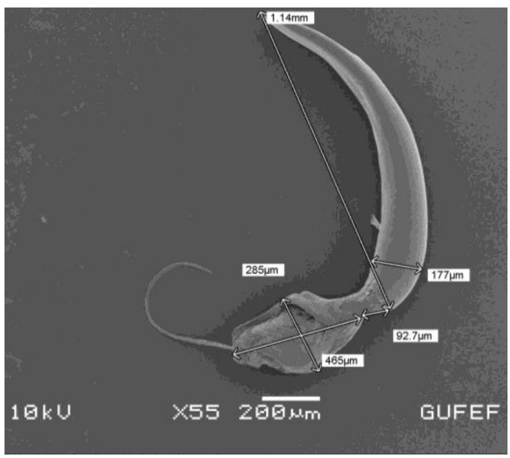

Figure 4. Aedeagus, lateral view.

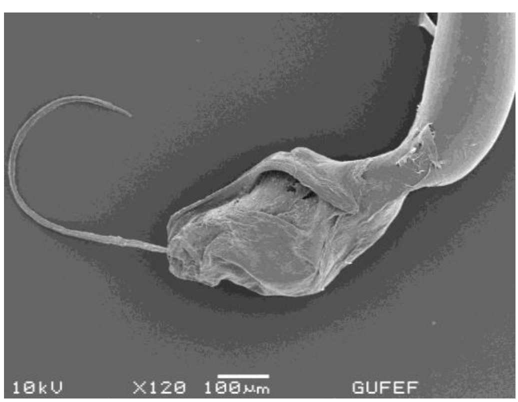

Figure 5. Aedeagus, lateral view of basal part.

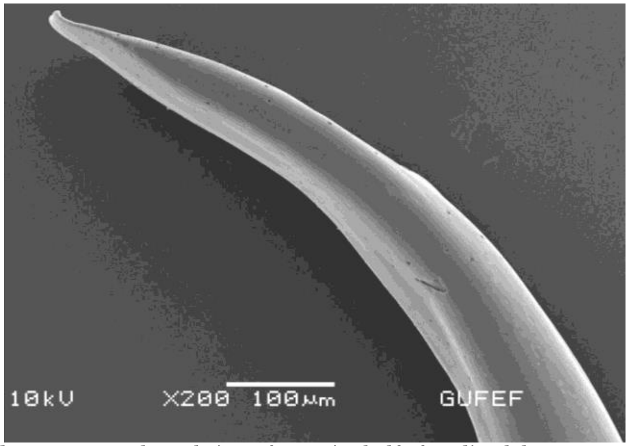

Figure 6. Aedeagus, ventro-lateral view of anterior half of median lobe.

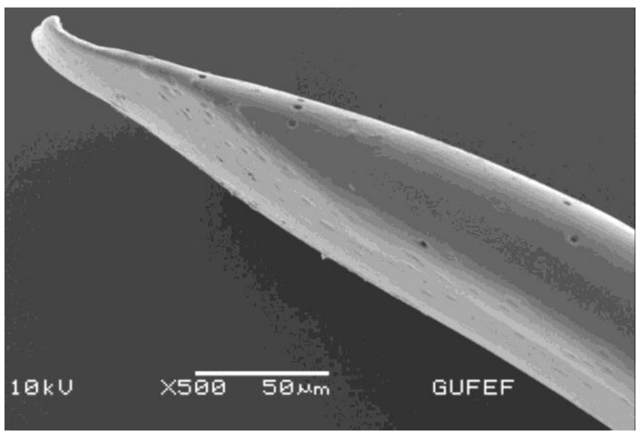

Figure 7. Aedeagus, ventro-lateral view of terminal part of median lobe.

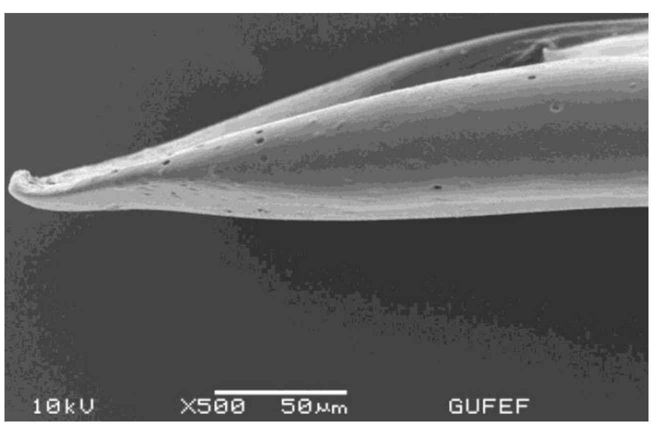

Figure 8. Aedeagus, lateral view of terminal part of median lobe.

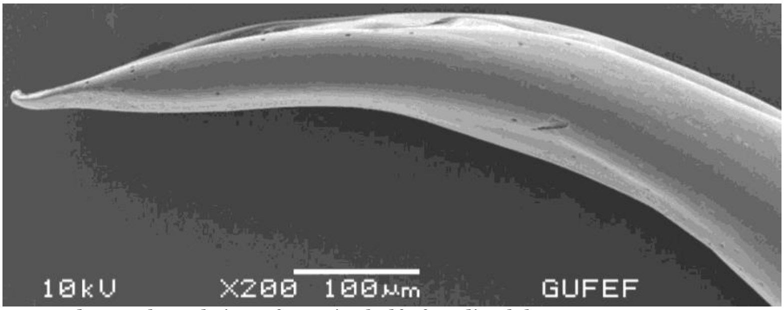

Figure 9. Aedeagus, lateral view of anterior half of median lobe.

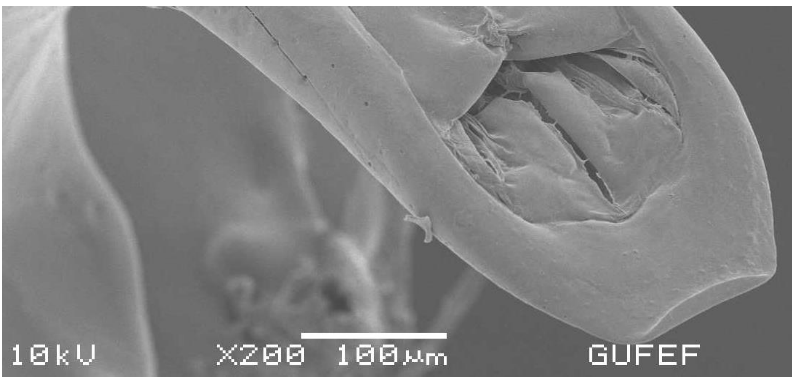

Figure 10. Aedeagus, dorsal view of terminal part of median lobe.

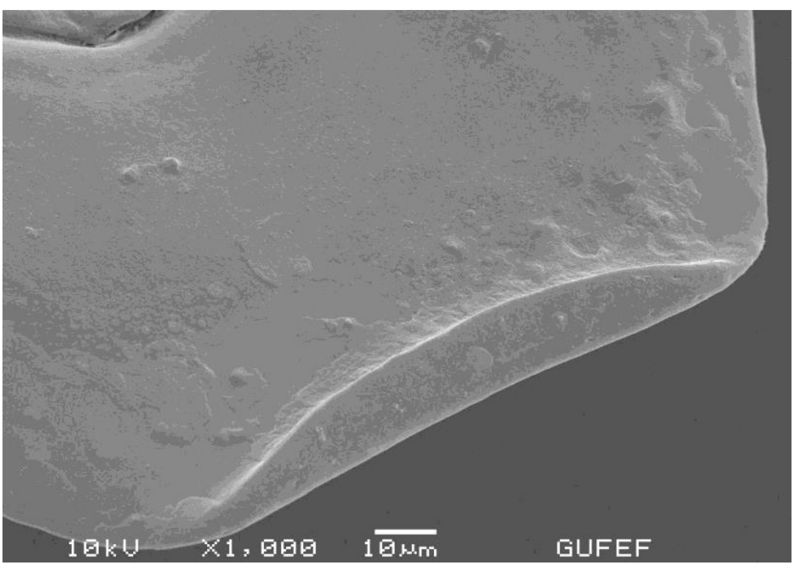

Figure 11. Aedeagus, dorsal view of flexure at apex of median lobe.

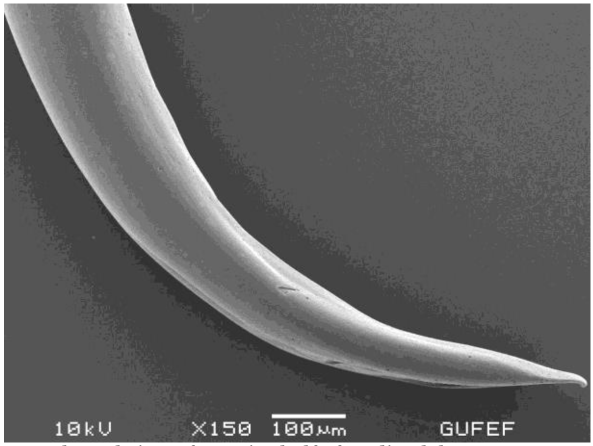

Figure 12. Aedeagus, lateral view of anterior half of median lobe.

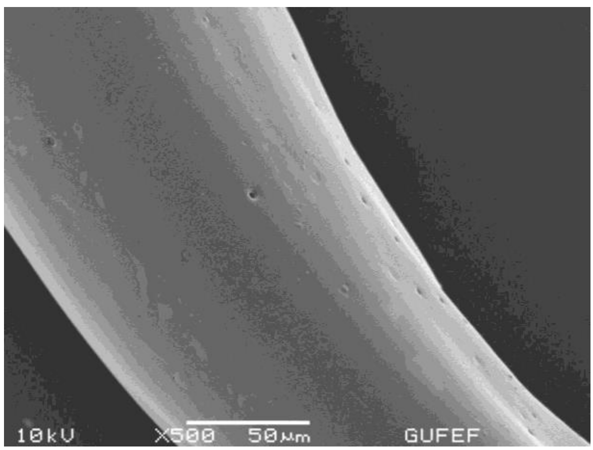

Figure 13. Aedeagus, the pits in ventro-lateral view of median lobe.

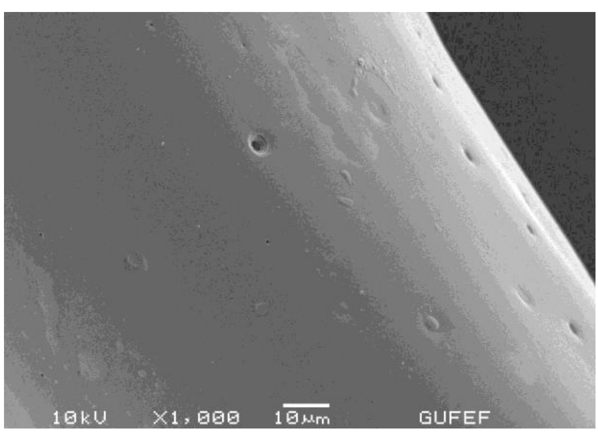

Figure 14. Aedeagus, the pits in ventro-lateral view of median lobe.

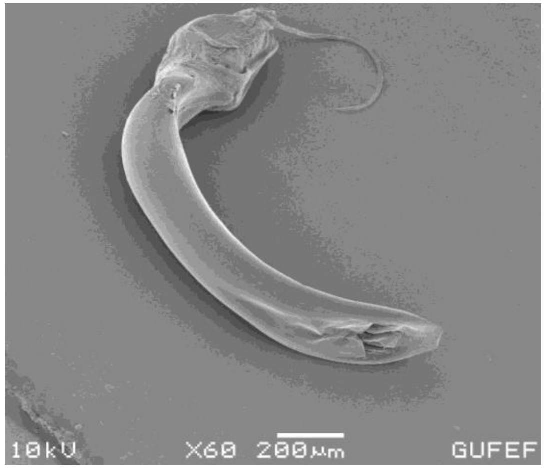

Figure 15. Aedeagus, dorso-lateral view.

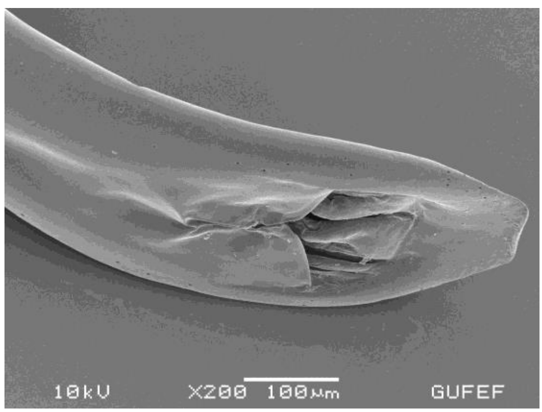

Figure 16. Aedeagus, dorsal view of terminal part of median lobe.

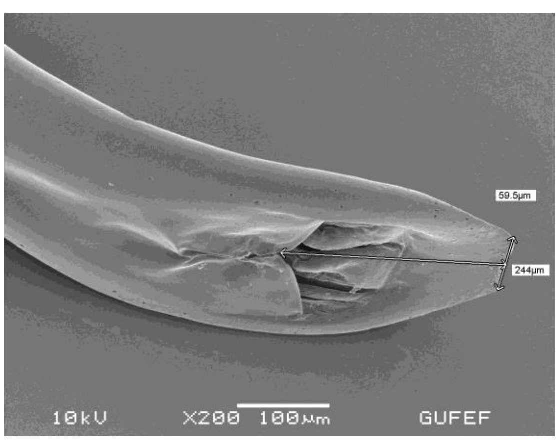

Figure 17. Aedeagus, dorsal view of terminal part of median lobe.

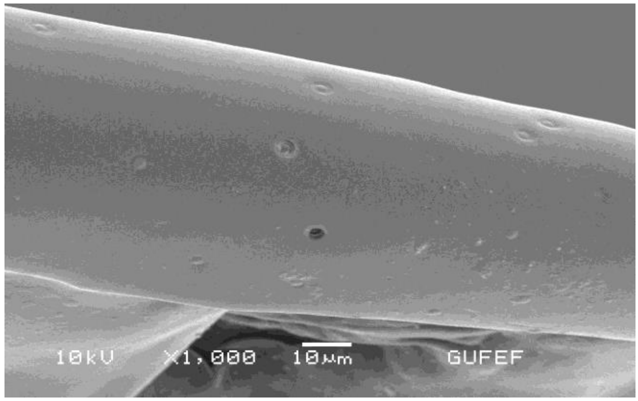

Figure 18. Aedeagus, the pits on lateral part of terminal part of median lobe in dorsal view.

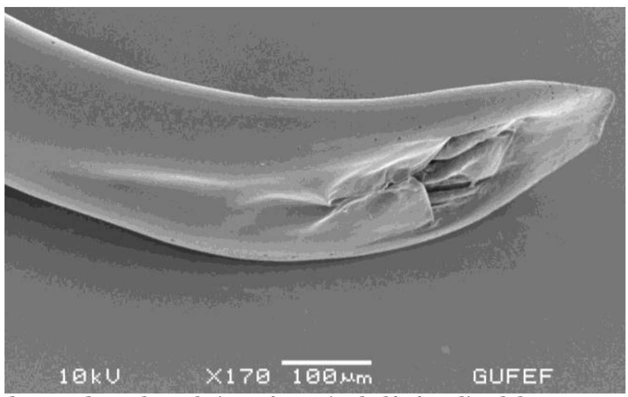

Figure 19. Aedeagus, dorso-lateral view of anterior half of median lobe.

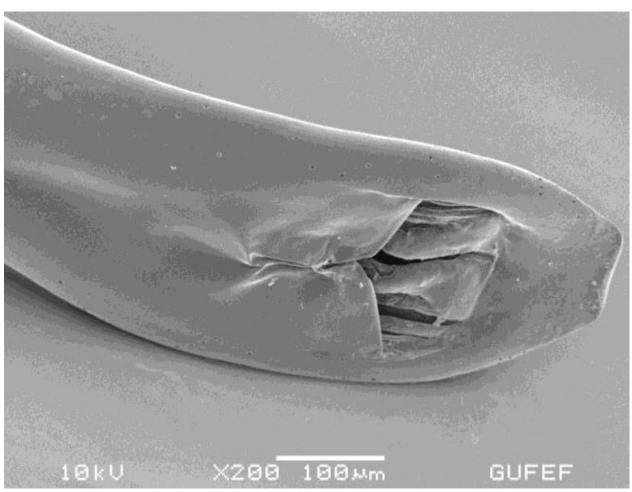

Figure 20. Aedeagus, dorsal view of terminal part of median lobe.

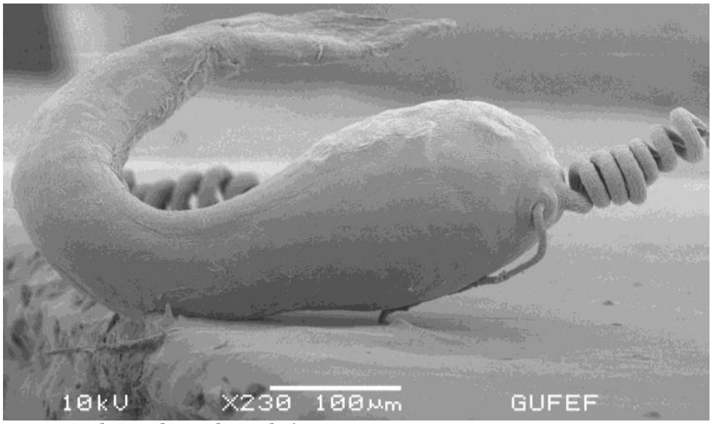

Figure 21. Spermatheca, dorso-lateral view.

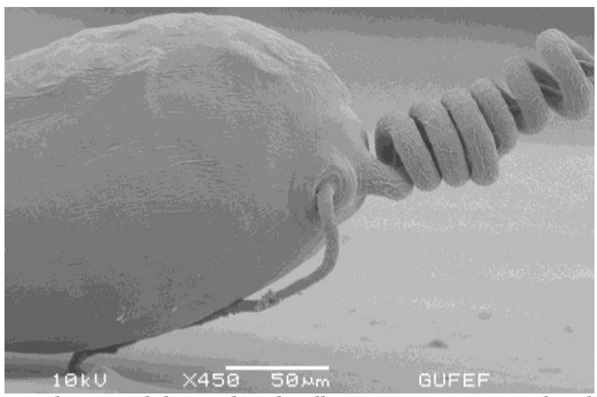

Figure 22. Spermatheca, nodulus, reduced collum + ramus, spermathecal gland, ductus spermatheca.

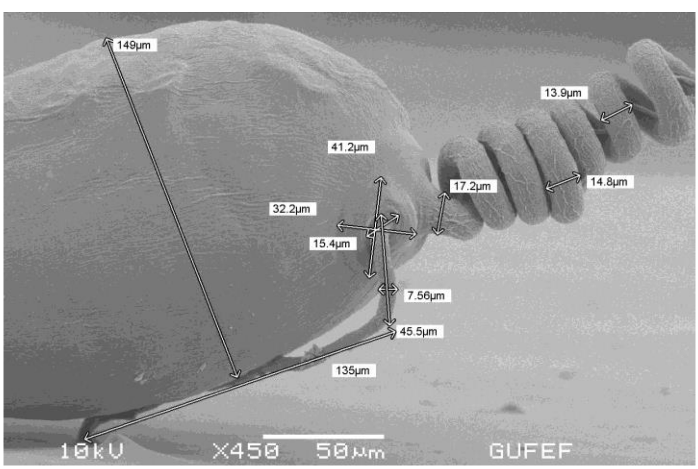

Figure 23. Spermatheca, nodulus, reduced collum + ramus, spermathecal gland, ductus spermatheca.

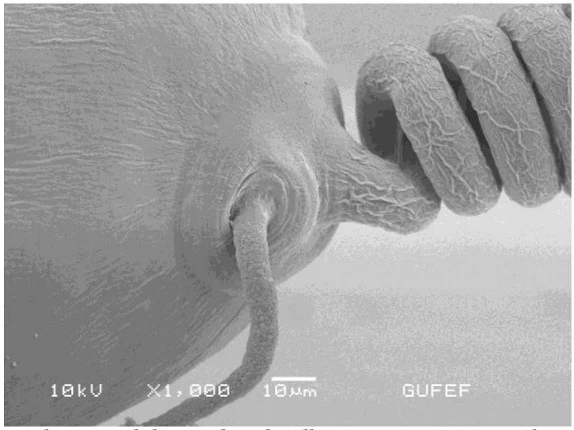

Figure 24. Spermatheca, nodulus, reduced collum + ramus, spermathecal gland, ductus spermatheca.

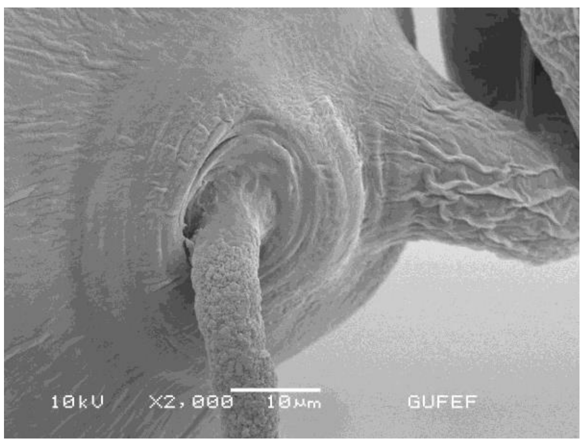

Figure 25. Spermatheca, reduced collum + ramus, spermathecal gland, ductus spermatheca.

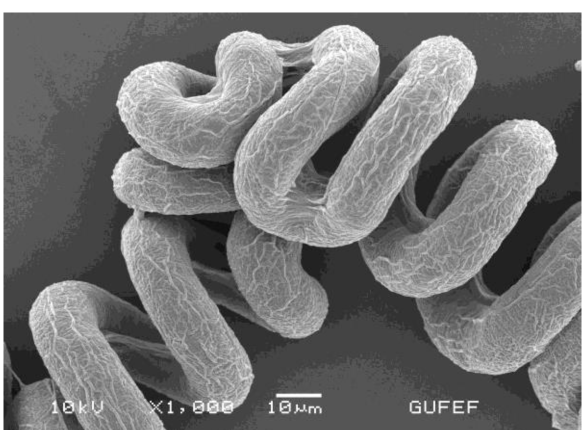

Figure 26. Spermatheca, ductus spermatheca.

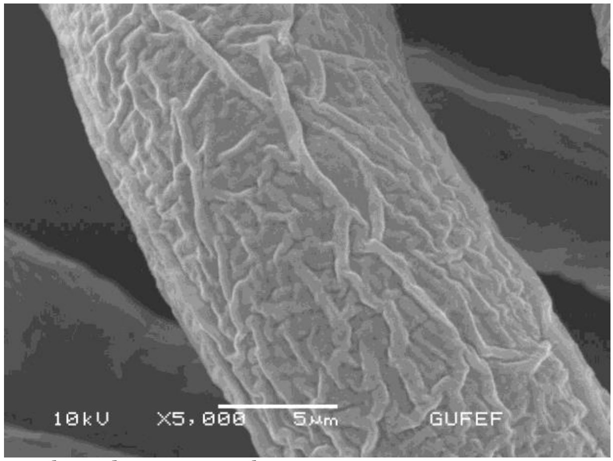

Figure 27. Spermatheca, ductus spermatheca.

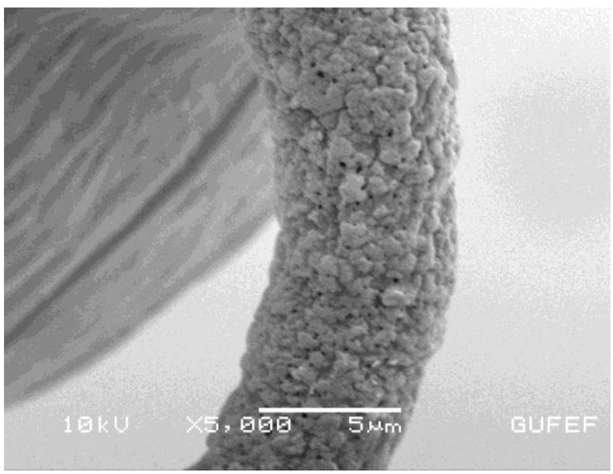

Figure 28. Spermatheca, pits on spermathecal gland.

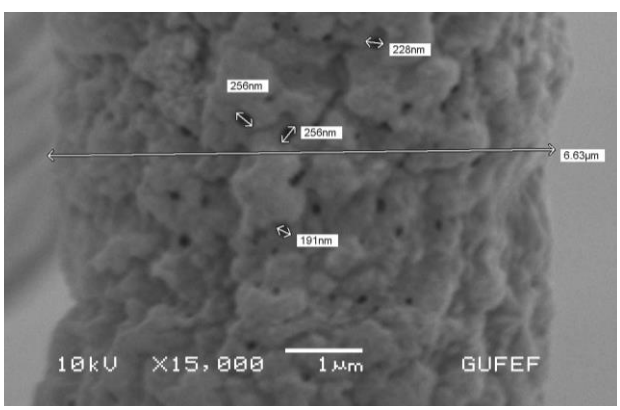

Figure 29. Spermatheca, pits on spermathecal gland.

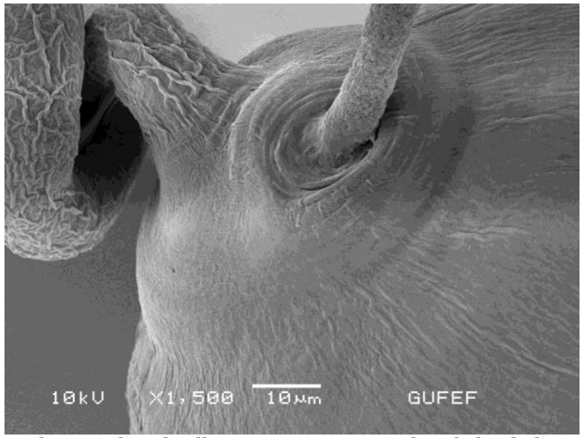

Figure 30. Spermatheca, reduced collum + ramus, spermathecal gland, ductus spermatheca.

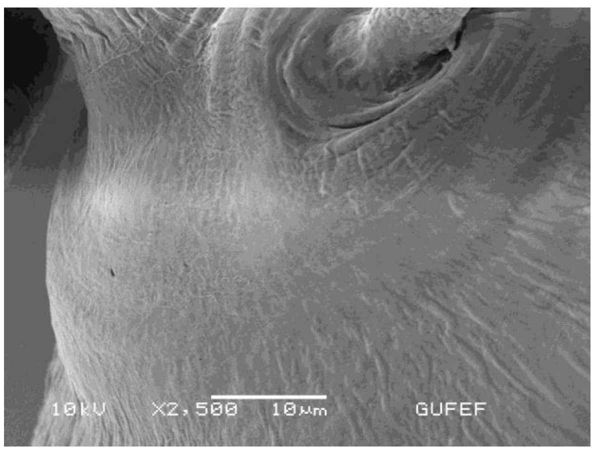

Figure 31. Spermatheca, pits on reduced collum + ramus.

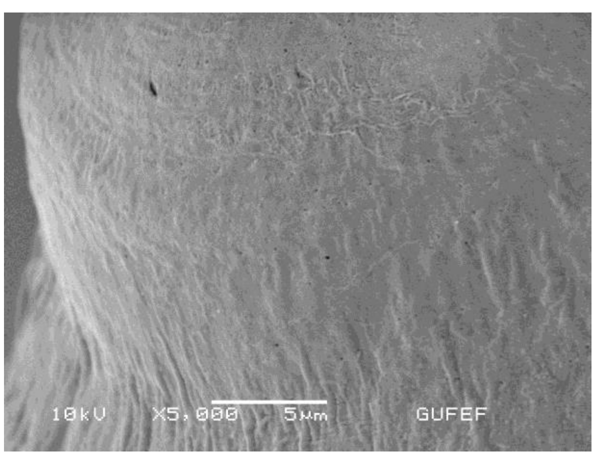

Figure 32. Spermatheca, pits on reduced collum.

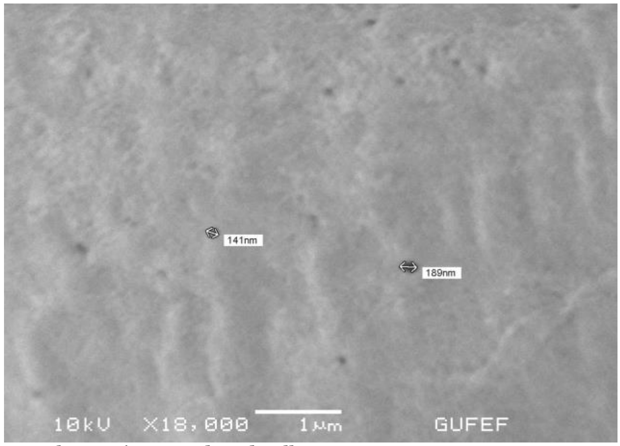

Figure 33. Spermatheca, pits on reduced collum.

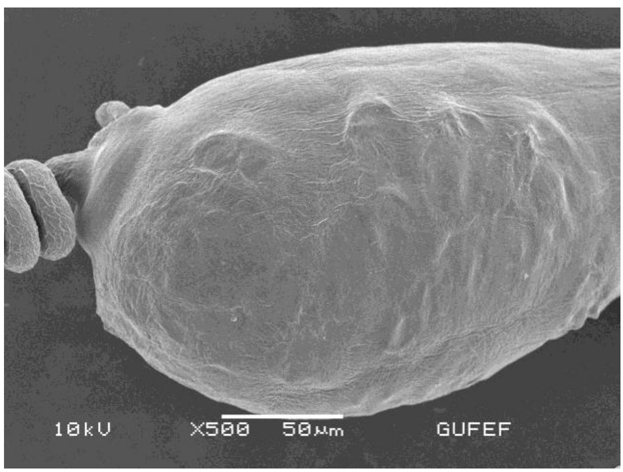

Figure 34. Spermatheca, nodulus.

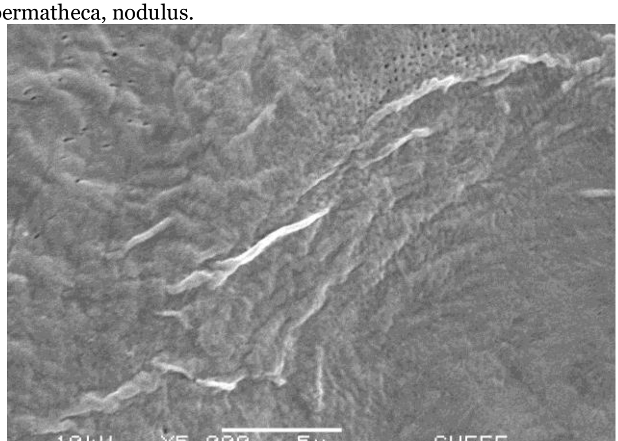

Figure 35. Spermatheca, pits on nodulus.

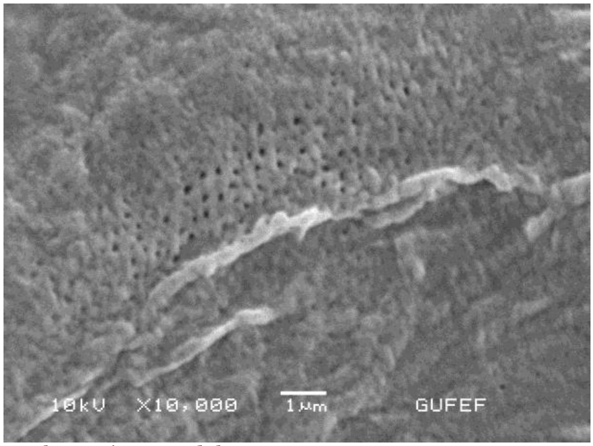

Figure 36. Spermatheca, pits on nodulus.

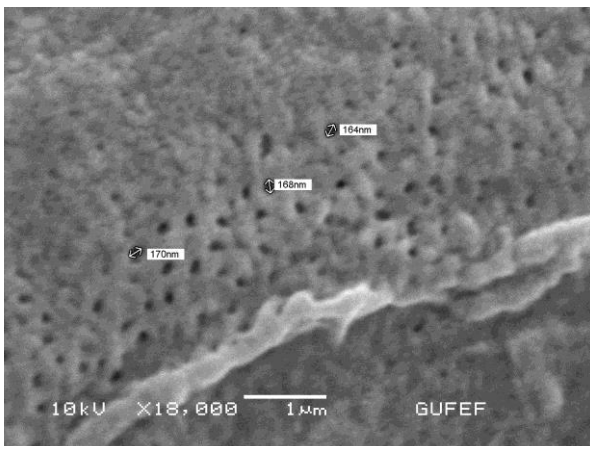

Figure 37. Spermatheca, pits on nodulus.

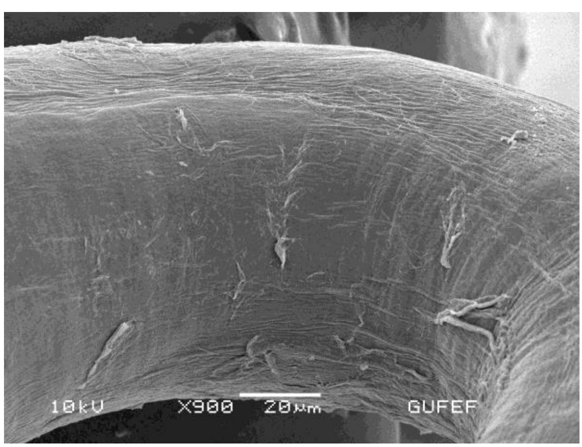

Figure 38. Spermatheca, cornu.

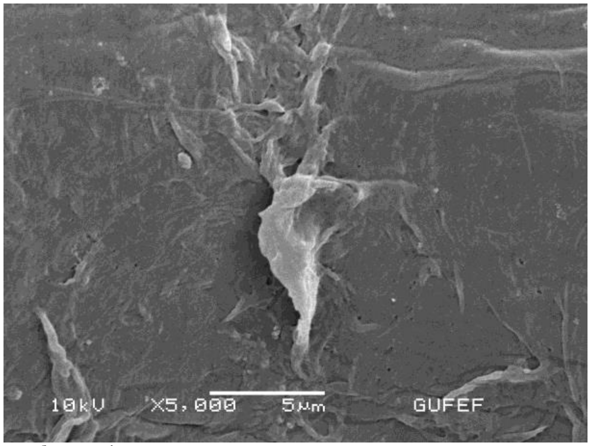

Figure 39. Spermatheca, pits on cornu.

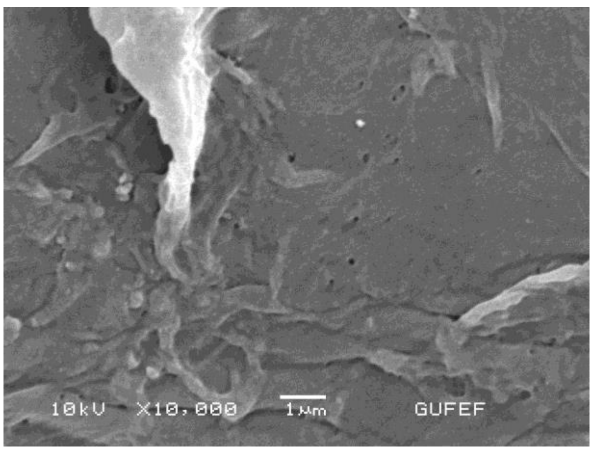

Figure 40. Spermatheca, pits on cornu.

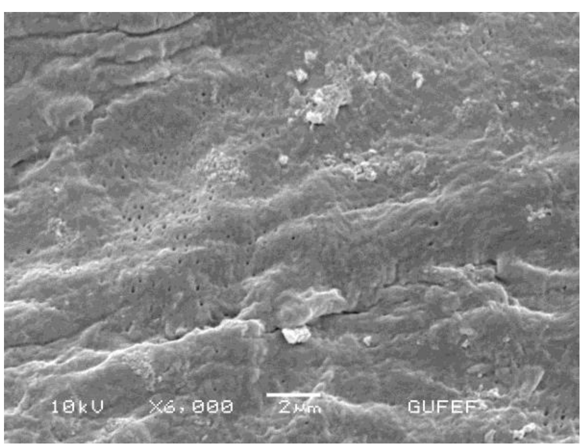

Figure 41. Spermatheca, pits on apical part of cornu.

NEW DISTRIBUTIONAL RECORDS OF ROBBER FLIES (INSECTA: DIPTERA: ASILIDAE) FROM THE DARJEELING HIMALAYA OF WEST BENGAL

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ABSTRACT: Eight species namely *Ommatius jonesi* Joseph & Parui, 1985; *Promachus maculatus* (Fabricius, 1775); *Machimus bicolor* Joseph & Parui, 1985; *Machimus indianus* Ricardo, 1919; *Machimus inutilis* Bromley, 1935; *Trichomachimus himachali* Parui, Kaur & Kapoor, 1999; *Trichomachimus pubescens* (Ricardo, 1922) and *Stenopogon subtus* (Bromley, 1935); belonging to five genera *viz*., *Ommatius* Wiedemann, 1821; *Promachus* Loew, 1848; *Machimus* Loew, 1849; *Trichomachimus* Engel, 1933 and *Stenopogon* Loew, 1847; of three subfamilies Ommatini, Asilinae and Stenopogoninae, are recorded for the first time from the Himalayan and sub-himalayan region of West Bengal, are listed, keyed, and discussed. Distribution pattern is also included wherever deemed necessary, along with morphology and methodology in aid of understanding the flies of family Asilidae.

KEY WORDS: Taxonomy, Asilidae, new records, Darjeeling Himalaya, West Bengal

Biodiversity or Biological Diversity plays a most crucial role in ecosystem functioning (Chapin et al., 1998; Tilman, 1999; Naeem, 2002; Ives et al., 2005). The diversity response to several ecological process for maintaining the ecosystem stability. The stability of populations and critical ecosystem process is the main phenomenon in community ecology. The most important ecological process is prey-predator relationship, where a single species or multiple species by changing the strength of its interaction with co-existing species affect the ecosystem function. Moreover, the pattern and strength of species interactions determine the stability of populations and food webs (May, 1973; De Ruiter et al., 1998; Neutel et al., 2002, 2007; Emmerson & Yearsley, 2004; Brose, 2010; Rall, 2010).

Robber flies or assassin flies (Insecta: Diptera: Asilidae), are an important group of predators in all zoogeographical regions. Asilidae comprises of approximately 7187 species (Geller-Grimm et al., 2015) belong to 776 genera (Dikow, 2016) distributed throughout the world and therefore is one of the most speciose family taxa among the Diptera or 'true flies' (Dikow, 2009). Robber flies are predatory, generally catching prey insects on the wing; they are distributed worldwide, with the exception of Antarctica (Bosák & Barták, 2000). The robber flies are most diverse in warm and arid regions, with species numbers rapidly decreasing toward the tropics and the temperate regions (Lyneborg, 1965). Adult Asilidae prey on multiple other insect orders and spiders (Wood, 1981; Dennis & Lavigne, 2007).

This predaceous mode of life is reflected in the distinctive morphology of the adults, which can be used to identify the family (Lyneborg, 1965). Especially conspicuous are the eyes, which are separated by the sunken vertex and provide forward- and backward- as well as stereoscopic vision. When prey is detected it is seized by the legs, which are unusually long, robust and usually covered with bristles and hairs. As diagnostic for the family as the eyes is the so-called mystax, which consists of hairs and bristles that are found in the middle of the face and are thought to protect the eyes from struggling prey. The mystax extends in some cases to the antennal bases and is often found on a protuberance (Wood, 1981). The victims of Asilidae are mostly insects, which are paralyzed by a neurotoxin injected through the hypopharynx (Geller-Grimm, 2003). The liquefied content of the victim is then imbibed through the proboscis of the predator (Geller-Grimm, 2003).

Asilidae, like most Diptera of the infraorder Asilomorpha, has stages like the egg, three free living larval instar, a pupa inside a puparium (the contracted and hardened integument of the mature third instar lara) and the adult. The phenology of the Asilidae in general is poorly known (Lyneborg, 1965). Information about the early immature stages exists only for 16 species (Musso, 1981) and complete life-cycle descriptions are restricted to four species: *Promachus yesonicus* Bigot, 1887, *Mallophora ruficauda* (Wiedemann, 1828), *Mallophora media* Clements & Bennett, 1969, and *Machimus rusticus* (Meigen, 1820) (Musso, 1981). Larvae of many genera live in soil while those of the Laphriinae and Laphystiinae usually occur in decaying logs and stumps, where they are predators of the larvae and pupae of other insects (Geller-Grimm, 2003). Much literature on the biology of immature Asilidae is related to their importance as predators (Larsen & Meier, 2004).

As Asilds are able to exploit a wide variety of prey, as a result they can respond to fluctuations in the relative abundances of alternative prey and occupy habitats with different prey communities (O'Neil et al., 1992). Populations of such predators may appear to be specialists if they switch to near exclusive use of the most abundant prey type (Mccravy & Baxa, 2011). Due to their habitat specialization and role as top insect predators, robber flies are becoming increasingly important as a group of special conservation concern (Barnes et al., 2007). The specialized habitat associations of some species may also make them valuable as bio-indicators (Van Veen & Zeegers, 1998).

Despite this high value as a bio-indicators, taxonomic studies on the family Asilidae are not sufficiently advanced, and the family is considered one of the least studied in Diptera and neglected as subject of interest (Geller-Grimm et al., 2015). As a result, details systematic studies of this group is essential to maintain biodiversity and to be able to react to climate change.

On the other hand, by many measures of biodiversity, the eastern Himalayas Region stands out as being globally important. It has been included among Earth's biodiversity hotspots (Myers et al., 2000) and includes 200 global ecoregions (Olson and Dinerstein, 1998). Several factors contribute to the exceptional biological diversity of the eastern Himalayas. The eastern Himalayas has multiple biogeographic origins. Its location at the juncture of two continental plates places it in an ecotone represented by flora and fauna from both. But unfortunately, most of the available recent studies of geographic distribution and occurrence of Asilid fauna in India had been focused on the southern, Western and northern region (Joseph & Parui, 1987a). Different taxonomist who has done research of immense importance about robber flies from this area are Macquart, 1838 followed accordingly by Lal, 1960; Joseph & Parui, 1983, 1986a,b,c, 1987b,c,d,e,f,g. As per the knowledge is concern there are very scatter studies conducted in the eastern Himalayan regions (Joseph & Parui, 1983). All the studies are hundred or more than hundred or near to hundred years old. Therefore a thorough study is essential to understand the real scenario of the top level predator and a potential bio-indicator species of robber flies from this area to react to climate change and maintain biodiversity.

With an aim to study the taxonomy of predator robber flies from this vast region of Eastern Himalaya, Himalayan and Sub-himalayan region of West Bengal was chosen as the representative study area. The Himalayan and Sub-himalayan region comprises of three district of West Bengal, mainly in the Darjeeling District, which comprises of the 'Darjeeling Himalaya', falling under Eastern Himalaya and the Himalayan foot hills and also in the Alipurduar and Jalpaiguri district, which mainly consists of the Terai region or Sub-Himalaya region of West Bengal. This region houses a unique pattern in its annual climatic scenario as well as in vegetation and topographic fashion. Thus, this region is remarkably recognized for being the habitat locality of many asilid species (Joseph & Parui, 1983). The data on Indian Asilidae from his region was not updated and sufficient (Joseph & Parui, 1983). Moreover, stray survey had been done in this long period of time by different dipterists since the British era. However major contribution was lacking in the field of asilid fauna from the Himalayan and Sub-himalayan region of West Bengal. Consolidated information regarding asilid fauna was never be available from this region. Therefore, the present study is the first exhaustive study of the robber flies fauna from the Himalayan and Sub-himalayan region of West Bengal. Thus this study, includes a thorough survey of Asilidae fauna and represent the overall picture of this region. As it leads to the discovery of biodiversity including description of new asilid fauna of *Heligmonevra paruii* sp. nov. (Naskar et al., 2018). Therefore, it also depicts the extensive species richness of robber flies fauna from this region, that may help for future implementation of effective biological control and improvising better management plan to counteract occasional attack of several pest species in agricultural field to prevent economical loss.

MATERIALS AND METHODS

(i) Collection and Preservation

Flies belonging to the family Asilidae are found in diverse habitats and method for collecting them is also different. Asilids were collected from different habitats such as dense vegetation surrounding water bodies, agricultural fields in village patches, rocks and crevices around the riverine belt of high altitudinal landscape, long patches across the forest area etc.

The Asilidae are very agile and swift on wings. A little practice was needed in netting the adults with an ordinary insect net. The greatest number of individuals of different species could be intercepted with help of several trapping and baited trap methods and also by sweeping with regular insect net. Traps specially malaise trap, canopy trap etc. can also be known as most effective method to catch large amount of asilids in a short time with minimum effort. For night collection light trap is an essential method. After collecting samples were usually killed by exposing them to the killing jar filled with ethyl acetate or high dose chloroform. The procedure took just fraction of time, immediately after that the entomo-fauna were transferred to the special drying envelope for the dehydration purpose. Then those specimens were kept there until they were brought back to the lab (ZSI, HQ) for further identification purpose.

(ii) Identification and taxonomic studies

Diptera structurally comprises the most highly specialised members of the class Insecta. All the subfamilies, tribe, genera and species of family Asilidae followed the classification scheme of Dikow, 2009 for convenience. Taxonomic analysis of asilids were carried out by consulting available literature followed by comparison with authentically identified reference collection, on availability basis. Several taxonomic keys were used for identifying several species during taxonomic studies as followed earlier by Hardy (1948), Hull (1962), Geller-Grimm (2003), Dikow (2009), and Trautwein et al., (2010). Morphological terminology was followed recommended earlier in Manual of Nearctic Diptera (Wood, 1981). Terminology of the antennae was carried out from Hennig (1972), Stuckenberg (1999), and Dikow and Londt (2000), and terms pertaining to male terminalia were used from Sinclair et al. (1994).

After taxonomic identification of all individuals of each representing species, specimens along with their associated data were digitised and all the important taxonomic characters were recorded by taking photographs. The photographs of habitus and different body parts of Asilid fauna were taken using Leica stereo-iso microscope M205A coupled with a LEICA DFC 500 camera and software Leica Application Suite LAS V3.6 for digital image processing. Photos of the terminalia were captured using a LEICA EZ4 HD optical microscope. The entire collection afterwards were deposited in the National Repository of the Zoological Survey of India, Ministry of Environment, Forests and Climate Change, Kolkata.

RESULTS

Taxonomy

(i) List of taxa

ORDER: DIPTERA
SUBORDER: BRACHYCERA
SUPER FAMILY: ASILOIDEA
FAMILY ASILIDAE

Subfamily OMMATIINAE Hardy, 1927
Genus *Ommatius* Wiedemann, 1821
Ommatius jonesi Joseph & Parui, 1985

Subfamily ASILINAE Latreille, 1802
Genus *Promachus* Loew, 1848
Promachus maculatus (Fabricius, 1775)
Genus *Machimus* Loew, 1849
Machimus bicolor Joseph & Parui, 1985
Machimus indianus Ricardo, 1919
Machimus inutilis Bromley, 1935
Genus *Trichomachimus* Engel, 1933
Trichomachimus himachali Parui, Kaur & Kapoor, 1999
Trichomachimus pubescens (Ricardo, 1922)

Subfamily STENOPOGONINAE Hull, 1962
Genus *Stenopogon* Loew, 1847
Stenopogon subtus (Bromley, 1935)

(ii) Systematic and diagnostic accounts

FAMILY ASILIDAE

Key to the subfamilies

1. R2+3 ending in Costa; neither a strong bristle present on the supero-posterior angle of anepisternum nor a row of bristles present on the katatergite..**Stenopogoninae** Hull, 1962
- R2+3 joining R1 proximal to end of R1, with cell r1 thus separated from wing margin; either anepisternum with at least one strong bristle on its supero-posterior angle, or katatergite with a vertical row of bristles or bristly hairs...2
2. Anatergite pilose, the hair situated on top of it; R4 never with an extra vein........................ ....**Asilinae** Latreille, 1802
- Anatergite bare, or if some hairs, these placed mostly on latero-internal margin of anatergite and on immediately adjacent area of mediotergite, but never on top of anatergite; R4, in this case, always with a short extra vein present at its junction with R5........................ ....**Ommatiinae** Hardy, 1927

Subfamily OMMATIINAE Hardy, 1927

Ommatiinae Hardy, 1927. Type genus *Ommatius* Wiedemann, 1821.

Diagnosis: Some median ommatidia larger than surrounding ones, post pedicel short and medially broadest, post metacoxal area entirely sclerotized.

Genus *Ommatius* Wiedemann, 1821

Ommatius Wiedemann, 1821. Dipt. exot., 1: 213. Type species: *Asilus marginellus* Fabricius; designated by Coquillett (1910:579).

Emphysomera Schiner, 1866. Verh. Zool. Bot. Ges. Wein., 16: 649-722. Type species: *Asilus conopsoides* Wiedemann; original designation.

Ommatius Becker, 1925. Ent. Mitt., 14: 18. Type species : *Asilus pingius* van der Wulp; designated by Engel (1926: 37).

Diagnosis: The genus can be easily distinguished by its short; pyriform third antennal segment and a long style bearing one or two rows of short hairs throughout its length.

Ommatius jonesi Joseph & Parui, 1985

Plate – 1A

1984b. Joseph A.N.T and Parui P. Oriental Insect, 18: 57. India.

Type Locality: Holotype [♂: NHM, London] India. Uttarakhand: Ranikhet, 1524-1821 m, 18 Aug 1945, Collector: C.G. Jones.

Material Examined: 2♂♂, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 4♂♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 2♂♂, collected from stones nearby streams, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar; 1♀, collected from stones nearby streams, 27.02.32.800N, 88.41.32.800E, 1103 m, Kuapani roadside 2, Kalimpong, 29 May 2015, Coll. A. Naskar.

Diagnosis: Black mystax, postocular bristles thin and black below which white setae present; setose pronotum, indistinct medio-longitudinal stripe on scutum, pleuron grey tomentose, dark brown legs with black bristles, coxa with reddish hairs laterally; lightly infuscated wing; Abdominal terga I and II with long white setae; male genitalia black with ark brown and pale yellow setae covered.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Darjeeling; Kalimpong, Uttarakhand, Himachal Pradesh.
Prey: Spider.
Remarks: This species is closely resembled with *Ommatius ater* Bromley but differs from it by the not metallic, but black, coloured abdomen, terga I and II with long, white setae and distally infuscated wing (Parui et al., 1999). This species is recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Subfamily ASILINAE Latreille, 1802
Asilinae Latreille, 1802. Type genus *Asilus* Linnaeus, 1758.
Diagnosis: Macrosetae on lateral margin of frons present, prosternum and proepisternum separated and prosternum triangular and pointed dorsally, female S8 proximally plate like and distally hypogynial valves forming a keel, male gonocoxites entirely free.

Key to genera of subfamily ASILINAE Latreille, 1802
1. Submarginal cells there, metanotal slopes devoid of bristly piles.......***Promachus* Loew**
- Submarginal cells two, Metanotal slopes bristly pilose..2
2. Disc of scutellum and abdominal tergites from second to fifth matted with dense piles, antennal style quite short and stout...***Trichomachimus* Engel**
- Scutellum and abdomen not densely pilose, scutellar disc with long bristly hairs, antennal style long...***Machimus* Loew**

Genus *Promachus* Loew, 1848
Promachus Loew, 1848. Linn. Ent., 3: 390. Type-species: *Asilus maculatus* Fabricius; designated by Coquillett (1910: 595).
Trypanoides Becker, 1925. Ent. Mitt., 14: 71. Type-species: *Tryyanoides testaceips* Macquart; designated by Engel (1926: 22).
Enagaedium Engel, 1930. Konowia, 8: 459. Type-species: *Asilus poetinus* Walker, 1849; original designation.

Promachus maculatus (Fabricius, 1775)
Plate – 1B
1775. Fabricius, J. C. Systema entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus. Kortii, Flensbvrgi et Lipsiae [= Flensburg & Leipzig]. [32] + 832 p.
1920. Ricardo, G. Notes on the Asilidae: sub-division Asilinae [part 30]. Ann. Mag. nat. Hist., (9) 5: 209-241.
Type locality: Holotype [unknown] India. Tamil Nadu: Tharangambadi.
Material Examined: 1♂, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 2♂♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 1♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar.
Diagnosis: Pale yellow moustache, yellow haired palpi; black bristles and yellow hairs present on the scutellum; tibia reddish in appearance, mid and fore femur covered with pale yellow hairs anteriorly; black spot present on both side of the abdomen with yellow band surroundings; hypandrium large and forked with short epandrium.

Global Distribution: Oriental region.
Distribution in India: West Bengal: Jalpaiguri; Kalimpong; Kurseong; Alipurduar, Tamil Nadu, Kerala, Orissa, Andhra Pradesh, Rajasthan.
Prey: Spider.
Remarks: Macquart's species is evidently identical with this widely distributed species, he described the hind tarsi as black (Joseph & Parui, 1983). This species is recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Genus *Machimus* Loew, 1849

Machimus Loew, 1849. Linn. Ent. 4: 1. Type species: *Asilus chrystis* Meigen; designated by Coquillett, 1910.
Diagnosis: The flies of this genus can be separated from the remaining genera of the tribe by the prominent facial pilosity with dense bristles; ovipositor laterally strongly compressed with eighth segment moderately long and ninth segment short.

Key to species of the genus *Machimus* Loew, 1849

1. All femora wholly black, Wings largely infuscated, hyaline only at base, eighth sternite without long black hairs at apex..*indianus* Ricardo
- All femora differently coloured, wings with no such infuscation, eight sternite with long black hairs at apex...2
2. Superior forceps prolonged into a process apically, mystax black with pale yellow-bristles below..*bicolor* Joseph & Parui
- Superior forceps without any process apically, mystax black with a few white bristles intermixed...*inutilis* Bromley

Machimus bicolor Joseph & Parui, 1985

Plate – 1C

1984. Joseph and Parui. On some Asilidae (Diptera) from India and adjoining countries present in the British Museum (Natural History). Oriental Insect. 18 (1): 63.
Type Locality: Holotype [♂: BMNH] India: Himachal Pradesh: Kangra district: Kulu, Dibibokri Nal Runi Thach, 3901 m, 10 Jul 1952.
Material Examined: 2♂♂, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 5♂♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 3♂♂, collected from stones nearby streams, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar; 1♀, collected from stones nearby streams, 27.02.32.800N, 88.41.32.800E, 1103 m, Kuapani roadside 2, Kalimpong, 29 May 2015, Coll. A. Naskar.
Diagnosis: Mystax black with some pale yellow bristles below, Palpi and proboscis both are black with pale yellow hairs; mesonotum with two black spot laterally and with a black medio-longitudinal stripe; black cox and trochanter, dorsally and anteriorly fore and mid femora black; basally hyaline wing with apically light infuscation; abdomen covered with black densely grey tomentose, hypandrium with few black hairs.
Global Distribution: Oriental region.

Distribution in India: West Bengal: Darjeeling; Kalimpong; Jalpaiguri, Himachal Pradesh, Rajasthan.
Prey: Spider.
Remarks: This species relatively abundant in comparison to other newly recorded asilid species and therefore commonly found throughout the study area. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Machimus indianus Ricardo, 1919

Plate – 1D

1919. Ricardo. Ann. Mag nat Hist., 3 (9): 50.
Type Locality: Lectotype [♂: BMNH] India: Uttarakhand: Kumaon, Takula, 29.vi.1912. Paralectotype [Female: BMNH] India: Uttarakhand: Kumaon, Takula, 15 May 1919.
Material Examined: 2♂♂, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 4♂♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 27 May 2015, Coll. A. Naskar; 3♂♂, collected from stones nearby streams, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar.
Diagnosis: Narrower head with dense grey tomentum; pale yellow mystax with one black bristle on both the side of lower margin, median transverse row of pale bristles present in pronotum, a medio-longitudinal stripe divided by a narrow grey stripe present on mesonotum; fore tibia and basitarsus ventrally with mat of golden hairs, remaining hairs predominantly white, bristles black; largely infuscated wing; Abdomen black with transverse white bands.
Global Distribution: Oriental region.
Distribution in India: West Bengal: Darjeeling; Kalimpong; Alipurduar, Uttarakhand, Punjab, Himachal Pradesh.
Prey: Spider.
Remarks: This species also commonly found throughout the study area. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Machimus inutilis Bromley, 1935

Plate – 2A

1935. Bromley. Rec. Indian Mus., 37: 221.
Type Locality: Holotype [♂: ZSI Registration No. 641/H6] India: Himachal Pradesh: Dalhousie. Collector S.L. Hora.
Material Examined: 2♂♂, collected from rocks nearby streams, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 2♂♂, collected from high altitude forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 2♂♂, collected from high altitude forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar; 1♂, collected from dense forest floor, 27.02.32.800N, 88.41.32.800E, 1103 m, Kuapani roadside 2, Kalimpong, 29 May 2015, Coll. A. Naskar.

Diagnosis: Broader head covered with grey tomentum; mystax black with a few white bristles intermingled; mesonotum with a medio-longitudinal black stripe divided by a narrow grey stripe, scutum covered with disc pale yellow haired; femur covered with dark brown anteriorly and ventrally and rest brownish yellow, mid tibia darker anteriorly; hyaline wing with fuscous apex; abdomen covered with grey and greyish-brown black tomentum; superior forceps terminating in a long slender process which is directed backwards.
Global Distribution: Oriental region.
Distribution in India: West Bengal: Darjeeling; Kalimpong; Kurseong, Himachal Pradesh, Uttarakhand.
Prey: Spider.
Remarks: This species is also commonly encountered throughout the moderate altitudes of Himalayan and sub-himalayan region. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Genus *Trichomachimus* Engel, 1933

Trichomachimus Engel, 1933. Ark. Zool. (A), 25 (22): 10. Type-species: *Machimus pubescens* Ricardo, 1922; original designation.
Diagnosis: The genus can be distinguished from the allied *Machimus* Meigen by the densely matted stiff piles on disc of scutellum and from second to fifth abdominal tergites, denser and larger piles on pleurae and more prominent pilosity of the face.

Key to the species of genus *Trichomachimus* Engel, 1933

1. Body and leg covered with whitish or pale yellow pile, particularly covering the whole of abdomen extending to the male genitalia; tergites 1-3 without any black pile; eighth sternite slightly produced bearing a fringe of dense white pubescence................*pubescence* (Ricardo)
- Pale yellow pile not covered all abdominal tergites; some portion of legs with black pile, rest with pale yellow, tergites 1-3 with black pile; eight sternites devoid of such dense white pubescence..*hilmachali* Parui, Kaur & Kapoor

Trichomachimus himachali Parui, Kaur & Kapoor, 1999

Plate – 2B

1994. Parui P., Kaur N. & Kapoor V.C. Three new species of Asilidae (Diptera) from Himachal Pradesh, India. Rec. Zool. Surv. India. 97: 221-229.
Type Locality: Holotype [♂: NZC, ZSI] India: Himachal Pradesh: Simla. 7 Oct 1992 Collector: C.N. Meeta.
Material Examined: 1♂, collected from rocks nearby streams, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 27 May 2015, Coll. A. Naskar; 2♂♂, collected from rocks nearby streams, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 28 May 2015, Coll. A. Naskar; 1♂, collected from hill top, 27.04.52.300N, 88.40.21.700E, 2209 m, Rachila, Kalimpong, 30 May 2015, Coll. A. Naskar; 1♂, collected from leaf litter in forest floor, 27.03.02.300N, 88.40.48.400E, 1599 m, Neora valley national park buffer zone, Kalimpong, 31 May 2015, Coll. A. Naskar.
Diagnosis: Antenna black with black piles and bristles. Palpi black with black piles; proboscis black with white piles ventrally; numerous yellowish brown tomentose, scutum unstriped, piles anteriorly black; reddish tarsi with black legs, long white piles ventrally covered fore coxa, yellow and black piles covered tibia;

wing with prominent infuscation in anterior half, squamal fringe black-brown and white; terga 1-3 with black piles, the remaining terga with yellowish-red piles; piles of sternites dense, black.
Global Distribution: Oriental region.
Distribution in India: West Bengal: Kalimpong; Darjeeling, Himachal Pradesh.
Prey: Small asilid species of subfamily Asilinae, spider.
Remarks: This species is relatively rare in occurrence and mainly encountered from higher altitudes of the study area. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Trichomachimus pubescens **(Ricardo, 1922)**

Plate – 2C

1922. Ricardo G. Notes on the Asilinae of the South African and Oriental regions [conl.]. Ann. Mag. nat. Hist., (9) 10: 36-73.

Type Locality: Holotype [♂: BMNH] Tibet: Gyangtse, 3900 m. Tibet Expedition 1905. Collector: H.J. Walton. Paratype: [♀: BMNH] Tibet: Gyangtse, 3900 m. Tibet Expedition, 1905. Collector: H.J. Walton.
Material Examined: 1♂, collected from rocks nearby streams, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 28 May 2015, Coll. A. Naskar; 2♂♂, collected from hill top, 27.04.52.300N, 88.40.21.700E, 2209 m, Rachila, Kalimpong, 30 May 2015, Coll. A. Naskar; 1♂, collected from leaf litter in forest floor, 27.03.02.300N, 88.40.48.400E, 1599 m, Neora valley national park buffer zone, Kalimpong, 1. Jun 2015, Coll. A. Naskar.
Diagnosis: Mustache composed of long soft black and yellow hairs, blackish antennae, two or three yellowish tomentose stripe present on thorax; the hind pair with white hairs and with stout reddish-yellow bristles; upper side of femora with white hairs; tibiae with white hairs, long and black on the underside of the fore pair; tarsi with chiefly black hairs, the posterior branch of the cubital vein with a slight bend inwards; epandrium stout, ending in a point curved downwards; the hypandrium shorter but stout; between them appear three reddish and black long processes.
Global Distribution: Palearctic region, Oriental region.
Distribution in India: West Bengal: Darjeeling; Kurseong; Sikkim, Himachal Pradesh.
Prey: Spider; small asilid species of subfamily Asilinae.
Remarks: Remarks: This species is relatively rare in occurrence and mainly encountered from higher altitudes of the study area. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Subfamily STENOPOGONINAE Hull, 1962

Stenopogoninae Hull, 1962. Type genus *Stenopogon* Loew, 1847.
Diagnosis: Facial swelling and mystax extending over lower facial half, all ommatidia same size, postpedicel cylindrical throughout, setae on anteroventral prothoracic tibiae absent, female spermathecal reservoir formed by more or less expanded and coiled ducts.

Genus Stenopogon Loew, 1847

Stenopogon Loew, 1847. Linn. Ent., 2: 453 Type-species: *Dasypogon sabaudus* Fabricius (1794); original designation.

Diagnosis: Medium to large flies; third antennal segment with two microsegments and usually as long as the first two segments together; scutellum micro pubescent, sternopleuron with a distinct patch of fine hairs, metanotal callosity with micropubescence only which separates the genus from S*cleropogon* Loew; males with epandrium widely divided from base hypandrium forms a broad basal plate to triangular process, females with seven pairs of curved, blunt spines on acanthophorites.

Stenopogon subtus (Bromley, 1935)

Plate – 2D

1935. Bromley S. W. New Asilidae from India. Rec. Indian Mus., 37: 219-230.

Type locality: Holotype [♀: NZC, ZSI Registration No. 653/H6] India. Himachal Pradesh: Dayankund Nallah, below bridge, between milestones 14 and 15 on Dalhousie-Khajiar Road, 2400 m. Collector: S L Hora.

Material Examined: 1♂, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 1♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 1♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar.

Diagnosis: Reddish yellow antennae, third segment black, Mystax composed of black bristles above and on sides whitish bristles anteriorly, becoming more numerous toward the lower portion. Scutellum grayish-yellow pollinose, legs reddish with black bristles and pale hairs. Anterior femora black above, with a black line above, extending three fourths of the length and a black area below basally seven-eighths the length. Middle femora basal anterior portion seven-eighths the length black. Posterior femora with the anterior portion black to seven-eighths; of the length, abdomen reddish with pale yellowish hairs.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Kalimpong; Darjeeling; Punjab, Andhra Pradesh, Himachal Pradesh.

Prey: Spider.

Remarks: This species exhibited moderate pattern of distribution throughout the study area in Himalayan and sub-himalayan region of the West Bengal. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

DISCUSSION

Eight species namely *Ommatius jonesi* Joseph & Parui, 1985; *Promachus maculatus* (Fabricius, 1775); *Machimus bicolor* Joseph & Parui, 1985; *Machimus indianus* Ricardo, 1919; *Machimus inutilis* Bromley, 1935; *Trichomachimus himachali* Parui, Kaur & Kapoor, 1999; *Trichomachimus pubescens* (Ricardo, 1922) and *Stenopogon subtus* (Bromley, 1935) under five genera were recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

The asilid fauna exhibited fascinating diurnal pattern of activity (Joseph & Parui, 1983). Likewise maximum activity of these newly recorded asilid species were observed and recorded between 11 am to 3 pm. Certain extreme weather conditions like strong breeze and cloud accumulation also reported to interfere with their daily activity pattern (Hull, 1962). In several studies, it has been observed that their daily activity pattern may change depending on several meteorological factors and largely depending on their distribution pattern (Geller-Grimm, 2003; Dikow, 2009; Geller-Grimm, 2015).

So far, in respect of qualitative richness of fauna, no asilid species and genus were endemic to the state of West Bengal. Of these, only single species of *Trichomachimus pubescens* (Ricardo, 1922) exhibited far wide spread in distribution, i.e. recorded from more than one zoo-geographical realms of Oriental and Palearctic region. Rest of the seven asilid species were recorded only from the single zoo-geographical realm of Oriental region.

In respect to the distribution of these asilid fauna in India, it can be said that six out of eight newly recorded asilid species namely *O. jonesi*; *M. bicolor; M. indianus; M. inutilis; T. pubescens* and *S. subtus* exhibited moderate pattern of distribution i.e. they were recorded from more than two and less than five states of India. Only single species of *P. maculatus* exhibited common distribution pattern, i.e. it was recorded from more than five states of India *viz*. Andhra Pradesh, Orissa, Kerala, Rajasthan, Tamil Nadu and West Bengal.

In respect to the distribution of these asilid species within the Himalayan and sub-himalayan region of the state of West Bengal, it can be said from the best of the knowledge accumulated on this family, that certain species occurring in West Bengal may immigrate at least to the neighbouring countries, such as Bangladesh, Nepal, Bhutan, Myanmar, Thailand, etc. or emigrate from those countries in the influence of allied topographic and climatic conditions. Indeed, nearly several species showed discontinuous distribution pattern, and this appears to be due to the need of thorough exploration of several area, unfavourable natural conditions in the area for survival and colonization, inaccessible area specially hilly mountain area, and border areas. Therefore Himalaya itself hereby acting as geographical barrier for migration of asilid species from upper Oriental region to higher altitudes of Palearctic region. Lastly, it can be concluded that more thorough exploitation of high altitude habitat in this Himalayan and sub-himalayan region of the state is largely wanted to accurately interpret on their distribution pattern, which is expected to be continuous in near future after proper taxonomic exploration.

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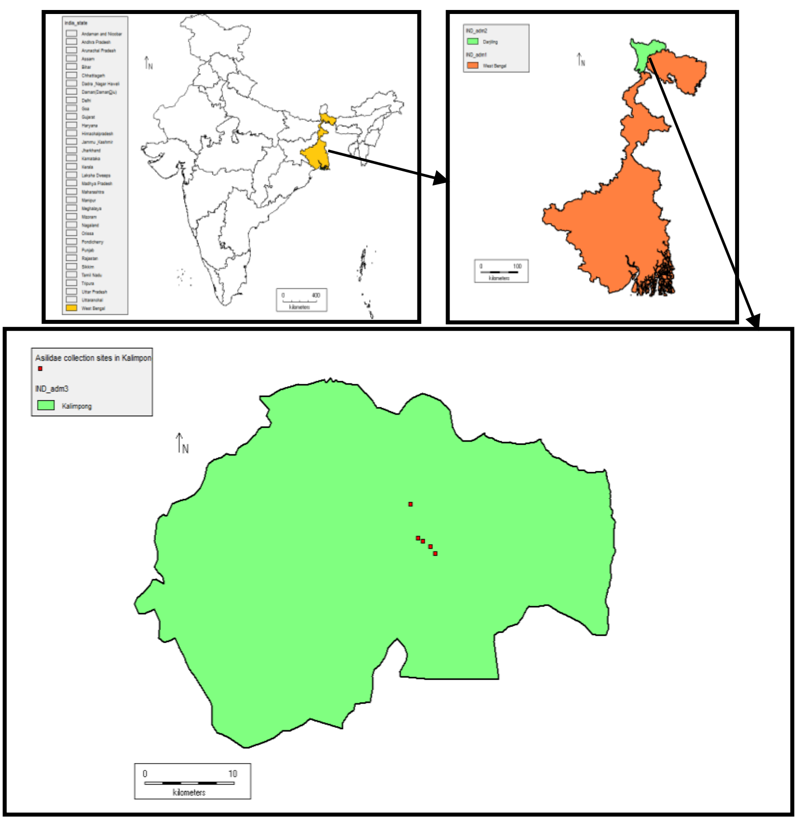

Figure 1. GIS map representing the study sites from where newly recorded asilid fauna were collected in Himalayan and sub-himalayan region of Darjeeling Himalaya, West Bengal.

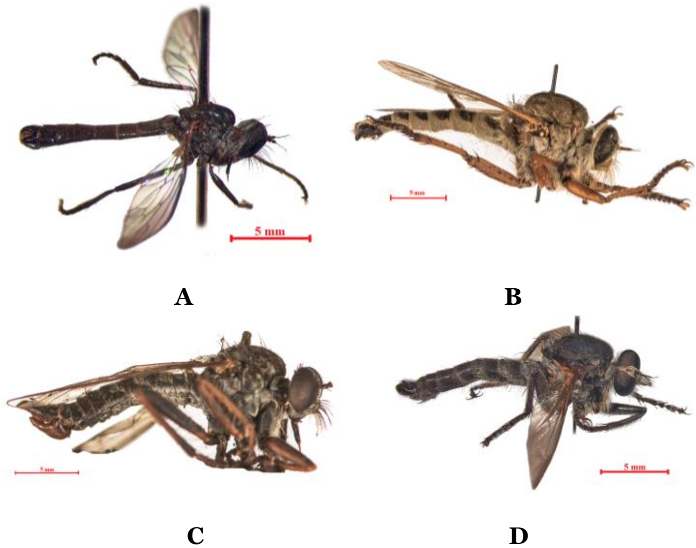

Plate 1A-D. Lateral view of habitus of **A**: *Ommatius jonesi* Joseph & Parui, 1985; **B**: *Promachus maculatus* (Fabricius, 1775); **C**: *Machimus bicolor* Joseph & Parui, 1985 and **D**: *Machimus indianus* Ricardo, 1919 (Scale bar – 5 mm).

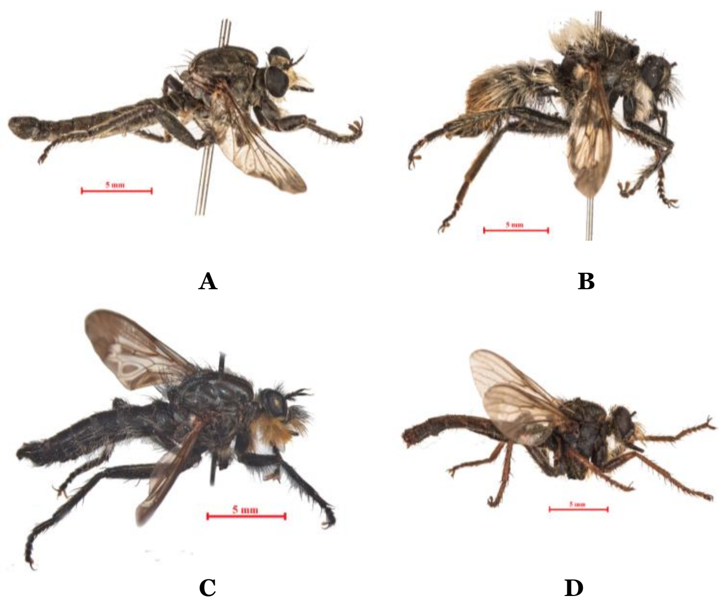

Plate 2A-D. Lateral view of habitus of **A**: *Machimus inutilis* Bromley, 1935; **B**: *Trichomachimus himachali* Parui, Kaur & Kapoor, 1999; **C**: *Trichomachimus pubescens* (Ricardo, 1922) and **D**: *Stenopogon subtus* (Bromley, 1935) (Scale bar – 5 mm).

FIRST REPORT IN SYRIA OF TWO PREDATORY TRUE BUGS: *MONTANDONIOLA INDICA* (HEMIPTERA: ANTHOCORIDAE) AND *GEOCORIS AMABILIS* (HEMIPTERA: GEOCORIDAE)

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[**Ali, A. Y. & Streito, J.-C.** 2019. First report in Syria of two predatory true bugs: *Montandoniola indica* (Hemiptera: Anthocoridae) and *Geocoris amabilis* (Hemiptera: Geocoridae). Munis Entomology & Zoology, 14 (2): 427-431]

ABSTRACT: In this study, two heteropterous species *Montandoniola indica* Yamada, 2011 (Heteroptera: Anthocoridae) and *Geocoris amabilis* Stål, 1855 (Heteroptera: Geocoridae) were detected on the leaves of *Ficus benjamina* plants, in the coastal area in Tartous, Syria. Adults and a nymph of *M. indica* were collected, on heavy infested leaves with *Gynaikothrips uzeli* Zimmermann, 1900 (Thysanoptera: Phlaeothripidae). This is the first record of the both bugs in Syria and the first detection of *M. indica* outside India.

KEY WORDS: *Montandoniola indica*, *Geocoris amabilis*, Anthocoridae, Geocoridae, *Gynaikothrips uzeli*, *Ficus benjamina*, Syria

Although catalogs of the Palaearctic Anthocoridae and Lygaeidae were published (Péricart, 1996; Péricart, 2001; Aukema et al., 2013) as well as a faunal list by El-Hariri (1971) which is completion based on Stichel (1955-1962), no specific study has been devoted to Syrian Heteroptera and this rich fauna remains poorly known.

By studying the weeping fig thrips *Gynaikothrips uzeli* (Zimmermann, 1900) (Thysanoptera: Phlaeothripidae), recently introduced in Syria where it appears to be successfully adapted (Ali 2014), we have collected two interesting species of predators: one of the genus *Montandoniola* (Anthocoridae: Anthocorinae: Oriini), the other of the genus *Geocoris* (Geocoridae: Geocorinae). In Syria, there is no report about the presence of species belonging to genus *Montandoniola*. Several species of *Geocoris* are reported by Péricart (2001) from Syria: *G. chloroticus* Puton, 1888, *G. anticus* Péricart, 1994, *G. ater* Fabricius, 1787, *G. fedtschenkoi* Reuter, 1885, *G. hispidulus* Puton, 1874, *G. lineola* Rambur, 1839, *G. megacephalus* Rossi, 1790, *G. nebulosus* Montando, 1907 but none of them correspond to our specimens.

MATERIAL AND METHODS

Infested leaves of *Ficus benjamina* L. (Moraceae) including the thrips species *G. uzeli* and the bug species *Montandoniola* sp. were collected during August 2017 at Wadi–Al Shatter location (34° 51' 50.60", 35° 53' 46.48") in Tartous Governorate. While, the Curled leaves of *F. benjamina* including *Geocoris* sp. bugs were sampled during February 2017 at Al –Jemaseh location (34° 44' 0.74", 35° 58' 39.64") also in Tartous Governorate. The bugs were removed using a fine brush and preserved in 95% alcohol. 21 *Montandoniola* and 3 *Geocoris* sp. Bugs were send to INRA-CBGP (Montpellier) and 30 specimens of genus *Montandoniola* and 10 specimens of genus *Geocoris* were deposited at the

Laboratory of Entomology in the Center of Tartous for Agricultural Research and identified.

Identification of *Montandoniola* was performed using recent publications especially new descriptions. Male and female genitalia were dissected after a maceration in a KOH 10% solution. Observations were performed under a stereomicroscope Leica DM205C and a microscope Leica DLMB, and some pictures were also sent to Prof. Yamada K. (Japan) for verification. We tried to identify the *Geocoris* using the Fauna of France (Péricart, 1998) but as our species was not included in this book we used the collections of Heteroptera of the Centre International en Recherche Agronomique pour le Développement (CIRAD – CBGP, Montpellier, France) and those of Museum National d'Histoire Naturelle (MNHN, Paris).

RESULTS AND DISCUSSION

Montandoniola indica (Yamada, 2011)

(Figs. 1, 3-4)

Our specimens correspond exactly to the description of *M. indica* Yamada, 2011. We sent photographs of the male and female habitus and genitalias to Prof. Yamada Y. who confirmed the similarity (Figs. 1, 3-4). It is the first record of a *Montandionola* species in Syria. Species belonging to this genus are known as predators of economically important thrips. Before Pluot-Sigwalt et al. (2009), most species of *Montandioniola*, and especially those used for biological control were merged under the name *M. moraguesi*. It follows that it is not currently possible to know which species refers to publications prior to 2009. This is particularly the case of the *Montandoniola* species studied by Muraleedharan & Ananthakrishnan (1971, 1978) in India. *G. uzelii* is an invasive species in Syria, probably introduced with horticultural trade in *F. benjamina* (Ali, 2014), that could have been transported with its natural enemies. It is native from Southeast Asia including Taiwan, China, and India (Mound et al., 1995; Held et al., 2005). In such a context we did not know which species of *Montandoniola* to expect.

M. indica is an efficient predator of gall-forming thrips, *Liothrips karnyi* Bagnall, 1924 (Thysanoptera: Phlaeothripidae), infesting black-pepper leaves in India (Yamada et al., 2011). Our knowledge on this species is very limited; it has never been reported since its description. More generally, Anthocoridae, even when they play an important role in pests' regulations, are very poorly known. The distribution of *M. indica* is potentially much wider than the only localities reported by Yamada et al. (2011). It is currently impossible to know whether it originates from Syria or is introduced, in particular because unintentional introduction by *G. uzelii* infected material is possible. Only further faunistic studies between Syria and India will make possible to decide on the origin of the Syrian population.

Geocoris (Geocoris) amabilis (Stål, 1855)

(Fig. 2)

Our specimens (Fig. 2) were identified by comparison with reference material preserved in Montpellier (CIRAD collection) and Paris (MNHN collection). They match well with the species *G. amabilis*. This species was not reported from Syria nor northern to Sahara.

The *Geocoris* species are known as generalist predators (Sweet, 2000). *G. amabilis* is a poorly known species although common and widespread in tropical Africa. Several subspecies have been described: *G. amabilis blandulus*

Montandon, 1907 from Ethiopia, *G. amabilis pictipes* Bolivar, 1879 from Congo, Ethiopia and Somalia. The species is cited unspecified as subspecies from Congo, Guinea, French Sudan (Mali), Natal, Nigeria, Rwanda, South Africa, Sudan, Uganda (Slater, 1964), Ivory Coast, Ghana, Liberia, Senegal, (Heinrichs & Barrion, 2004), and Somalia (Linnavuori, 1982). The online catalogue "Lygaeoidea Species File" (Dellapé & Henry, 2018) does not give more details.

We have examined specimens from the following countries: Central African Republic, Benin (MNHN general collection), Cameroun, Chad (MNHN, Péricart collection), Burkina Faso (Streito J.C. collection, Montpellier, France), Benin, Togo, Mali, Congo Brazzaville (CIRAD collection). This species is known as predator in cotton fields (Renou & Brévault, 2015; Couilloud, 1989) and Rice (Heinrichs & Barrion, 2004) in Western Africa. We didn't find anything else on its biology.

Both species are predators and were not reported before from Syria. These reports extend greatly known distributions of these true bugs. It is possible that our faunistical knowledge of Heteroptera is too incomplete and that in fact both species are more widespread than expected. This is particularly the case for *M. indica* described very recently and confused for years with *M. moraguesi*. *G. amabilis* is, however, a long known species whose taxonomy has so far been fairly stable and it is surprising that it has never been reported from the Near-East by the authors who have prospected the region, notably R. Linnavuori. Moreover, recent catalogues published from neighboring countries do not mention this species either Linnavuori et al. (2014) for United Arab Emirates; Ghahari & Moulet (2012) for Iran; Kiyak et al. (2004), Matocq & Özgen (2010), Matocq et al. (2014) for Turkey. Under these conditions it is not excluded that *G. amabilis* but perhaps also *M. indica* have recently arrived in Syria, either naturally favored by climate changes, or via exchanges of plants, goods or transport of passengers.

These two species could be of interest for biological control. *G. amabilis* is badly known, but it is a polyphagous predator that can be found on many crops and natural environments. If it becomes established in agrosystems on a long-term basis it is likely to play a potentially important role. *M. indica*, as probably most if not all *Montandoniola* species, is specialized in thrips predation. Yamada et al. (2011) showed that eggs, all nymphal instars and adults of *M. indica* were found within the leaf curl galls induced by the thrips, *Liothrips karnyi* on the black pepper leaves, *Piper nigrum* (Piperaceae). Adults and nymphs of *M. indica* were collected, inside the galls induced by the thrips *G. uzeli* on *F. benjamina* in Tartous governorate, that means the thrips species *G. uzeli* is considered as prey for this anthocorid bugs. Yamada et al. (2011) demonstrated that *M. indica* is an efficient predator of gall-forming thrips, *L. karnyi*, therefore *M. indica* could reduce the population of the thrips species *G. uzeli* but further experiments especially in biological control in the laboratory and field condition are required.

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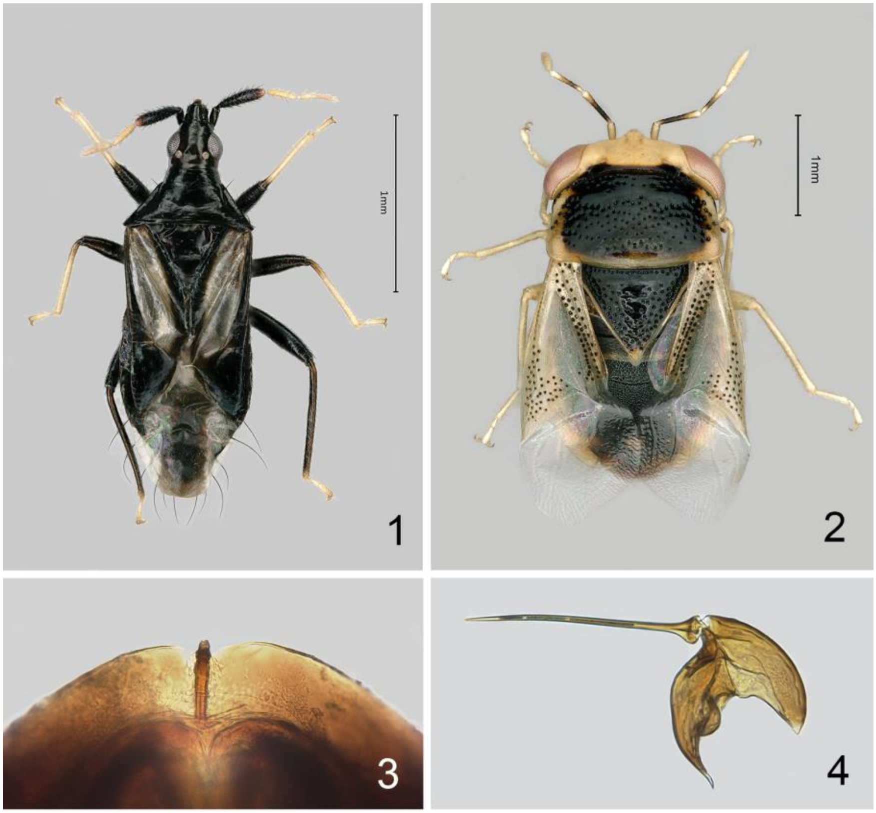

Figures 1-4. Morphological details of *Montandoniola indica* Yamada and *Geocoris amabilis* Stål collected in Syria. 1 – *M. indica*, habitus of a female from Wadi–Al shatter, 2 – *G. amabilis* habitus of a male from Al –Jemaseh, 3–4 *M. indica* from Wadi–Al Shatter; 3 – female, copulatory tube; 4 – male, paramere. Scale bars = 1 mm.

NEW HOSTS [BROAD BEAN (*VICIA FABA* L.)] AND RECORD OF ROOT-KNOT NEMATODE IN TURKEY

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[Kepenekçi, İ., Keleş, G., Dura, O., Dura, S. & Yeşilayer, A. 2019. New hosts [broad bean (*Vicia faba* L.)] and record of root-knot nematode in Turkey. Munis Entomology & Zoology, 14 (2): 432-438**]**

ABSTRACT: Plant-parasitic nematodes (PPNs), particularly *Meloidogyne* spp. root-knot nematodes (RKNs), are widely distributed and cause significant yield losses in a wide range of crops. Major root-knot nematode species: *M. arenaria*, *M. exigua*, *M. graminicola*, *M. hapla*, *M. incognita*, *M. javanica*, *M. mayaguensis*. PPNs, host association and distribution in different localities of Turkey have been surveyed. A total number of 240 nematode species of PPNs belonging to 56 genera of Tylenchida detected in Turkey. These nematode species found associated with 66 plants from 48 different localities of the country. In Turkey, the species *M. incognita*, *M. arenaria*, *M. javanica* and *M. hapla* are the most commonly found, with *M. incognita* and *M. javanica* which causes serious problems to a number of economically important agriculture and greenhouse crops. During a survey of PPNs, moderate to severe root-knot infection was observed on the roots of broad bean (*Vicia faba* L.) growing in the vegetable and legumes production in Niksar district, Yolkonak village (Tokat, Turkey). After examination of the root galls, mature females were found attached in abundance on the roots. On the basis of perennial pattern of mature females of *Meloidogyne javanica* (Treub) were identified. Broad bean (*Vicia faba* L.) (Fabaceae) appeared to be a new hosts of the RKNs in Turkey not previously reported. In Turkey, *Meloidogyne javanica* was found for the first time in Iğdır on unknown host and is presently widespread in various Turkish regions, where it causes severe damages. It is extremely polyphagous, attacks severely plants but is very damaging also to *Vitis vinifera*, vegetables, Cucurbitaceae, ornamental plant, *Musa* sp., *Arachis hypogaea*, *Lycopersicum esculentum* and *Capsicum annuum.*

KEY WORDS: Plant-parasitic nematodes, root-knot nematodes, *Meloidogyne javanica,* broad bean, *Vicia faba,* new host, Turkey

Nematodes have a wide distribution area, whose were among the least known organism groups throughout the years. Initial work on nematodes, which are harmful to plants, began with the discovery of damage to cultural plants in the 19th century. Nematological studies started 60 years after entomological studies and 40 years after phytopathological studies (Thorne, 1961). It is impossible to admit that soil microbiology of plants that grows in a mixed environment was damaged by a single organism group under natural conditions. For this reason, crop losses due to plant parasitic nematodes (PPNs) are based on some estimates. According to Wallas (1963), PPNs reduce the amount of products by 50% in some cultivated plants such as, potatoes, tobacco. Taylor (1967) believes that the 10% loss of crops due to nematodes in vegetables. Jensen (1972) reported that the loss rate was 15% (tomatoes, green peppers) and 20% (beans, carrots, cucumbers, watermelons and melons) in vegetables. PPNs, especially root-knot nematodes (RKNs) from the genus *Meloidogyne* are widely distributed and cause significant yield loses in a wide range of crops (Davis, 2005; Luc et al., 2005). Major RKN species are *M. arenaria*, *M. exigua*, *M. graminicola*, *M. hapla*, *M. incognita*, *M. javanica* and *M. mayaguensis* (Luc et al., 2005). In Turkey, the species *M. incognita*, *M. arenaria*, *M. javanica* and *M. hapla* are the most commonly found, with *M. incognita and M. javanica* which causes serious problems to a number of economically important agriculture and greenhouse crops (Kepenekci, 2012). RKNs emerged in 1887 by Goeldi in the identification of *M. exigua* from the galleries in the roots of coffee trees in Brazil (Chitwood, 1949). In Europe and America, especially in the second half of the 20th century, in parallel with the development of the sugar industry, detailed studies have been carried out on the sugar beet and other cultivated RKNs. According to Eisenback & Triantaphyllou (1991) reported that the number of this genus belongs to over 60 species, and that four of these species are the main harmful species and show widespread distribution in agriculture fields around the world. RKNs include species that live as endoparasites in more than 2000 plants and cause economic damage. It is known that 52% of the area used as agricultural land in the world is contaminated with root-knot nematodes (Taylor, 1987).

The nematological studies on PPNs was initiated by İyriboz (1934). Diker (1952) reported RKN (*M. hapla*) from Black Sea region and cyst nematode (*Heterodera schachtii*) from sugarbeet (*Beta vulgaris* L.) in Turkey. However, the first report of PPNs from Samsun district, Turkey was published by İrtel et al., (1952). Alkan (1962) compiled the list of PPNs reported from Turkey with their systematic and morphological description. In the coarse of nematode faunal investigations many researchers reported PPNs and their host associations from time to time in Turkey. Ökten et al., (2000) have published a list containing 172 plant parasitic nematode species belonging to order Tylenchida. Kepenekci (2014b) has published a list of 240 species belonging to 56 genera of order Tylenchida detected in Turkey. It can be configured that 68 species have been added to Turkey nematode fauna. The works carried out on this issue in Turkey seems to follow the progress of the world generally. The initial work on the subject is mostly detected (İyriboz, 1934; Diker, 1955; 1959; Alkan, 1962). Yüksel (1966a; 1966b; 1967)'s studies on the morphology of RKNs are available. Due to the fact that the RKNs are economically important detriments, some studies were carried out in different regions in Turkey and host controls (Ertürk & Özkut, 1974; Ağdacı, 1978; Ediz & Enneli, 1978; Gürdemir, 1979; Enneli, 1980).

RKNs, which cause significant damage to vegetables, cause loss of economic importance in the Mediterranean and Aegean regions, especially where uncovered vegetable growing is common in Turkey. With the widespread of greenhouses in the last years, there is an important problem in the areas with microclimate properties with the passage areas to the coastal areas. Up to this day, ten species of RKNs (*Meloidogyne acrita*, *M. artiellia*, *M. arenaria*, *M.exigua*, *M. ethiopica*, *M. chitwoodi*, *M. hapla*, *M.incognita*, *M. javanica* and *M. thamesi*) were detected in Turkey (Table 1).

MATERIAL AND METHODS

During a survey of PPNs, moderate to severe root-knot infection was observed on the roots of broad bean (*Vicia faba* L.) growing in the vegetable and legumes production in Niksar district, Yolkonak village (Tokat, Turkey). After examination of the root galls, mature females were found attached in abundance on the roots. On the basis of perennial pattern of mature females (Southey, 1986) of *Meloidogyne javanica* (Treub) were identified (Jepson, 1987; Eisenback, & Triantaphyllou, 1991).

RESULTS AND DISCUSSION

Broad bean (*Vicia faba* L.) (Fabaceae) appeared to be a new host of the RKNs in Turkey not previously reported (Kepenekci et. al., 2002; Kepenekci & Evlice, 2004; Kepenekci, 2012; Kepenekci, 2014a; b; Kepenekci et al., 2014b). In Turkey, *Meloidogyne javanica* was found for the first time in Iğdır on unknown host and is presently widespread in various Turkish regions, where it causes severe damages. It is extremely polyphagous, attacks severely plants but is very damaging also to *Vitis vinifera*, vegetables, Cucurbitaceae, ornamental plant, *Musa* sp., *Arachis hypogaea*, *Lycopersicum esculentum* and *Capsicum annuum* (Table 1.). The distribution and host association of root-knot nematodes (*Meloidogyne*) in Turkey are given in Table 1. It includes different hosts collected from different sites of Turkey.

Note: A part of this study was presented in the International Symposium on Ecology 2018 and published as short summaries.

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Table 1. Distribution and host association of root-knot nematodes (*Meloidogyne*) in Turkey.

Nematodes	Host association	Localities *	Ref.
Meloidogyne acrita	Vegetables, *Nicotiana* sp., *Triticum aestivum* L.	(KB)	Bora, 1970
	Vitis vinifera L.	(Izm)	Ertürk & Borazancı, 1975
M. artiellia	*Cicer arietinum* L.	Unknown	Di Vito et al., 1994
M. arenaria	*V.vinifera* L.	(EB)	Ertürk & Borazancı, 1975
	Cucurbitaceae	(GAB)	Ağdacı, 1976
	Ornamental plant	(Izm)	Borazancı, 1977
	Chlorophytum Ker.	(IAB)	Toros et al., 1984
	Lycopersicum esculentum Mill.	(Izm)	Pehlivan & Kaşkavalcı, 1992
	L.esculentum Mill., *Solanum melongena* L.	(Adn),(Ic)	Elekçioğlu, 1992
	L. esculentum Mill.	(Sam)	Mennan & Ecevit, 1996
	Cut flowers	(Yal)	Akgül et al., 2000
	Pimpinella anisum L.	(Bur)	Kepenekci, 2003
	Amaranthus viridis L., *Eleusine indica* (L.), *Setaria verticillata* (L.), *Portulaca oleracea* L.	(Adn), (Mer)	Ercan, 2009
	L. esculentum Mill.	(Ant), (EB), (Esk), (GAB), (Ic), (MB)	Özarslandan et al., 2009
	Capsicum annuum L.	(Mer)	
	S. melongenae L.	(EB)	
	Morus spp.	(AB)	
	Cucumis sativus L.	(Adn), (Esk), (Ic)	
	V. vinifera L.	(Igd)	
	Petroselinum crispum L.	(KB)	Mennan et al., 2011
	Solanum muricatum L.	(KB)	Akyazı et al., 2012
M. exigua	*Capsicum annuum* L.	(Ant)	Kepenekci et al., 2002; Kepenekci et al., 2014a
M. ethiopica	*L. esculentum* Mill. *C. sativus* L.	(Sam)	Aydınlı et al., 2013
M. chitwoodi	*Solanum tuberosum* L.	(IAB)	Özarslandan et al., 2007; Yıldız et al., 2009; Özarslandan et al., 2013
	S. tuberosum L	(IAB)	Özarslandan et al., 2009
M. hapla	Unknown	(KB)	Diker, 1959
	L. esculentum Mill.	(Sam)	Mennan & Ecevit, 1996
	Vegetables	(Ayd)	Kaşkavalcı, 1998
	S. tuberosum L.	(Aks),(Nev), (Nig)	Kepenekci et al., 2006
	S. muricatum L.	(KB)	Akyazı et al., 2012
	C. sativus L.	(Isp), (Bur)	Kepenekci et al., 2002; Kepenekci et al., 2014a

M. incognita	*L.esculentum* Mill.	(Izm)	Yüksel, 1966
	Vegetables	(Mal),(Ela)	Öztürün, 1970
	Vegetables	(Izm)	Bora, 1970
	Cucubitaceae	(GAB)	Ağdacı, 1976
	L. esculentum Mill.	(IAB)	Enneli, 1980
	Chlorophytum Ker.	(IAB)	Toros et al., 1984
	Citrus sp., *Musa* sp., Sebzeler	(AB)	Elekçioğlu 1992
	L. esculentum Mill.	(Sam)	Mennan & Ecevit, 1996
	Vegetables	(Ayd)	Kaşkavalcı, 1998
	Cut flowers	(Yal)	Akgül et al., 2000
	Dolichos lubia L., *L. esculentum* Mill., *C. annuum* L.	(Ant), (Bur), (Esk), (Isp)	Kepenekci & Evlice, 2003
	Ficus spp., *Morus* sp.	(Adn), (Mer)	Kepenekci et al., 2006
	Juglans regia L.	(Kah)	Evlice et al., 2007
	A. retroflexus L., *Amaranthus viridis* L., *Chenopodium album* L., *Chenopodium* sp., *Trifolium* sp., *Malva sylvestris* L., *Eleusine indica* (L.), *Setaria verticillata* (L.), *Paspalum paspaloides* (Michx.) Scribn., *Solanum nigrum* L.	(Adn), (Mer)	Ercan, 2009
	Morus sp., *Punica granatum*	(Adn)	Özarslandan et al., 2009
	L. esculentum Mill.	(Mer), (Izm), (MB), (IAB)	
	C. sativus L.	(Mer), (Ant), (EB), (Izm)	
	C. annuum L.	(Mer)	
	V. venifera L.	(GAB)	
	Vegetables	(Tok)	Akyazı & Ecevit, 2011
	S. tuberosum L.	(MB)	Erdoğuş et al., 2011
	Actinidia deliciosa L.	(KB)	Akyazı & Felek, 2013
	L. esculentum Mill., *C. annuum* L.	(Bur), (Isp), (Esk), (Ant)	Kepenekci et al., 2014a
	L. esculentum Mill., *C. annuum* L. *S. melongena* L.	(Kah)	Cetintas & Cakmak, 2016
	Anethum graveolens L.	(Yal)	Kepenekci & Dura, 2017
	Vegetables	(Tok)	Kepenekci et al., 2017
M. javanica	Unknown	(Igd)	Yüksel, 1967
	Vegetables	(Izm)	Ertürk et al., 1975
	Cucurbitaceae, Ornamental plant	(GAB), (Ist)	Ercan, 1976
	Cucurbitaceae, Ornamental plant	(GAB), (Ist)	Borazancı, 1977
	V. vinifera L.	(EB)	Elekçioğlu, 1992

	L. esculentum Mill.	(MB), (EB)	Pehlivan & Kaşkavalcı, 1992
	Musa sp., *Arachis hypogaea* L,. *L. esculentum* Mill	(AB)	Elekçioğlu, 1992
	Vegetables	(Ayd)	Kaşkavalcı, 1998
	A. albus L., *A. retroflexus* L., *Amaranthus viridis* L., *Xanthium strumarium* L., *Chenopodium album* L., *Cyperus rotundus* L., *Eleusine indica* (L.), *Digitaria sanguinalis* (L.), *Cynodon dactylon* (L.), *Portulaca oleracea* L., *Solanum nigrum* L., *Physalis angulata* L.,	(Adn), (Mer)	Ercan, 2009
	L. esculentum Mill.	(Ant), (AB), (EB), (Mer), (MB), (IAB), (GAB)	Özarslandan et al., 2009
	C. sativus L.	(Adn), (AB), (Yal), (IAB)	
	S. nigrum L.	(Adn)	
	Citrullus lanatus L.	(Mer)	
	L. esculentum Mill., *C. annuum* L.	(Esk), (Bur), (Isp)	Kepenekci et al., 2014a
	Vegetables	(Tok)	Kepenekci et al., 2017
	Vicia faba L.	(Tok)	This study
M. thamesi	*V. vinifera* L.	(EB)	Ertürk & Borazancı, 1975
	Cucurbitaceae	(GAB)	Gündemir & Ağdacı, 1975

* (Adn): Adana province; (AB): Akdeniz Bölgesi -Mediterranean region-; (Aks): Aksaray province; (Ant): Antalya province; (Ayd): Aydın province; (y): Balıkesir province; (Bur): Burdur province; (EB): Ege Bölgesi -Aegean region-; (Ela): Elazığ province; (Esk): Eskişehir province; (GAB): Güney Anadolu Bölgesi -South Anatolia region-; (Igd): Iğdır province; (Isp): Isparta province; (IAB): İç Anadolu Bölgesi -Central Anatolia region-; (Ic): İçel province; (Ist): İstanbul province; (Izm): İzmir province; (Kar): Kahramanmaraş province; (KB): Karadeniz Bölgesi -Black Sea region-; (Mal): Malatya province; (MB): Marmara Bölgesi -Marmara region-; (Mer): Mersin province; (Nev): Nevşehir province; (Nig): Niğde province; (Sam): Samsun province (Bafra & Çarşamba Ovası -Bafra & Çarşamba Plain-); (Tok): Tokat province; (Yal): Yalova province;

FIRST COMPREHENSIVE FAUNISTIC LIST ON THE LEPIDOPTERA SPECIES OF BATMAN PROVINCE (SOUTHEASTERN TURKEY)

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ABSTRACT: In this paper, Lepidoptera samples collected from Batman Province, south-east of Turkey, in 2014-2018, are evaluated faunistically. In total, detected 177 species are listed. The number of butterflies increased to 85, moths increased to 165 and total Lepidoptera species reached to 250, in the study area. Among them, 15 butterfly and 96 moth species are reported for the first time from Batman Province. Additionally, noteworthy adult and genitalia armature figures of *Stueningia wolfi* Hausmann, 1993 (Geometridae) and *Valerietta boursini* De Freina & Hacker, 1985 (Noctuidae), which are endemic, are provided.

KEY WORDS: Fauna, Lepidoptera, moth, butterfly, Batman, Turkey

The province of Batman, in the Southeastern Anatolia Region, is mostly steep and mountainous in the north and northeast, and the south is generally hilly. The provincial lands are more often covered with steppes and on the other hand, in some mountainous regions contains sparse oak forests.

Even though, Hesselbarth et al. (1995) were given some butterfly species, first studies on the Lepidoptera fauna of Batman Province was conducted by Kemal et al. and Kemal & Koçak, in 2008 from collected samples in Kozluk district. And with result of these surveys, they were reported totally 58 diurnal Lepidopteran species. Later, Koçak & Kemal (2009) listed 66 butterfly and 8 moth species in their paper. In 2016, 4 butterflies and 50 moth species were added to these list by Seven (2016a). Then, repectively *Idaea allongata* (Staudinger, 1898) (Geometridae), (Seven, 2016b), *Agriphila cyrenaicella* (Ragonot, 1887) (Pyralidae) (Akın & Seven, 2017) and *Charissa adjectaria* Staudinger, 1897 (Geometridae) (Seven, 2018) were reported with different papers. According to the latest published list in 2018, the known Lepidoptera species in Batman Province raised to 139 (Koçak & Kemal, 2018) and, with this study, this number is reached to 250 species.

In Turkey, 5577 taxa of the Lepidoptera in 76 families (9 butterfly, 67 moth families) are known (Koçak & Kemal, 2018). But, Batman's Lepidoptera fauna is extremely little known, yet it is poorly studied and, even insect fauna is the least known in the region. The number of Lepidoptera species, especially moths, which are mostly active at night, is quite low because of the area is very mountainous and rugged, security problems and insufficient studies in the field. Until now, 70 butterfly and 69 moth species have been known in Batman (Kemal et al., 2008; Kemal & Koçak 2008a,b; Koçak & Kemal, 2018; Seven, 2016a,b, 2018). As a result of the research, the number of butterflies increased to 85 and the number of moths increased to 165 species (Table 1, 2). And all of them, 15 butterflies and 96 moths are new recorded in the Lepidoptera fauna of Batman Province.

MATERIALS AND METHODS

The present materials were collected from Batman Province, between in the years of 2014-2018 by irregular expeditions, conducted during daytime and night. The nocturnal moths were caught with a special automatic UV light trap. And a sweep net was used to capture diurnal species. Once the collected samples were inactivated, pinned, labeled and placed in wooden boxes. Nikon SMZ1000 stereo microscope was used for the preparation of the genitals and Olympus SZ61 stereo microscope and Olympus DP20 camera were used for photographing. Diagnosis was made according to the literature data by considering the external morphological and genital structures of the softened and stretched materials. To identification and distribution of the species, the sources utilized are as follows: Freina & Hermann (1985), Freina & Witt (1987), Hausmann (1993, 1996), Koçak & Seven (1994a, 1994b), Hesselbarth et al. (1995), Seven (1996), Fibiger (1997), Riemis (1998), Ronkay et al. (2001), Hacker et al. (2002), Mironov (2003), Zilli et al. (2005), Leraut (2006, 2009), Akkuzu et al. (2007), Fibiger & Hacker (2007), Can (2008), Okyar & Mironov (2008), Okyar (2009), Hausmann & Viidalepp (2012), Akın (2014, 2015), Seven (2014, 2016a, 2016b, 2018), Skou & Sihvonen (2015) Akın & Seven (2017), Koçak & Kemal (2018) and Kemal & Koçak (2018). Samples are deposited in the special collection of the author (SCES) and in the Biology Laboratory of Batman University.

Abbreviations:

Arc: Arctiidae, **Arg:** Argynnidae, **Cos:** Cossidae, **Cte:** Ctenuchidae, **Eth:** Ethmiidae, **Geo:** Geometridae, **Hes:** Hesperiidae, **Las:** Lasiocampidae, **Lyc:** Lycaenidae, **Lym:** Lymantriidae, **Noc:** Noctuidae, **Pap:** Papilionidae, **Pie:** Pieridae, **Pyr:** Pyralidae, **Sat:** Saturniidae, **Ses:** Sesiidae, **Sph:** Sphingidae, **Str:** Satyridae, **Tha:** Thaumetopoeidae, **Zgy:** Zygaenidae.

RESULTS

In this paper, totally 177 species gathered from Batman Province, representing 6 butterfly and 14 moth families, are presented in alphabetical order by listing. The species, new recorded in Batman Province, are marked with "(*)" an asterisk.

<u>Faunistic list of the species</u>

List of the butterflies

Family Argynnidae

1. *Argynnis pandora* ([Denis & Schiffermüller], 1775)
2. *Melitaea phoebe* (Goeze, 1779)*
3. *Melitaea cinxia* (Linnaeus, 1758)
4. *Precis orithya* (Linnaeus, 1758)*
5. *Vanessa cardui* (Linnaeus, 1758)
6. *Vanessa atalanta* (Linnaeus, 1758)*

Family Hesperiidae

7. *Carcharodus alceae* (Esper, [1780])
8. *Muschampia poggei* (Lederer, 1858)
9. *Spialia orbifer* (Hübner, [1823])
10. *Thymelicus acteon* (Rottemburg, 1775)

11. *Thymelicus sylvestris* (Poda, 1761)

Family Lycaenidae
12. *Chilades trochylus* (Freyer, [1843])
13. *Glaucopsyche lessei* Bernardi, 1964*
14. *Glaucopsyche alexis* (Poda, 1761)*
15. *Lycaena phlaeas* (Linnaeus, 1761)
16. *Lycaena kefersteinii* (Gerhard, [1850])*
17. *Polyommatus icarus* (Rottemburg, 1775)
18. *Tomares callimachus* (Eversmann, 1848)
19. *Zizeeria karsandra* (Moore, 1865)

Family Papilionidae
20. *Papilio machaon* Linnaeus, 1758*
21. *Zerynthia deyrollei* (Oberthür, 1869)*

Family Pieridae
22. *Anthocharis cardamines* (Linnaeus, 1758)*
23. *Aporia crataegi* (Linnaeus, 1758)
24. *Colias crocea* (Fourcroy, 1785)
25. *Colotis fausta* (Olivier, [1804])*
26. *Euchloe ausonia* (Hübner, [1804])*
27. *Pieris ergane* (Geyer, [1828])
28. *Pieris mannii* (Mayer, 1851)*
29. *Pontia chloridice* (Hübner, [1813])*
30. *Pontia edusa* (Fabricius, 1777)*

Family Satyridae
31. *Brintesia circe* (Fabricius, 1775)
32. *Coenonympha pamphilus* (Linnaeus, 1758)
33. *Hyponephele lupina* (Costa, [1836])
34. *Maniola telmessia* (Zeller, 1847)
35. *Pararge aegeria* (Linnaeus, 1758)*

List of the Moths

Family Arctiidae
36. *Cymbalophora oertzeni* (Lederer, 1855)*
37. *Manulea pseudocomplana* (Daniel, 1939)*
38. *Ocnogyna loewii* (Zeller, 1846)
39. *Paidia rica* (Freyer, [1855])*
40. *Phragmatobia fuliginosa* (Linnaeus, 1758)*
41. *Utetheisa pulchella* (Linnaeus, 1758)*

Family Cossidae
42. *Dyspessa ulula* (Borkhausen, 1790)
43. *Stygia mosulensis* Daniel, 1965*

Family Ctenuchidae
44. *Dysauxes famula* (Freyer, 1836)*

Family Ethmiidae
45. *Ethmia bipunctella* (Fabricius, 1775)

Family Geometridae
46. *Aspitates ochrearia* (Rossi, 1794)*
47. *Camptogramma bilineatum* (Linnaeus, 1758)*
48. *Charissa dubitaria* (Staudinger, 1892)*
49. *Charissa adjectaria* (Staudinger, 1898)
50. *Charissa onustaria* (Herrich-Schäffer, [1852])*
51. *Chiasmia aestimaria* (Hübner, [1809])*
52. *Cyclophora puppillaria* (Hübner, [1799])*
53. *Eumera hoeferi* Wehrli, 1934*
54. *Eupithecia breviculata* (Donzel, 1837)*
55. *Eupithecia cerussaria* (Lederer, 1855)*
56. *Eupithecia oblongata* (Thunberg,1784)*
57. *Glossotrophia sacraria* (A.Bang-Haas, 1910)*
58. *Gnophos pseudosnelleni* (Rjabov, 1964)*
59. *Idaea allongata* (Staudinger, 1898)
60. *Idaea camparia* (Herrich-Schäffer, [1852])*
61. *Idaea degeneraria* (Hübner, [1799])*
62. *Nychiodes variabila* Brandt, 1938*
63. *Orthonama obstipata* (Fabricius, 1794)
64. *Phaiogramma etruscaria* (Zeller, 1849)*
65. *Protorhoe unicata* (Guenée, [1858])
66. *Rhodometra sacraria* (Linnaeus, 1767)
67. *Scopula marginepunctata* (Goeze, 1781)
68. *Scopula submutata* (Treitschke, 1828)
69. *Selidosema plumarium* ([Denis & Schiffermüller], 1775)*
70. *Stueningia wolfi* Hausmann, 1993 (fig. 1 a-b, fig. 2 a)

Family Lasiocampidae
71. *Lasiocampa eversmanni* (Kindermann, 1843)*
72. *Lasiocampa grandis* (Rogenhofer, 1891)*

Family Lymantriidae
73. *Euproctis melania* (Staudinger, 1892)*
74. *Leucoma wiltshirei* Collenette, 1938*
75. *Ocnerogyia amanda* Staudinger, [1892]*
76. *Polymona lapidicola* (Herrich-Schäffer, [1852])*

Family Noctuidae
77. *Abrostola agnorista* Dufay,1956
78. *Abrostola clarissa* (Staudinger, 1900)*
79. *Acronicta psi* (Linnaeus, 1758)*
80. *Acronicta rumicis* (Linnaeus, 1758)*
81. *Agrotis bigramma* (Esper, [1790])*

82. *Agrotis obesa* (Boisduval, 1829)*
83. *Agrotis puta* (Hübner, [1803])*
84. *Agrotis ipsilon* (Hufnagel, 1766)
85. *Agrotis segetum* ([Denis & Schiffermüller], 1775)
86. *Apamea polyglypha* (Staudinger, 1892)*
87. *Autographa gamma* (Linnaeus, 1758)
88. *Autophila banghaasi* Boursin, 1940*
89. *Caradrina draudti* (Boursin, 1936)*
90. *Caradrina clavipalpis* (Scopoli, 1763)
91. *Caradrina flavirena* (Guenée, 1852) *
92. *Catocala abacta* Staudinger, 1900
93. *Catocala hymenaea* ([Denis & Schiffermüller], 1775)*
94. *Chersotis margaritacea* (Villers, 1789)*
95. *Cleonymia baetica* (Rambur, 1837)
96. *Cleonymia opposita* (Lederer, 1870)
97. *Clytie syriaca* (Bugnion, 1837)
98. *Colobochyla platyzona* (Lederer, 1870)*
99. *Cornutiplusia circumflexa* (Linnaeus, 1767)
100. *Craniophora pontica* (Staudinger, 1879)*
101. *Dichagyris erubescens* (Staudinger, 1892)
102. *Dichagyris singularis* (Staudinger, 1877)*
103. *Dichagyris nachadira* (Brandt, 1941)*
104. *Dysgonia torrida* (Guenée, 1852)*
105. *Earias insulana* (Boisduval, 1833)
106. *Episema korsakovi* (Christoph, 1885)*
107. *Episema lederi* Christoph, 1885
108. *Episema tersa* ([Denis & Schiffermüller], 1775)*
109. *Eublemma straminea* (Staudinger, 1892)*
110. *Eublemma pura* (Hübner, [1813])
111. *Eublemma polygramma* (Duponchel, [1842])*
112. *Eublemma ostrina* (Hübner, [1808])
113. *Euchalcia maria* (Staudinger, 1892)
114. *Grammodes bifasciata* (Petagna, 1786)
115. *Grammodes stolida* (Fabricius, 1775)*
116. *Hadena impressa* (Esper, [1790])*
117. *Haemerosia renalis* (Hübner, [1813])*
118. *Hecatera bicolorata* (Hufnagel, 1766)*
119. *Hecatera spinaciae* (Vieweg, 1790)*
120. *Hecatera weissi* (Boursin, 1952)
121. *Helicoverpa armigera* (Hübner, [1808])*
122. *Heliothis nubigera* Herrich-Schäffer, [1851]
123. *Heliothis peltigera* ([Denis & Schiffermüller], 1775)*
124. *Hoplodrina ambigua* ([Denis & Schiffermüller], 1775)*
125. *Hypeuthina fulgurita* Lederer, 1855
126. *Leucania loreyi* (Duponchel, 1827)*
127. *Leucania punctosa* (Treitschke, 1825)*
128. *Leucochlaena muscosa* (Staudinger, 1892)
129. *Metachrostis dardouini* (Boisduval, 1840)

130. *Mythimna alopecuri* (Boisduval, 1840)
131. *Mythimna l-album* (Linnaeus, 1767)
132. *Mythimna vitellina* (Hübner, [1808])*
133. *Noctua janthina* ([Denis & Schiffermüller], 1775)*
134. *Noctua orbona* (Hufnagel, 1766)
135. *Noctua comes* (Hübner, [1813])*
136. *Noctua pronuba* (Linnaeus, 1758)*
137. *Nola subchlamydula* Staudinger, 1870
138. *Pamparama acuta* (Freyer, [1837])
139. *Phylapora canescens* (Duponchel, 1826)
140. *Plecoptera inquinata* (Lederer, 1857)*
141. *Polymixis bischoffi* (Herrich-Schäffer, 1850)*
142. *Polymixis serpentina* (Treitschke, 1825)
143. *Pseudenargia deleta* (Osthelder, 1933)*
144. *Scoliopteryx libatrix* (Linnaeus, 1758)
145. *Scotochrosta pulla* ([Denis & Schiffermüller], 1775)*
146. *Shargacucullia lychnitis* (Rambur, 1833)
147. *Spodoptera exiguum* (Hübner, [1808])
148. *Stilbina hypaenides* Staudinger, 1892
149. *Valerietta boursini* De Freina & Hacker,1985* (fig. 1 c, fig. 2 b)
150. *Victrix tabora* (Staudinger, 1892)*
151. *Xestia palaestinensis* (Kalchberg, 1898)*
152. *Zekelita ravalis* (Herrich-Schäffer, [1852])*

Family Pyralidae

153. *Anania crocealis* (Hübner, 1796)*
154. *Anthophilopsis baphialis* (Staudinger, 1870)*
155. *Antigastra catalaunalis* (Duponchel, 1833)*
156. *Cynaeda gigantea* (Staudinger, 1879)*
157. *Denticera divisella* (Duponchel, 1842)*
158. *Endotricha flammealis* ([Denis & Schiffermüller], 1775)*
159. *Epascestria pustulalis* (Hübner, [1823])*
160. *Ephelis cruentalis* (Geyer, [1832])*
161. *Epischnia prodromella* (Hübner, [1799])*
162. *Eudonia mercurella* (Linnaeus, 1758)*
163. *Nomophila noctuella* ([Denis & Schiffermüller], 1775)*
164. *Pyralis farinalis* (Linnaeus, 1758)*
165. *Pyralis kacheticalis* (Christoph, 1893)*
166. *Pyrausta aurata* (Scopoli, 1763)*
167. *Pyrausta despicata* (Scopoli, 1763)*
168. *Pyrausta virginalis* Duponchel, 1832*
169. *Udea ferrugalis* (Hübner, 1796)*
170. *Uresiphita gilvata* (Fabricius, 1794)*

Family Sphingidae

171. *Hyles euphorbiae* (Linnaeus, 1758)*
172. *Hyles livornica* (Esper, [1780])
173. *Macroglossum stellatarum* (Linnaeus, 1758)
174. *Marumba quercus* ([Denis & Schiffermüller], 1775)*

175. *Smerinthus kindermanni* Lederer, 1852*

Family Thaumetopoeidae
176. *Thaumetopoea solitaria* (Freyer, [1838])*

Family Zygaenidae
177. *Jordanita notata* (Zeller, 1847)*

DISCUSSION

According to the results, the number of Lepidoptera in Batman Province reached to totally 250 species (85 butterflies and 165 moths) in the family of Arctiidae, Argynnidae, Cossidae, Ctenuchidae, Ethmiidae, Geometridae, Hesperiidae, Lasiocampidae, Lycaenidae, Lymantriidae, Noctuidae, Papilionidae, Pieridae, Pyralidae, Saturniidae, Sesiidae, Sphingidae, Satyridae, Thaumetopoeidae, and Zygaenidae. Among them, totally 111 species (15 butterflies and 96 moths) are detected for the first time in the Lepidoptera fauna of Batman. 34 % of these species are butterflies and 66 % are moths. The family of Lycaenidae is the species rich group with detected 29 species so far in the butterflies. And nearly 47 % of moths were found to contain members of the Noctuidae family. These numbers will rise in the future reports, as the ongoing researches in the study area.

Stueningia wolfi (Figs. 1a-b, 2a) was described by Hausmann (1993) and he reported that the species was distributed in the "Southern Anatolia, Southern and Western Taurus" from Turkey. *S. wolfi* is also known from Adana, Antalya, Hakkari, Mersin, Konya, Van and Batman Provinces (Koçak & Kemal, 2018; Kemal & Koçak, 2018). The species is endemic and still only known in Turkey.

Valerietta boursini (Figs. 1c, 2b) was diagnosed by De Freina & Hacker in 1985 from Hakkari and Bitlis Provinces. Koçak and Kemal (2018) reported that the species is spread of "Bitlis, Hakkari, Van and Şırnak Provinces" from Turkey. It is new recorded from Batman Province. The species is rare and endemic and just known from east and south of Turkey.

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Table 1. The number of butterflies before and after the research.

Butterflies	Arg	Hes	Lyc	Pap	Pie	Str	Total
Before	11	13	26	-	5	15	**70**
After	14	13	29	2	11	16	**85**

Table 2. The number of moths before and after the research.

Moths	Arc	Cos	Cte	Eth	Geo	Las	Lym	Noc	Pyr	Sat	Ses	Sph	Tha	Zyg	Total
Before	2	1	-	1	20	2	-	34	3	1	1	3	-	1	**69**
After	7	2	1	1	37	4	4	77	21	1	1	6	1	2	**165**

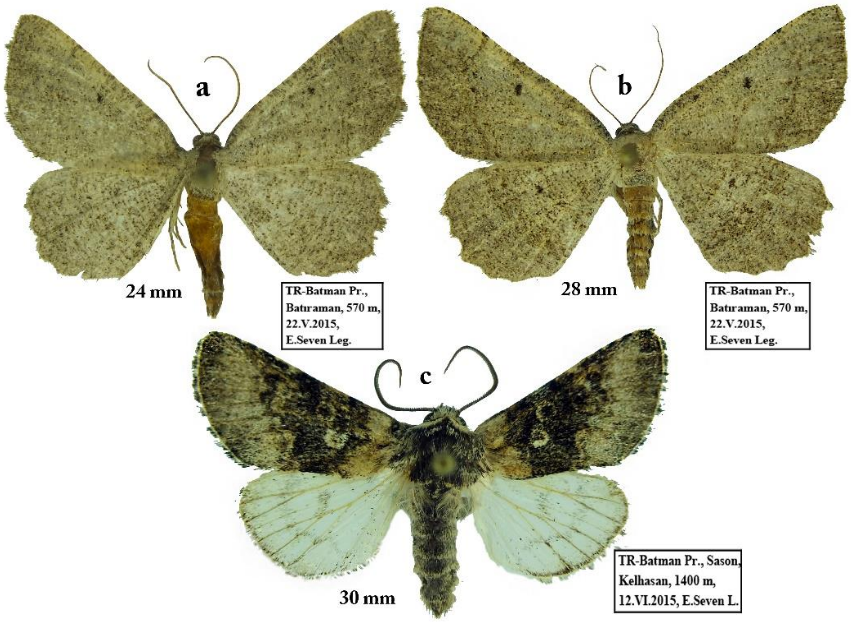

Figure 1. Adult species: a-b. Male and female of *Stueningia wolfi* Hausmann, 1993, c. Male of *Valerietta boursini* De Freina & Hacker, 1985.

Figure 2. Male genitals (scale bar: 1 mm): a. *Stueningia wolfi* Hausmann, 1993 (slide No: 2015-040), b. *Valerietta boursini* De Freina & Hacker, 1985 (slide No: 2015-035) .

A NEW SPECIES OF FLEA BEETLE GENUS *ARGOPUS* FISHER VON WALDHEIM, 1824 FROM TURKEY (CHRYSOMELIDAE: GALERUCINAE: ALTICINI)

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[Özdikmen, H., Kılıç, T., Coral Şahin, D. & Bal, N. 2019. A new species of Flea Beetle genus *Argopus* Fisher Von Waldheim, 1824 from Turkey (Chrysomelidae: Galerucinae: Alticini). Munis Entomology & Zoology, 14 (1): 448-453**]**

ABSTRACT: A new species, *Argopus circumaedeagus* sp. nov., is described from İzmir province in Turkey. For the time being, the species is endemic to the Turkey. *Argopus circumaedeagus* sp. nov. was compared with all European and Iranian species of *Argopus* Fischer von Waldheim, 1824. It can be distinctively differentiated from these species on the base of its aedeagal characters especially. Accordingly, the genus *Argopus* Fischer von Waldheim, 1824 of tribe Alticini (Chrysomelidae: Galerucinae) is recorded from Turkey for the first time.

KEY WORDS: Chrysomelidae, Galerucinae, Alticini, *Argopus,* new species, Turkey

The genus *Argopus* Fischer von Waldheim, 1824 numbers 30 species, which occur in the Palaearctic and Oriental regions (Bukejs, 2008). According to Döberl (2010) in Palaearctic catalogue of Löbl & Smetana (2010), the genus *Argopus* Fischer von Waldheim, 1824 includes 24 species in Palaearctic region. Only four species as *Argopus ahrensii* (Germar, 1817), *A. bicolor* Fischer von Waldheim, 1824, *A. brevis* Allard, 1859 and *A. nigritarsis* (Gebler, 1823) are known in Europe (Gruev & Döberl, 1997; Warchalowski, 2003, 2010; Döberl in Löbl & Smetana, 2010). Three of them (except for *A. nigritarsis*) are distributed also in Balkan countries near European Turkey (Thrace). Also only one species as *Argopus clematidis* Rapilly, 1978 is known in Iran near Asian Turkey (Anatolia). However, any species of the genus has not been recorded from Turkey until now (Ekiz et al., 2013; Özdikmen, 2014).

According to Doguet (1994), the species of *Argopus* Fischer von Waldheim, 1824 feed on Ranunculaceae (*Clematis, Trollius, Pulsatilla, Ranunculus*) and Asteraceae (*Cynara, Cirsium*). Larvae develop within leaf mines and pupate in soil. Jolivet (1991) mentioned some other host plants for this species as Fagaceae (*Quercus*), Rutaceae (*Citrus*), Euphorbiaceae (*Euphorbia*), Phytolaccaceae (*Phytolacca*) and which are not necessarily real host-plants.

Only one male specimen of *Argopus* was found in İzmir, Turkey. It is described as a new species. Thus, it is also the first record of the genus *Argopus* from Turkey.

Argopus circumaedeagus sp. nov.

(Figs. 1-3)

The new species *Argopus circumaedeagus* sp. nov., comes from west Turkey, İzmir province. Now, it is a species endemic to Turkey, which was compared with all European and Iranian species of *Argopus* Fischer von Waldheim, 1824. It can be distinctively differentiated from these species on the base of its aedeagal characters especially.

HOLOTYPE: Male – Turkey, İzmir province, Urla, Demircili, 03 May 2018 (1 specimen, ♂), on *Cynara scolynus* L. (Asteraceae), leg. T. Kılıç. The holotype is stored in Nazife Tuatay Plant Protection Museum (NTM) (Turkey, Ankara).

Description of holotype.
Length: 3.81 mm.
Body: The whole body oval wide and short, subhemispheric. Almost completely brick red (except for black eyes and apical parts of mandibles). Upper side almost completely glabrous. Underside and legs clothed with short, rather dense, recumbent or semirecumbent reddish hairs.
Head: Almost completely brick red (except for black eyes and apical parts of mandibles). Almost entirely impunctated, at most here and there with very fine and very sparsely a few punctures. More or less distinctly pubescent behind base of antennae. Nasal carina wide. Frontal callus distinct. Frons and vertex smooth and glabrous. Antennae reddish, with sparse, reddish-yellow pubescence throughout their surfaces.
Pronotum: Trapezoidal and convex, widened basally. Completely brick red. Entirely glabrous and almost impunctated, at most here and there with very fine and very sparsely a few punctures. Pronotum clearly transverse and approximately as long as 3/5 its width.
Scutellum: Small and triangular. Completely brick red. Entirely glabrous. With a few punctures.
Elytra: Completely brick red. Entirely glabrous. Strongly convex, very rounded on the sides, with variable, very fine and scattered punctures. Punctures of elytra double (fine and stronger punctures mixed). Punctures on elyra more distinct and denser than on head and pronotum. Humeral callus more or less elevated. Epipleura entirely brick red. Elytra largest in the midlength.
Legs: Completely brick red and clothed with short, rather dense, recumbent or semirecumbent reddish-yellow hairs. Upper side of mid- and hind tibiae in apical half with broad longitudinal furrow delimited by ridges.

Aedeagus: In lateral view, apical part of median lobe slightly curved median foramen to apex. Sharpened towards to apex.

In dorsal view, median lobe broadly rounded apically, apex perceptibly protruted. Upper and lateral margins of orifice almost rounded. Dorsal plate distinct, large and entire. Median lobe in lateral parts and fore part of orifice thickened. Thickening in lateral parts approximately as wide as the fore part. Median lobe behind the dorsal plate more or less broadly hollowed to latero-median part, not only median part.

In ventral view, median lobe broadly rounded apically, apex perceptibly protruded, shaped as a finger. Median lobe with longitudinal, considerably flattened area in median part.

Female: Unknown.

Differential diagnosis. The new species *Argopus circumaedeagus* sp. nov., exerts considerable morphological features differentiation from other species of the genus. Mainly, aedeagus are unique in the new species. At least median lobe broadly rounded apically in the new species while median lobe more or less narrowed or sharpened in the other species. See the description of the new species and key for the other diagnostic characters.

The closest species to the new species with regard to external morphological features is *A. ahrensii*. Then, *A. clematidis* is followed. Other two species *A. bicolor* and *A. nigritarsis* due to partly blackish or black body parts are clearly distinguished from the new species.

Distribution: The new species is known from İzmir province (Urla) in Aegean region of Turkey. For the time being, the species is endemic to the Turkey.

Etymology: The specific name of the new species is based on the shape of apical part of aedeagus.

A key for the species of *Argopus* Fischer von Waldheim, 1824 in Western Palaearctic region (the key based on Bieńkowski, 2004; Warchalowski, 2010)

1. Whole body uniformly brick red. Upper side of mid- and hind tibiae in apical half with broad longitudinal furrow delimited by ridges (Fig. 5)..**2**
-. At least legs partly blackish or black. Upper side of mid- and hind-tibiae in apical half without furrow, but with narrow longitudinal mid ridge...**5**

2. Punctures of elytra double (fine and stronger punctures mixed).......................................**3**
-. Punctures of elytra very fine, almost uniform. Anterior angles of pronotum more distinctly protruding. Aedeagus stout, apex of aedeagus slightly but rather obtusely sharpened or rather obtusely sharpened. Length 3.8-4.5 mm. Europe (France, Greece (North Sporades Islands), Spain and North Africa (Algeria, Morocco, Tunisia). *Clematis*.................................
....***A. brevis* Allard, 1859**

3. Elytra largest in the midlength..**4**
-. Elytra largest in hind part. Apex of aedeagus narrowed. Length 4.3-4.8 mm. Asia (Iran). *Clematis*..***A. clematidis* Rapilly, 1978**

4. Apex of aedeagus slightly sharpened. Length 3.5-5.2 mm. Europe (Albania, Austria, Bosnia and Herzegovina, Belarus, Croatia, Czech Republic, Germany, Greece, Hungary, Italy, Latvia, Macedonia, Moldova, Poland, Romania, Russia, Slovakia, Slovenia, Switzerland, Ukraine, Serbia & Montenegro). *Clematis*...........***A. ahrensii* (Germar, 1817)**
-. Apex of aedeagus broadly rounded. Length 3.81 mm. Turkey. *Cynara*...............................
....***A. circumaedeagus* sp. nov.**

5. Dorsum rufous, 4th-11th antennomeres, underside, and legs black. Length 3.5-5.1 mm. Europe (Bulgaria, Croatia, Hungary, SE Poland, Romania, Slovakia, Ukraine, Serbia & Montenegro), Asia (Caucasus). *Clematis, Pulsatilla*...
....***A. bicolor* Fischer von Waldheim, 1824**
-. Body rufous, 4th-11th antennomeres, tibiae, and tarsi black. Length 3.6-4.8 mm. Europe (Belarus, Hungary, Poland, Russia, Slovakia, Ukraine), Asia (China, East Siberia, Far East, Korea, Mongolia, Japan, Taiwan, Turkestan). *Pulsatilla, Adonis, Clematis, Phytolacca*..........
....***A. nigritarsis* (Gebler, 1823)**

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Figure 1. The locality of *Argopus circumaedeagus* sp. nov. in Turkey.

Figure 2. Holotype (male) of *Argopus circumaedeagus* sp. nov., dorsal habitus (left), ventral habitus (right).

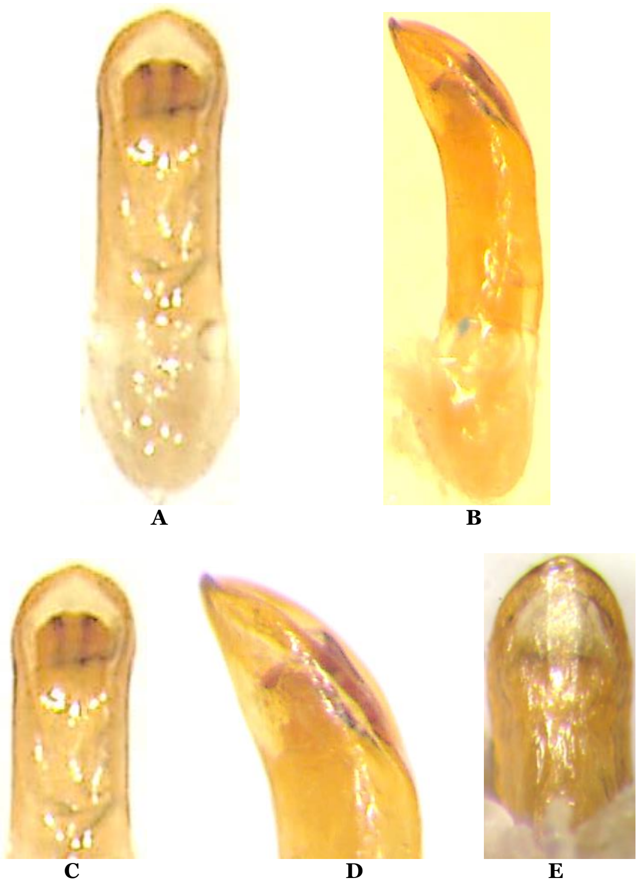

Figure 3. Aedeagus of *Argopus circumaedeagus* sp. nov., A. Dorsal view, B. Lateral view, C. Apical part of median lobe in dorsal view, D. Apical part of median lobe in lateral view, E. apical part of median lobe in ventral view.

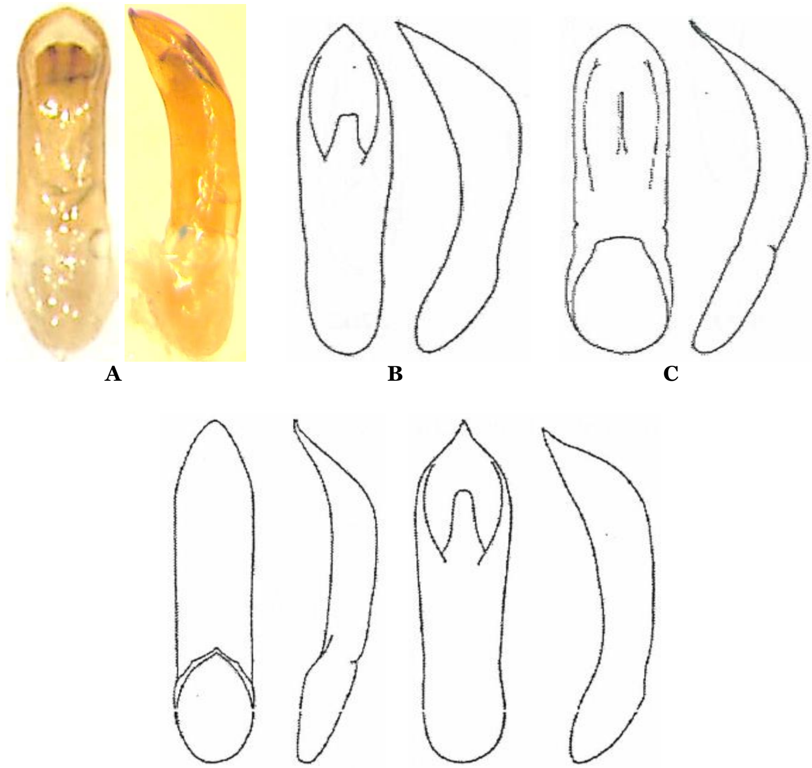

Figure 4. Aedeagus in dorsal and lateral view, A. *Argopus circumaedeagus* sp. nov., B. *Argopus ahrensii* (Germar, 1817), C. *Argopus brevis* Allard, 1859, D. *Argopus bicolor* Fischer von Waldheim, 1824, E. *Argopus nigritarsis* (Gebler, 1823) (from A. Warchalowsky, 2010).

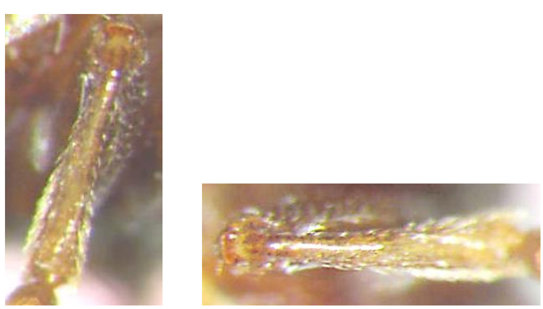

Figure 5. Broad longitudinal furrow in apical half of hind tibia.

BIODIVERSITY OF APHIDIINAE SPECIES (BRACONIDAE: HYMENOPTERA) IN SARGODHA REGION WITH PARTICULAR REFERENCE TO CITRUS ORCHARDS

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[Khalil, H., Afzal, M., Aqueel, M. A., Raza, A. B. M., Khalil, M. S. & Khalil, F. 2019. Biodiversity of Aphidiinae species (Braconidae: Hymenoptera) in Sargodha region with particular reference to citrus orchards. Munis Entomology & Zoology, 14 (2): 454-465**]**

ABSTRACT: In nature, different Aphidiinae parasitoids play a vital role in the reduction of aphid that cause huge economic losses to citrus by attacking even before flowering to fruit formation which ultimately results in decreased fruit production and poor juice contents. The diversity of Aphidiines has never been surveyed in citrus growing localities of Sargodha region. So, their distribution, richness and dominance in the specified area have to be investigated for their bio-control efficiency. Surveys were done during January 2014 to December 2015 from various citrus growing localities using malaise traps yielded 1107 parasitoids belonging to 5 species under 4 genera. Out of them, 2 species (*Lipolexis gracilis*, *L. scutellaris*) were new records to the area. Aphidiinae population was abundant in citrus orchards during the months of Feb-April and Oct-Dec while less in remaining months of the year. So this study helps us in knowing the abundance, richness and dominance of Aphidiinae in citrus growing localities of Sargodha, Pakistan and also tells us that in which season or weather Aphidiinae parasitoids are abundant in nature to control aphid pests.

KEY WORDS: Braconidae, Hymenoptera, Parasitoids, Citrus orchards, Taxonomic keys

Citrus is one of the most important fruits and is grown in more than 52 countries around the world. Pakistan also occupies a prominent position in citrus production. It is mostly growing in Punjab, particularly in Sargodha region. It plays a vital role in Pakistan economy through its export (Anon, 2004). A large number of insect pests attack on citrus crop but aphid cause great damage to plants directly or indirectly which results in decreased fruit production and poor juice contents (Aslan et al., 2004; Kavallieratos et al., 2005, 2008a).

In nature, different natural enemies such as parasitoids play a vital role in the reduction of aphid population (Stary, 1970; Kavallieratos et al., 2001, 2004, 2008a and b; Aslan et al., 2004; Rakhshani et al., 2006; Alexandre et al., 2013). Majority of aphid parasitoids belongs to the subfamily Aphidiinae within the family Braconidae. They are specialized solitary endo-parasitoids of aphids (Stary, 1970; Kavallieratos et al., 2001, 2004; Rakhshani et al., 2007; Tomanovic et al., 2003b, 2004, 2008). About 400 species of Aphidiinae parasitoids belonging to 55 genera are described worldwide (Stary, 1988; Dolphine & Quick, 2001; Aslan et al., 2004; Rakhshani et al., 2007). The aim of the present study was to identify the biodiversity of aphid parasitoids in different localities of Sargodha region.

Raychaudhuri (1990) explored the Aphidiinae parasitoids of Northeast India. He reported 122 species of parasitoids under 20 genera infecting more than 100 aphid species. Stary et al. (2000) collected 49 species of subfamily Aphidiinae from Iran. Wei et al. (2005) reported 20 genera and 99 species of Aphidiinae from

China. Rakhshani et al. (2007) recorded genus *Praon* Haliday (Aphidiinae: Braconidae: Hymenoptera) with its host relationships in Iran. A tentative key for the species identification of this genus has also been provided. Rakhshani et al. (2008a) illustrated 17 species of genus *Aphidius* Nees in different parts of Iran along with their host relationships. For species identification of genus *Aphidius* they also gave an illustrated key. Rakhshani et al. (2008b) also reported 11 species of subfamily Aphidiinae attacking 7 species of wheat aphids in Iran. Stary et al. (2008) examined a new species, *Areopraon thailandicum* of Aphidiinae parasitoids of aphids and recorded *Aphidius autriquei* for the first time in Thailand. Stary & Havelka (2008) studied faunal relationships of Aphidiinae parasitoids and illustrated that they are significant biological control agents in the world.

Kazemzadeh et al. (2009) explored a new species of aphid parasitoid *Areopraon lepelleyi* (Aphidiinae: Braconidae: Hymenoptera) informing that a total of 59 species have been discovered from Iran up till now. Talebi et al. (2009) found 34 species of Aphidiinae parasitoids on medicinal plants and also provided a list of tritrophic associations of aphid hosts, parasitoids and the respective food plants along with identification key. Barahoei et al. (2010) described 5 species of genus *Praon* along with 18 tritrophic relationships from which 2 parasitoid species, 7 host aphids, 5 host plants and 6 host aphid host plant relations were new for Iran. Stary et al. (2010) reported 11 aphid parasitoids species belonging to 10 genera from Thailand. Mejias, Hanson & Stary (2010) recorded ten species of Aphidiinae parasitoids belonging to six genera in Central America.

Bodlah (2010) reported 30 species of aphid parasitoids from Pakistan, out of those 11 species were recorded from Potohar region of Punjab Province of Pakistan. Bodlah et al. (2012a) described genus *Binodoxys* Mackauer (Aphidiinae: Braconidae: Hymenoptera) and its five species from Punjab Province of Pakistan. *Binodoxys rubicula* and *Binodoxys angelicae* were reported for the first time from Punjab. Bodlah et al. (2012b) also reported genus *Proan* Haliday (Aphidiinae: Braconidae: Hymenoptera) for the first time from Punjab Province. Rakhshani et al. (2015) identified 16 aphid parasitoids in Malta. Two species, *Aphidius absinthii* and *Trioxys pallidus* are newly recorded from the Maltese fauna.

However, no efforts have been made to explore the Aphidiinae parasitoids fauna in citrus growing areas of Sargodha. Hence, an extensive taxonomic survey of the Aphidiinae parasitoids was carried out in different citrus growing localities of Sargodha to determine their seasonal biodiversity in relation to temperature and relative humidity.

MATERIALS AND METHODS

The present study was conducted to investigate or explore the biodiversity of Aphidiinae (Braconidae: Hymenoptera) in Sargodha region with particular reference to citrus orchards for the duration of two years.

Study region and sampling locations

The adult parasitoid wasps were collected by using hand net and installing malaise traps during the years 2014-2015 from the six citrus growing localities (Bhalwal, Kot Momin, Sahiwal, Sargodha, Shahpur and Sillanwali) of Sargodha. Three malaise traps were installed in each district, total eighteen traps were installed.

The parasitoids collected with the help of net sweeping were killed in a poison bottle containing potassium cyanide while 70% ethanol was used for malaise trap collections.

Mounting and preservation of Aphidiinae parasitoids

In the laboratory, collected specimens were thoroughly washed with dilute (5-10%) soap solution and then rinsed with distilled water to remove any dust or waxy material on them. These specimens were then dehydrated by passing through ascending grades of alcohol, i.e., 70%, 80%, 90%, 95% and absolute by keeping them in each grade for about half an hour. The spreading of wings was managed through needles by keeping the specimens in a drop of absolute ethanol. After that, they were mounted from dorso-lateral side by sticking them with water based seccotine glue on triangular card points which were held by entomological pin no. 16. Small specimens were mounted on microscopic slides by using Hoyer's medium (Distilled water 50cc, Gum arabic 30g, Chloral hydrate 200g, Glycerin 20cc, Glacial acetic acid 1-2cc).

Each specimen was properly labeled and then stored in insect wooden collection boxes. The stored specimens were protected from ants and dermestid beetles by keeping naphthalene balls on pins and coopex powder in small containers in the collection boxes.

Identification of Aphidiinae parasitoids

The parasitoids were then identified under Wild M3B binocular microscope having three magnifications of 10X x 6.4X, 10X x 16X and 10X x 40X up to the species level. The illustrations were drawn by using the line drawings and camera lucida. The classification and terminology of sub family Aphidiinae have been partly followed as given by Chou (1981), Sureshan & Narendran (2000), Kavallieratos et al. (2001), Tomanovic & Kavallieratos (2002), Kavallieratos & Lykouressis (2004), Rakhshani et al. (2006) and Kos et al. (2012).

The temperature and relative humidity of all the selected localities were also been appended.

Data analysis

Diversity index (Simpson diversity index) was conducted for the analysis of species richness and evenness in different citrus growing areas of Sargodha. In this diversity index biodiversity and prevalence of Aphidiinae parasitoids were investigated in different citrus growing localities of Sargodha in different seasons. Temperature and relative humidity of the selected orchards were also correlated with parasitoids biodiversity.

RESULTS AND DISCUSSION

As a result of extensive surveys done during January 2014 - December 2015 from various localities of Sargodha districts, a total of 1107 parasitoids belonging to 5 species under 4 genera were identified. Out of them, 2 species (*Lipolexis gracilis*, *L. scutellaris*) were new records to the area.

Key to the genera of Aphidiinae parasitoids (based on adult females)

1. Last sternite modified into prongs (Fig. 2), antennae 11 segmented...***Binodoxys* Mackauer**

-. Last sternite not modified into prongs, antennae more than 11 segmented........................**2**

2. Ovipositor sheath curved downwards (Figs. 4, 5)................................***Lipolexis* Forster**

-. Ovipositor sheath curved upwards...**3**

3. Wing venation extremely reduced, only radial vein developed, antennae 13-15 segmented 140 (Fig. 3)..***Diaeretiella* Starỳ**

-. Both radial and median veins developed, antennae 15-22 segmented (Fig. 1)......................
....*Aphidius* **Nees**

Genus *Aphidius* Nees

1) *Aphidius transcaspicus* Telenga: (Figs. 1a-f)

Material Examined: Bhalwal: 4♀♀ and 2♂♂, 3-1-2014; 6♀♀ and 3♂♂, 3-2-2014; 13♀♀ and 8♂♂, 18-3-2014; 7♀♀ and 5♂♂, 3-4-2014; 5♀♀ and 4♂♂, 3-10-2014; 7♀♀ and 3♂♂, 3-1-2015; 9♀♀ and 6♂♂, 18-3-2015; 3♀♀ and 1♂, 3-12-2015; **Sahiwal:** 5♀♀ and 3♂♂, 27-1-2014; 14♀♀ and 11♂♂, 12-3-2014; 19♀♀ and 16♂♂, 27-3-2015; 7♀♀ and 5♂♂, 12-4-2015; 4♀♀ and 3♂♂, 12-9-2015; **Sargodha:** 9♀♀ and 2♂♂, 16-2-2014; 21♀♀ and 11♂♂, 1-3-2014; 8♀♀ and 4♂♂, 16-4-2014; 18♀♀ and 7♂♂, 1-3-2015; 12♀♀ and 5♂♂, 16-3-2015; 4♀♀ and 1♂, 1-12-2015; **Shahpur:** 9♀♀ and 3♂♂, 24-3-2014; 6♀♀ and 2♂♂, 9-4-2014; 2♀♀ and 1♂♂, 24-12-2014; 13♀♀ and 4♂♂, 9-3-2015; 3♀♀ and 1♂, 9-11-2015; 6♀♀ and 2♂♂, 24-1-2015; **Sillanwali:** 11♀♀ and 2♂♂, 15-3-2014; 5♀♀ and 1♂, 15-4-2014; 14♀♀ and 3♂♂, 30-3-2015; 3♀♀ and 1♂, 15-9-2015.

Genus *Binodoxys* Mackauer

2) *Binodoxys indicus* Subba Rao and Sharma: (Figs. 2a-d)

Material Examined: Material Examined: Bhalwal: 11♀♀ and 9♂♂, 18-3-2014; 5♀♀ and 4♂♂, 3-4-2014; 12♀♀ and 5♂♂, 3-3-2015; 4♀♀ and 3♂♂, 3-10-2015; **Sahiwal:** 4♀♀ and 3♂♂, 27-2-2014; 7♀♀ and 5♂♂, 12-3-2014; 3♀♀ and 2♂♂, 12-11-2015; **Sargodha:** 10♀♀ and 8♂♂, 16-2-2014; 6♀♀ and 5♂♂, 1-4-2014; 16♀♀ and 14♂♂, 1-3-2015; 8♀♀ and 7♂♂, 1-4-2015; 5♀♀ and 4♂♂, 16-12-2015; **Sillanwali:** 4♀♀ and 3♂♂, 30-1-2014; 11♀♀ and 9♂♂, 15-3-2015; 2♀♀ and 2♂♂, 30-10-2015.

Genus *Diaeretiella* Starỳ

3) *Diaeretiella rapae* M'Intosh: (Figs. 3a-e)

Material Examined: Bhalwal: 12♀♀ and 10♂♂, 3-3-2014; 7♀♀ and 5♂♂, 18-4-2014; 14♀♀ and 12♂♂, 18-2-2015; 10♀♀ and 9♂♂, 3-9-2015; **Kot Momin:** 8♀♀ and 6♂♂, 21-1-2014; 11♀♀ and 8♂♂, 21-3-2014; 15♀♀ and 12♂♂, 6-2-2015; 7♀♀ and 5♂♂, 21-10-2015; 10♀♀ and 8♂♂, 21-11-2015; **Sahiwal:** 9♀♀ and 3♂♂, 12-2-2014; 12♀♀ and 7♂♂, 27-3-2015; 4♀♀ and 2♂♂, 12-5-2015; **Sargodha:** 8♀♀ and 5♂♂, 16-2-2014; 13♀♀ and 12♂♂, 1-4-2014; 17♀♀ and 15♂♂, 1-3-2015; 9♀♀ and 7♂♂, 16-12-2015; **Shahpur:** 5♀♀ and 3♂♂, 24-2-2014; 9♀♀ and 5♂♂, 9-4-2015; 3♀♀ and 2♂♂, 24-11-2015; **Sillanwali:** 2♀♀ and 1♂, 30-3-2014; 4♀♀ and 2♂♂, 28-2-2015.

Genus *Lipolexis* Foerster

4) *Lipolexis gracilis* Foerster: (Figs. 4a-d)

Material Examined: Kot Momin: 5♀♀ and 3♂♂, 21-2-2014; 9♀♀ and 6♂♂, 6-3-2014; 11♀♀ and 7♂♂, 21-4-2014; 6♀♀ and 3♂♂, 21-2-2015; 5♀♀ and 3♂♂, 6-4-2015; 4♀♀ and 2♂♂, 21-8-2015; **Sahiwal:** 4♀♀ and 2♂♂, 12-1-2014; 9♀♀ and 5♂♂, 27-3-2015; 3♀♀ and 2♂♂, 12-12-2015; **Sillanwali:** 3♀♀ and 1♂, 15-3-2014; 2♀♀ and 1♂, 28-2-2015.

5) *Lipolexis scutellaris* Mackauer: (Figs. 5a-b)

Material Examined: Bhalwal: 4♀♀ and 2♂♂, 18-1-2014; 7♀♀ and 3♂♂, 3-3-2014; 5♀♀ and 2♂♂, 3-5-2014; 10♀♀ and 5♂♂, 18-3-2015; 7♀♀ and 4♂♂, 3-10-2015; **Sargodha:** 6♀♀ and 2♂♂, 16-1-2014; 8♀♀ and 5♂♂, 1-3-2014; 5♀♀ and 3♂♂, 1-5-2014; 11♀♀ and 8♂♂, 16-2-2015; 4♀♀ and 2♂♂, 1-4-2015; 3♀♀ and 1♂, 16-4-2015; 5♀♀ and 2♂♂, 16-11-2015; **Sillanwali:** 5♀♀ and 3♂♂, 15-2-2015; 2♀♀ and 1♂, 30-3-2015.

The results (Table 1) regarding the richness of braconid parasitoids in different localities of Sargodha showed that species richness was more in Sillanwali (5) while less in Kot Momin (2) and Shahpur (2) so Sillanwali was the richest locality with a higher number of braconid species. Only one species, *Diaeretiella rapae* was found in all citrus growing localities of Sargodha.

Among all the species collected from different citrus growing areas of Sargodha (Table 2), *Aphidius transcaspicus* was a dominant species with 367 individuals while *Lipolexis gracilis* (96) was least dominant. Aphidiinae parasitoids *Aphidius transcaspicus* (102), *Lipolexis scutellaris* (65) and *Binodoxys indicus* (83) were collected in higher number from Sargodha while population of *Aphidius* and *Lipolexis* was less in Sillanwali (40, 11) and *Binodoxys* in Sahiwal (24). In Kot Momin, *Diaeretiella rapae* (90) and *Lipolexis gracilis* (64) population was higher while less in Sillanwali (9, 7). Among localities Sargodha was a dominant locality as having 336 Aphidiinae individuals while Shahpur (79) was least dominant.

The results of table 3 revealed that the diversity of Aphidiinae (0.54) species was highest in Shahpur whereas in Sargodha Aphidiinae (0.25) parasitoids were less diverse.

The results shown in figs. 6-11 depicted that Aphidiinae population in various citrus growing localities of Sargodha was positively correlated with relative humidity while negatively correlated with temperature, as temperature increases Aphidiinae population decreases. The results also showed that Feb-April and Oct-Dec were favorable months for the activity of Aphidiines due to environmental conditions and availability of their hosts in citrus orchards. As the population of aphids was more on citrus crop during these months so Aphidiinae population was also higher in order to control them.

CONCLUSION

This study helps us in knowing the abundance, richness and dominance of Aphidiinae in citrus growing localities of Sargodha, Pakistan. Aphidiinae population is abundant in citrus orchards during the months of Feb-April and Oct-Dec. So there is a need to conserve their population during these months by avoiding excessive use of chemical insecticides in citrus orchards.

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Table 1. An overview of presence and absence of Aphidiinae parasitoids in various localities of Sargodha collected during 1-1-2014 to 30-12-2015.

Species	Localities					
	Bhalwal	Kot Momin	Sahiwal	Sargodha	Shahpur	Sillanwali
Aphidius transcaspicus	+	-	+	+	+	+
Binodoxys indicus	+	-	+	+	-	+
Diaeretiella rapae	+	+	+	+	+	+
Lipolexis gracilis	-	+	+	-	-	+
Lipolexis scutellaris	+	-	-	+	-	+
Total Species (Richness)	**4**	**2**	**4**	**4**	**2**	**5**

Table 2. Sex ratio of Aphidiinae parasitoids collected during 1-1-2014 to 30-12-2015.

Subfamilies	Localities						Total
	Bhalwal	Kot Momin	Sahiwal	Sargodha	Shahpur	Sillanwali	
Aphidius transcaspicus	**86**	-	**87**	**102**	**52**	**40**	**367**
	54♀ 32♂	-	49♀ 38♂	72♀ 30♂	39♀ 13♂	33♀ 7♂	247♀ 120♂
Binodoxys indicus	**53**	-	**24**	**83**	-	**31**	**191**
	32♀ 21♂	-	14♀ 10♂	45♀ 38♂	-	17♀ 14♂	108♀ 83♂
Diaeretiella rapae	**79**	**90**	**37**	**86**	**27**	**9**	**328**
	43♀ 36♂	51♀ 39♂	25♀ 12♂	47♀ 39♂	17♀ 10♂	6♀ 3♂	189♀ 139♂
Lipolexis gracilis	-	**64**	**25**	-	-	**7**	**96**
	-	40♀ 24♂	16♀ 9♂	-	-	5♀ 2♂	61♀ 35♂
Lipolexis scutellaris	**49**	-	-	**65**	-	**11**	**125**
	33♀ 16♂	-	-	42♀ 23♂	-	7♀ 4♂	82♀ 43♂
Total	**267**	**154**	**173**	**336**	**79**	**98**	**1107**

Table 3. Diversity Index (Simpson).

Localities	Aphidiinae
Bhalwal	0.26
Kot Momin	0.51
Sahiwal	0.33
Sargodha	0.25
Shahpur	0.54
Sillanwali	0.29

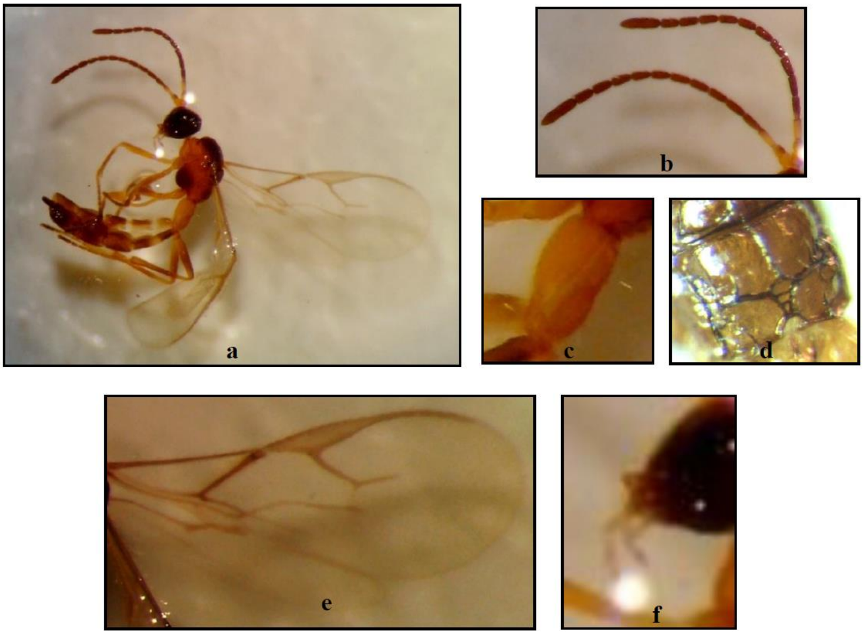

Figure 1. *Aphidius transcaspicus* Telenga. a: External Morphology; b: F1 and F2; c: Lateral view of tergite-1; d: Propodeum; e: Forewing; f: Labial palpi.

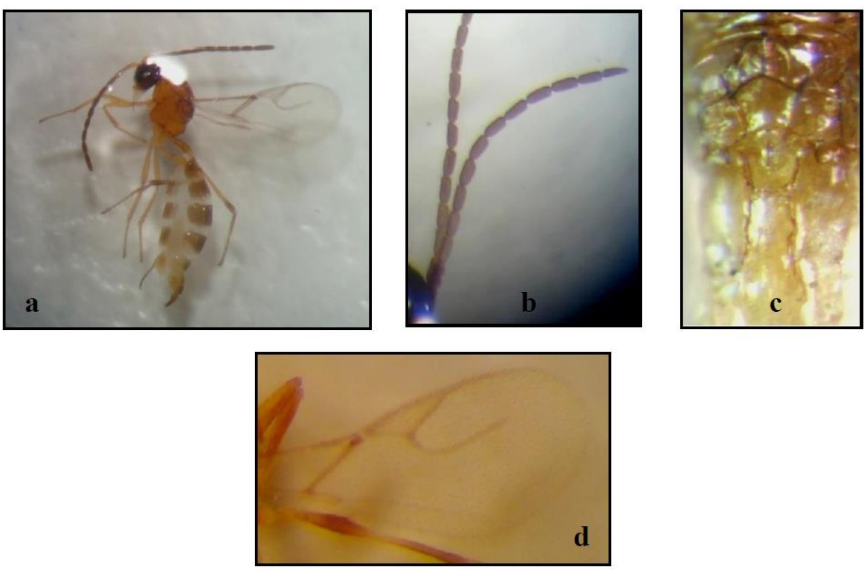

Figure 2. *Binodoxys indicus* Subba Rao and Sharma. a: External Morphology; b: F1 and F2; c: Propodeum; d: Forewing.

Figure 3. *Diaeretiella rapae* M'Intosh. a: External Morphology; b: F1 and F2; c: Lateral view of tergite-1; d: Forewing; e: Propodeum.

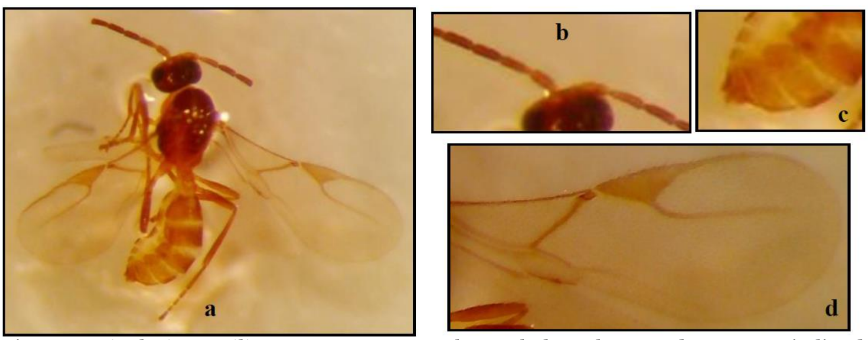

Figure 4. *Lipolexis gracilis* Foerster. a: External Morphology; b: F1 and F2; c: Genitalia; d: Forewing.

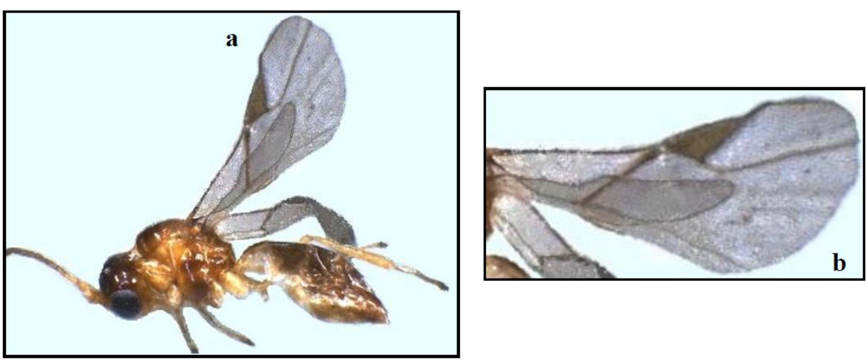

Figure 5. *Lipolexis scutellaris* Mackauer. a: External Morphology; b: F1 and F2.

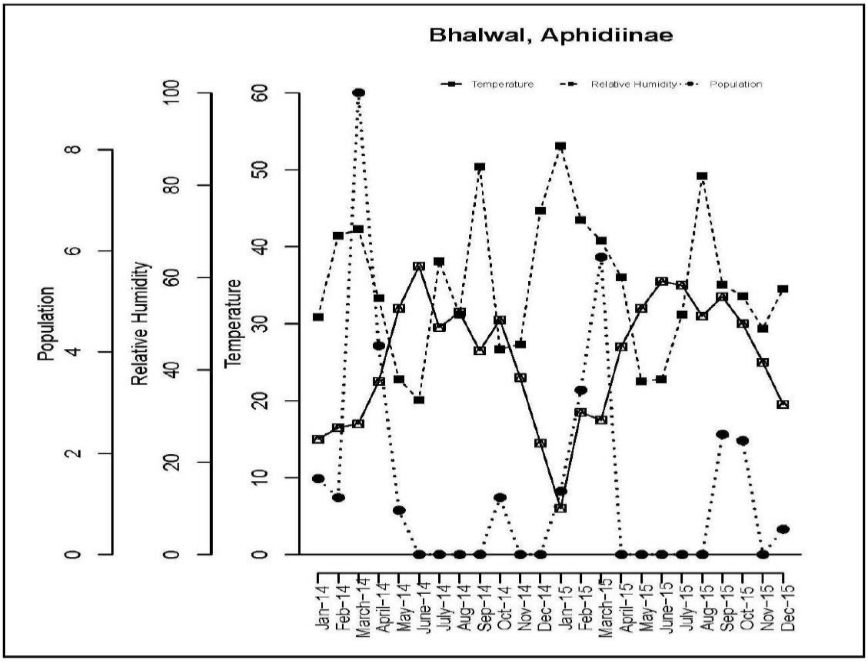

Figure 6. Monthly population of Aphidiinae parasitoids in relation to temperature and relative humidity in Bhalwal.

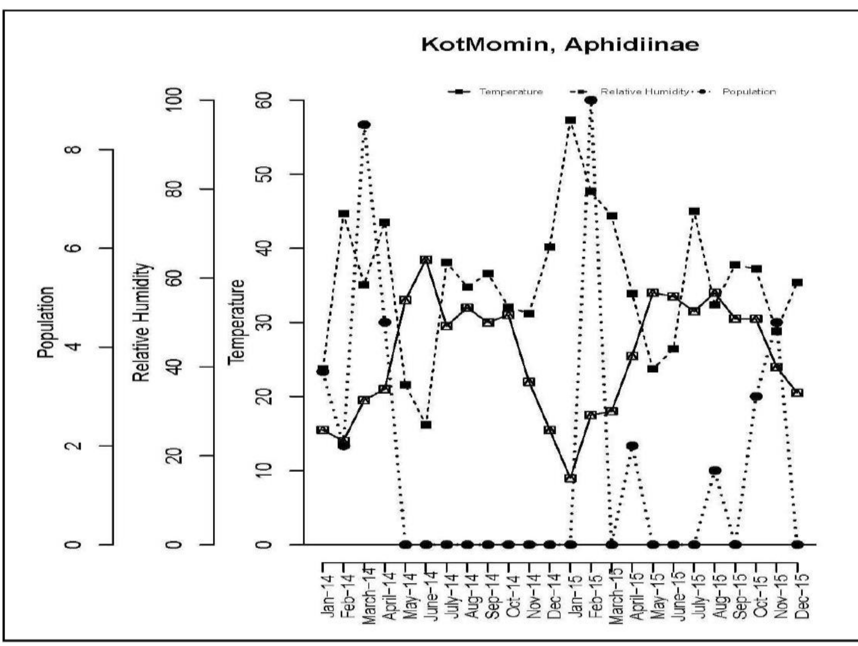

Figure 7. Monthly population of Aphidiinae parasitoids in relation to temperature and relative humidity in Kot Momin.

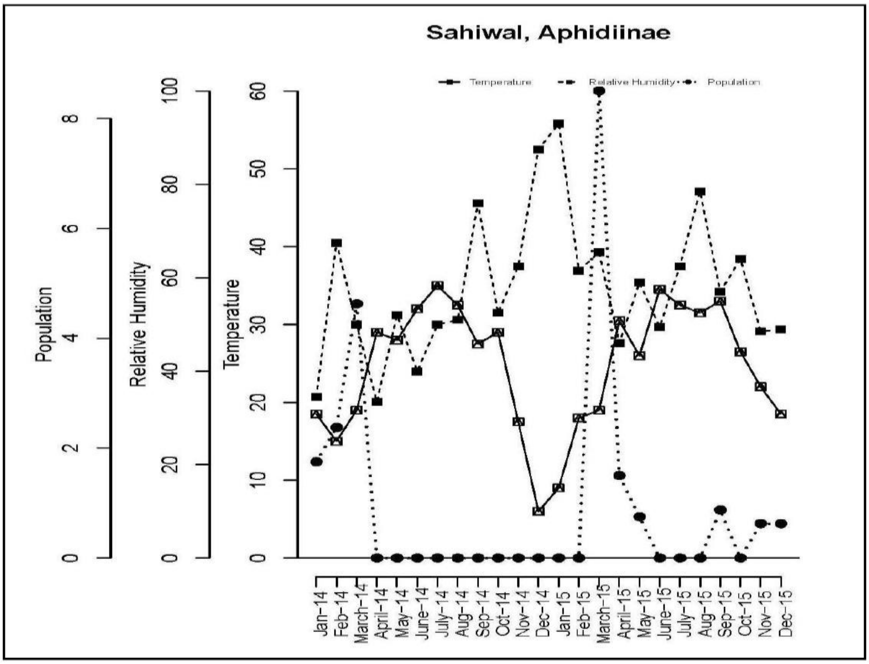

Figure 8. Monthly population of Aphidiinae parasitoids in relation to temperature and relative humidity in Sahiwal.

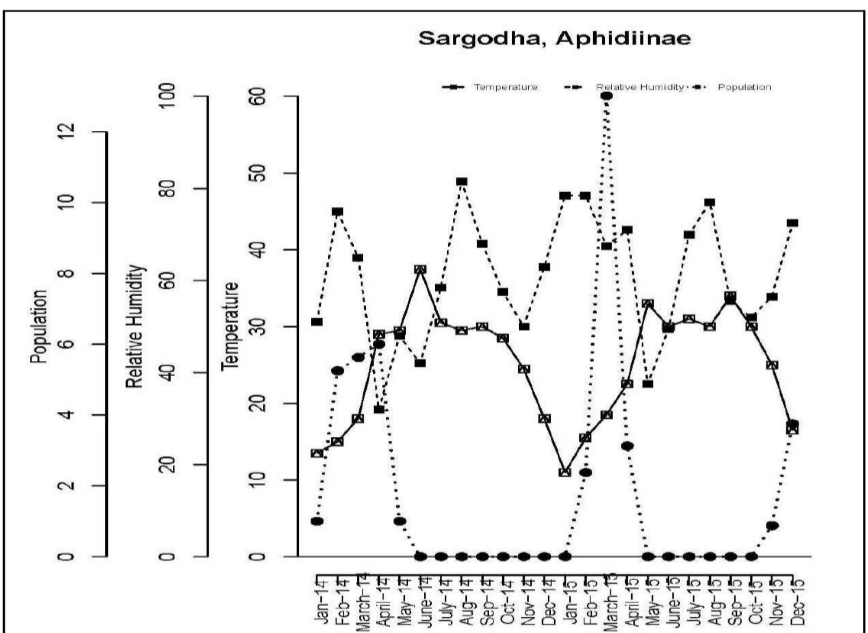

Figure 9. Monthly population of Aphidiinae parasitoids in relation to temperature and relative humidity in Sargodha.

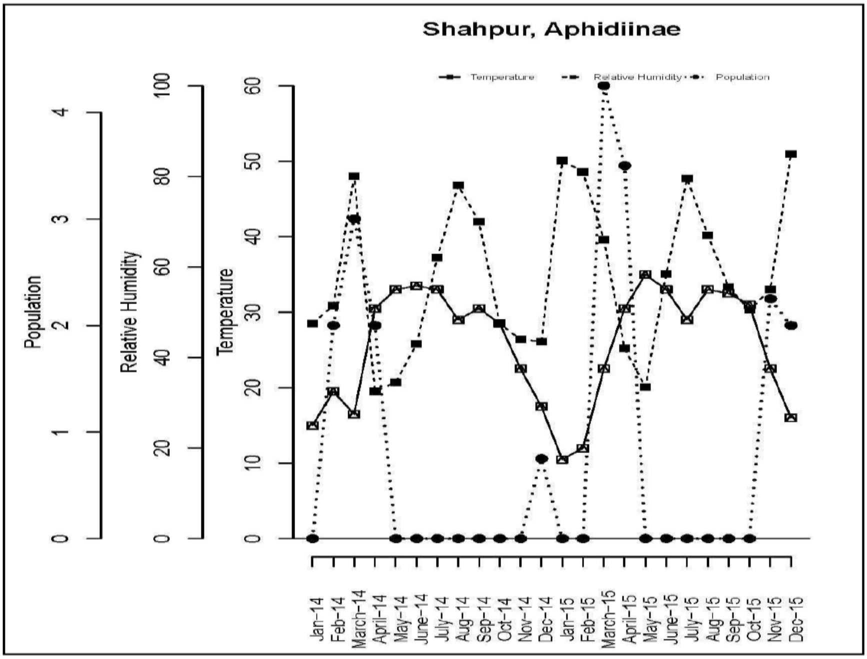

Figure 10. Monthly population of Aphidiinae parasitoids in relation to temperature and relative humidity in Shahpur.

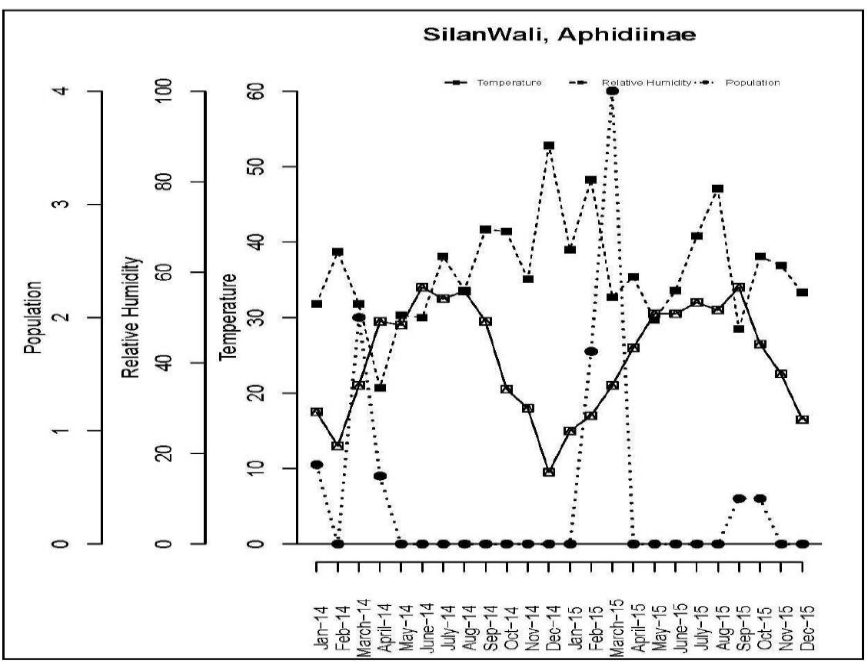

Figure 11. Monthly population of Aphidiinae parasitoids in relation to temperature and relative humidity in Sillanwali.

VARIATION IN THE SUSCEPTIBILITY OF SOME POTATO (*SOLANUM TUBEROSUM* L.) CULTIVARS TO INFESTATION WITH CERTAIN PIERCING SUCKING INSECT PESTS

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ABSTRACT: Potato (*Solanum tuberosum* L.) is an economically important vegetable crop all over the world. The piercing sucking insect pests are a serious pests threatening potato plantations in many countries. The present investigation contributes to the knowledge on the susceptibility of certain potato cultivars to infestation with these insects in Beheira Governorate, Egypt. Five cultivars currently used in Egypt's potato production were evaluated through two successive seasons (summer plantations) in field experiments for their susceptibility to sucking insect infestation. None of the tested potato cultivars was immune or highly resistant to the tested insect pests. The cultivars Banba and Diamante were found quite resistance to piercing sucking insect pests. The cultivars Herms was found as moderately susceptible while Spunta and Cara were found to be the most susceptible cultivars. The green lacewing, *Chrysoperla carnea*; seven-spotted lady beetle, *Coccinella septempunctata*; eleven spotted lady beetle, *Coccinella undecimpunctata* and the pirate bug, *Orius* sp. are the most important predators in the potato cultivars.

KEY WORDS: Potato, sucking insect pests, aphids, thrips, whitefly, natural enemies

The potato (*Solanum tuberosum* L.) is the third most important world crop, after rice, and wheat (Visser et al., 2009). It is a major source of energy, contains high levels of carbohydrate, mineral and significant amounts of vitamins B and C (Abdel-Aal et al., 1977). Potato as an economic crop has been attacked by several pests especially piercing sucking insect pests. These insects are a major pests on the vegetable plants for their direct damages that are caused by the insect feeding on the plants and/or the indirect damages as a virus vector to these planting materials. Many researchers investigated the sucking insect pests and reported that the whitefly, *Bemisia tabaci* (Gennadius); the green peach aphid, *Myzus persicae* (Sulzer), potato leaf hopper, *Empoasca discipiens* (Paoli) and the onion thrips, *Thrips tabaci* Lindeman attacked potato plants just after the first appearance of seedlings until harvesting date (Mogahed, 2000; El-khawas & Shoeb, 2004; Musa et al., 2004; Saguez et al., 2005, 2010; Mogahed, 2015; Fernandes & Fernandes, 2015 and D'Auria et al., 2016). The whitefly, *B. tabaci* has a high reproductive capacity and destructive life habits in addition to feeding on more than 700 host plant species (Greathead, 1986). The leafhopper, *Empoasca* sp., usually associated with potato crop and many other crops around the world (Lamp et al., 1994). Aphids are among the most destructive pests on potato plants in the temperate regions (Nderitu & Mueke, 1986) as a vector for the many of plant viruses. The green peach aphid is represents one of the major insect pests affecting potato production, it is distributed worldwide and feeding on over than 400 species of host plants (Raman, 1984; Hooker, 1986; Cloyd et al., 1998). The control of piercing sucking insect pests in several crops has become a challenge to growers, because the damages caused by these insects have increased in various countries (including Egypt). Among control methods, the use of resistant cultivars is very important, and it is considered the ideal method. Therefore, the present study was carried out to evaluate the susceptibility of five cultivars with respect to piercing sucking insect pest's infestation under the field conditions. Also to determine the role of beneficial species in suppressing potato piercing sucking insect pests populations.

MATERIALS AND METHODS

The present study was conducted at private farm in Abu El Matamir district (09°30′52.71″E, 56°30′16.98″N), Beheira Governorate, Egypt in summer plantation (the tubers were sown in Mid-January, 2017 and 2018 years). An area of about halve feddan was divided into 20 equal plots comprised the five cultivars (Herms, Diamante, Banba, Spunta and Cara) of potato of 4 replicates each at an inter-row distance of 75 cm and an intra-row distance of 25 cm. The experiment was designed in a completely randomized block design and the plots were separated by one meter non-cropped area. All plots received the normally recommended agricultural and kept free from any insecticidal application.

After five weeks from the sowing, samples of 40 leaves/ cultivar (10 leaves from each plot) were randomly selected and direct counts of *Bemisia tabaci* (adults) and *Empoasca decipiens* (adults), were carefully done in the early morning (when insects were less active) on both surfaces of these leaves. Also, the predators that associated with such insect pests were counted directly in the fields (in ten whole plants from each plot). Then, the investigated samples were picked and placed into paper bags and transferred to the laboratory for examine *B. tabaci* (nymphs), *E. decipiens* (nymphs), *Myzus persicae*, *Aphis gossypii*, *Thrips tabaci* (adults and nymphs) by the aid of stereoscopic microscope. Sampling continued until the crop harvest. The analysis of variance (F-test) was adopted and the L.S.D values were used to determine the significance between means of cultivars for both insect species and natural predators (SAS Statistical software, 1999).

RESULTS AND DISCUSSION

Data presented in Tables (1, 2) shows the means of weekly counts (adults and nymphs) of whitefly, onion thrips, leafhopper, cotton aphid and green peach aphid through the whole season on the leaves of five cultivars of potato plants namely, Herms, Diamante, Banba, Spunta and Cara. None of the tested potato cultivars was immune or highly resistant to the tested sucking insect pests. However, the different tested cultivars of potato showed different resistance capacity against piercing sucking insect pests.

Data presented in Table (1) and illustrated in Fig. (1) indicated that, among the different potato cultivars, Cara recorded the highest attraction of whitefly, *B. tabaci* with mean numbers of 8.89 individuals/ leaf which was significant ($P > 0.05$) than Banba (4.68 individuals/ leaf), and Diamante (3.6 individual/leaf) and insignificance with Spunta (7.91 individuals/ leaf) and Herms (8.76 individuals). Regarding to the onion thrips, *T. tabaci*, the L. S. D value was 0.44, accordingly there is no significant differences between Spunta cultivar and the four cultivars; Cara, Banba, Herms and Diamante. The lowest mean numbers of thrips /leaf were recorded in Diamante (0.44 individuals) while the highest mean of thrips /leaf was recorded in Spunta cultivar (1.02 individuals). Also the results in Table 1 reveals that the potato cultivars were arranged descendingly according to their susceptibility to potato leafhopper, *E. decipiens* as follow: Spunta (11.25

individuals/ leaf), Cara (8.56 individuals/ leaf), Herms (6.58 individuals/ leaf), Diamante (3.77 individuals/ leaf) and Banba (3.64 individuals/ leaf). The mean numbers of *M. persicae* ranged between 5.74 individuals / leaf in Spunta cultivar to 1.53 individuals/leaf in Diamante cultivar while the Cara cultivar recorded the highest number of cotton aphids (3.37 individuals). Generally, the obtained results in Table (1) showed that the tested potato cultivars showed significant variation in their susceptibility to the infestation by the sucking insect complex. Spunta cultivar was the most susceptible one because it was harbored the highly numbers of the piercing sucking insect pests especially leafhopper than the other cultivars while the Diamante cultivar was the lowest sensitivity cultivar.

Coexistence of sucking pests on different cultivars of potato plants on the summer plantation:

Data presented in Table 1 summarized the coexistence of five sucking insect pests infesting five potato cultivars during the summer plantation of 2017 season. The insects showed variable population densities and coexistence percentages. The most common and dominant sucking insect pests on Herms, Banba and Cara was the whitefly, *B. tabaci*, which was represented by 43.7, 34.98 and 32.77 %, respectively, followed by the leafhoppers, which was represented by 32.82, 27.2 and 31.55 %, respectively, of the total sucking insects population. Meanwhile, the most abundant sucking pest on Spunta and Diamante cultivars was the leafhopper, *E. decipiens* which coexisted by 38.47 and 36.43%, followed by *B. tabaci* (27.05% and 34.78) of the total population of sucking insects. Meanwhile the species of *T. tabaci* which had low values of dominance degrees (3.35, 3.39, 3.49, 4.25 and 5.46 % in Cara, Herms, Spunta, Diamante and Banba, respectively) is expected to be of little economic importance as it may cause a minor role as a pest in potato plantations.

The same trend of infestation was repeated on the 2nd season, 2018 with slightly variation, the obtained results (Table 2 & Fig. 2) indicated that there were no significant differences ($P > 0.05$) in the mean numbers of *B. tabaci* among Herms, Spunta and Cara varieties, then, the highest mean number of whitefly infestation was recorded on Herms (5.42 individual/ leaf) followed by Spunta (4.42 individual/ leaf). Concerning the leafhopper, *E. decipiens* the tested cultivars could be arranged in descending order according to intensity of infestation as follow: Spunta, Herms, Cara, Banba and Diamante, respectively. The highest significant differences ($P < 0.05$) in the mean of infestation of the green peach aphid, *M. persicae* and leafhopper, *E. decipiens* were recorded between Spunta and Diamante. On the other hand, the data in Table (2) show that, generally Spunta cultivar recorded the highest infestation by *M. persicae* through the period of study (6.11 individual/leaf) while Cara cultivar (4.34 individual/leaf) come in the second order. The lowest infestation with *M. persicae* (2.32) and *A. gosypii* (0.93 individual / leaf) was in Diamante Cultivar while Cara cultivar was the highest susceptibility cultivar to infestation with *A. gosypii* (2.35).

Data presented in Table 2 and illustrated in Fig. 2 show the coexistence of sucking pests on different cultivars of potato cultivars on the 2nd season, 2018, *E. decipiens* seems to be the most important economic pests on all the tested cultivars except Banba, it made up 37.77, 39.48, 32.48 and 34.19 % of the total piercing sucking insect complex in Herms, Spunta, Cara and Diamante cultivars, respectively. The green peach aphid had high abundance degrees (27.32, 27.47, 25.73 and 28.54) in Banba, Spunta, Cara and Diamante cultivars, respectively. Also, Table 3 shows that the *B. tabaci* made up 34, 28.32, 24.6, 22.63 and 19.87 of the total insect pests on Herms, Banba, Cara, Diamante and Spunta respectively.

Co-existents of predacious insects in potato varieties:

Results in Tables (3-4) showed predatory species found on potato plants cultivars during two seasons, 2017 and 2018 in summer plantation. During the 1st season (Table 3), the overall mean population of the green lacewing in potato cultivars was 4.61, 3.55, 3.16, 2.91 and 2.65 / plant in Spunta, Diamante, Cara, Banba and Herms, respectively. The highest mean number of the seven spotted lady beetle *C. septempunctata* was recorded in Spunta cultivar (2.48) while the lowest mean number of this species was recorded in Diamante (1.11 individuals/ plant). On the other hand, the overall mean population of *C. undecimpunctata* were 2.04, 1.87, 1.4, 1.3 and 0.82 per plant on Spunta, Cara, Banba, Herms and finally Diamante, respectively. The population of *Orius sp* varied non-significantly ($F_{0.05}$=1.713) with potato cultivars where's the overall mean population of *Orius sp* were 1.52 individuals/plant in Spunta cultivar followed by 1.13, 1.11, 0.84 and 0.71 in Cara, Diamante, Herms and Banba, respectively.

The same trend was repeated on the 2nd season (Table 4) where's the Spunta cultivar harbored the highest numbers of *C. carnea* (4.38), *C. septempunctata* (2.41), *C. undecimpunctata* (1.55) and *Orius* sp (1.32 individuals / plant). Followed by Cara cultivar (2.75, 1.36, 1.13 and 0.76 for *C. carnea*, *C. septempunctata*, *C. undecimpunctata* and *Orius* sp., respectively). The lowest mean of population density of *C. carnea* (1.32 individual / plant) was recorded in Herms cultivars while the lowest means population of *C. septempunctata* (2.41) and *C. undecimpunctata* (1.55) were recorded in Diamante cultivar.

DISCUSSION

The crop cultivars that are resistant to insect pests considered one of the most important items in integrated pest management system. Resistance cultivars may be less preferred by insects because their effect on the survival and normal development of these insects. (Hoffman & Frodsham, 1993). The resistance cultivars have been used greatly day after day to avoid the use chemical insecticides and their toxic effect. Many studies have investigated the susceptibility of different cultivars of different crops to several piercing insect pests such as Musa et al. (2004) who studied the sensitivity of two potato cultivars (Romano & Desiree) to *M. persicae* and Mogahed (2015) who studied the sensitivity of Nicola and Spunta cultivars to aphids, jassids and whitefly. Silva et al. (2008) evaluated the resistance of 24 potato genotypes to *B. tabaci* in five greenhouse experiments. They found that the cultivar Achat was the most resistant while clone NYL 235-4 was the most susceptible to *B. tabaci*.

Although no any cultivar showed 100% resistance against the sucking insect pests, the hypothesis of the planned work was verified on the present results that the different cultivars of potato plants have different resistance capacity against piercing sucking insect pests. Throughout the study, the most susceptible cultivar was Spunta followed by Cara; whereas, Diamante showed more resistance against sucking insect complex as compared to the other tested cultivars tested. In general, the mean number of whiteflies and leafhopper populations were more abundant compared to that of thrips or aphids populations. These results are in harmony with those recorded by Mogahed (2015) who found that each of the leaf hopper, *E. discipiens* and white fly, *B. tabaci* were more present on the potato plants than other piercing pests. In Pakistan, Ali et al. (2011) found that the population density of aphids per leaf of potato plants was more abundant than leafhopper and whitefly population before the treatment with some chemical against the aphids, jassids and whiteflies.

The results revealed that the maximum green peach aphid's population was observed on Spunta followed by Cara and were statistically similar to each other, while the minimum green peach aphids population was observed on Diamante cultivar. Musa et al. (2004) in Kosovo, found that the highest number of *M. persicae* was recorded on potato plants var. Romano (16.8 as a verage number of aphids/100 leaves), whereas the lowest number of this species was recorded on potato plants var. Desiree (2.2 aphids/100 leaves). Fréchette et al. (2009) found that the wild potato more resistant to *M. persicae* than the commercially cultivated *S. tuberosum* cv. Désirée. Mahmoud et al., 2011 studied the host preference of potato leaf hopper, *E. decipiens* from six plant species and find that the potato plants was the 2nd preferred host to this insect after broad bean plant and followed by squash, Pea, green bean and finally lupin. During this study the Spunta cultivar was the most susceptible for this insect while diamante was the less preferred potato cultivars. On the whole, it is clear that the total numbers of the *B. tabaci*, *T. tabaci*, *E. decipiens* and *A. gosypii* on the different cultivars were more abundant during the 1st season than the 2nd season. On the contrary, the green peach aphids was more abundant during the 2nd season than 1st seasn. These levels of infestation between the two seasons might be attributed to the differences in the weather factors. Also, the previous results revealed that the green lacewing, *C. carnea*; seven-spotted lady beetle, *C. septempunctata*; eleven spotted lady beetle, *C. undecimpunctata* and the pirate bug, *Orius* sp. were the most important predators in the potato plants. The green lacewing, *C. carnea* was the most prevailing pests on potato plant cultivars representing from 38.54 to 53.87% and from 35.11 to 47.22% of the total predators in the different cultivars during the 1st and 2nd seasns, respectively. In this respect, Sherief, *et al.* 2013 in sugar beet plants in Zagazig district in Sharkia Governorate found that the *Chersoperla carnea* represented about 54.75 and 45.05 % of the total predators in 1st and 2nd season, respectively. While these results are in disagreement with Hamouda (1993) who stated that the chrysopid predator represented 5.5-10.2% while the coccinellid predator species represented 78.5-90.1% of the total predator species in vegetable fields.

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Table 1. Seasonal mean numbers (and coexistence %) of certain sucking insect pests on different potato plant cultivars at Beheira Governorate during the summer plantation of 2017.

Cultivar	*B. tabaci*	*T. tabaci*	*E. decipiens*	*A. gosypii*	*M. persicae*	General mean
Herms	8.76 ± 0.96^{a}	0.68 ± 0.158^{ab}	6.58 ± 0.76^{b}	1.66 ± 0.16^{b}	2.37 ± 0.41^{bc}	20.05 ± 1.99^{b}
	(43.7)	(3.39)	(32.82)	(8.27)	(11.82)	(100 %)
Banba	4.68 ± 0.55^{b}	0.73 ± 0.161^{ab}	3.64 ± 0.55^{bc}	1.56 ± 0.18^{b}	2.77 ± 0.27^{b}	13.37 ± 1.46^{c}
	(34.98)	(5.46)	(27.2)	(11.66)	(20.7)	(100 %)
Spunta	7.91 ± 0.72^{a}	1.02 ± 0.174^{a}	11.25 ± 0.95^{a}	3.32 ± 0.4^{a}	5.74 ± 0.63^{a}	29.24 ± 2.16^{a}
	(27.05)	(3.49)	(38.47)	(11.35)	(19.63)	(100 %)
Cara	8.89 ± 0.77^{a}	0.91 ± 0.178^{a}	$8.56 \pm .97^{b}$	3.37 ± 0.41^{a}	5.4 ± 0.56^{ab}	27.13 ± 2.3^{a}
	(32.77)	(3.35)	(31.55)	(12.42)	(19.9)	(100 %)
Diamante	3.6 ± 0.33^{c}	0.44 ± 0.088^{b}	3.77 ± 0.57^{c}	1.01 ± 0.18^{b}	1.53 ± 0.23^{c}	10.35 ± 1.22^{c}
	(34.78)	(4.25)	(36.43)	(9.76)	(14.78)	(100 %)
$F_{0.05}$	12.419	2.088	17.363	14.208	17.7	19.44
L.S.D.	1.98155	0.4412	2.2133	0.8.199	1.2769	5.3247

Means followed by the same letter(s) within the same column are nonsignificantly different ($P \leq 0.05$)

Table 2. Seasonal mean numbers (and coexistence %) of certain sucking insect pests on different potato plant cultivars at Beheira Governorate during the summer plantation of 2018.

	B. tabaci	*T. tabaci*	*E. decipiens*	*A. gosypii*	*M. persicae*	General mean
Herms	5.42 ± 0.95^{a}	0.25 ± 0.05^{c}	6.02 ± 0.78^{ab}	1.18 ± 0.19^{cd}	3.07 ± 0.47^{bc}	15.92 ± 2.2^{b}
	(34)	(1.57)	(37.77)	(7.4)	(19.26)	(100 %)
Banba	3.11 ± 0.58^{bc}	0.33 ± 0.07^{b}	3.07 ± 0.53^{b}	1.47 ± 0.14^{bcd}	3 ± 0.59^{bc}	10.98 ± 1.75^{bc}
	(28.32)	(3)	(27.96)	(13.39)	(27.32)	(100 %)
Spunta	4.42 ± 0.59^{ab}	0.9 ± 0.16^{a}	8.78 ± 0.88^{a}	2.03 ± 0.32^{ab}	6.11 ± 0.97^{a}	22.24 ± 2.31^{a}
	(19.87)	(4.05)	(39.48)	(9.13)	(27.47)	(100 %)
Cara	4.15 ± 0.49^{ab}	0.55 ± 0.13^{b}	5.48 ± 0.84^{ab}	2.35 ± 0.28^{a}	4.34 ± 0.74^{ab}	16.87 ± 2.3^{ab}
	(24.6)	(3.26)	(32.48)	(13.93)	(25.73)	(100 %)
Diamante	1.84 ± 0.34^{c}	0.26 ± 0.07^{bc}	2.78 ± 0.88^{b}	0.93 ± 0.12^{d}	2.32 ± 0.37^{c}	8.13 ± 1.19^{c}
	(22.63)	(3.2)	(34.19)	(11.44)	(28.54)	(100 %)
$F_{0.05}$	4.792	6.805	11.18	6.846	5.15	7.535
L.S.D.	1.77	0.29905	2.08095	0.6411	1.8764	5.66935

Means followed by the same letter(s) within the same column are nonsignificantly different ($P \leq 0.05$)

Table 3. Coexistence of certain insect predators on different potato cultivars at Beheira Governorate during the summer plantation of 2017.

	C. carnea	*C. septempunctata*	*C. undecimpunctata*	*Orius sp*	General mean
Herms	2.65 ± 0.53^{b}	1.4 ± 0.4^{ab}	1.4 ± 0.29^{ab}	0.84 ± 0.17^{ab}	6.29 ± 1.34
	(42.13)	(22.26)	(22.26)	(13.35)	(100 %)
Banba	2.91 ± 0.57^{b}	1.35 ± 0.34^{ab}	1.3 ± 0.29^{ab}	0.71 ± 0.2^{b}	6.26 ± 1.28
	(46.41)	(21.53)	(20.73)	(11.32)	(100%)
Spunta	4.61 ± 0.93^{a}	2.48 ± 0.55^{a}	2.04 ± 0.52^{a}	1.52 ± 0.32^{a}	10.65 ± 2.22
	(43.29)	(23.29)	(19.15)	(14.27)	(100%)
Cara	3.16 ± 0.83^{ab}	2.03 ± 0.51^{a}	1.87 ± 0.3^{a}	1.14 ± 0.26^{ab}	8.2 ± 1.66
	(38.54)	(24.76)	(22.8)	(13.9)	(100%)
Diamante	3.55 ± 0.81^{ab}	1.11 ± 0.21^{b}	0.82 ± 0.15^{b}	1.11 ± 0.22^{ab}	6.58 ± 1.3
	(53.87)	(16.84)	(12.44)	(16.84)	(100%)
$F_{0.05}$	1.035	1.803	2.088	1.713	1.38
L.S.D.	1.6737	1.19655	0.95325	0.6787	4.5505

Means followed by the same letter(s) within the same column are nonsignificantly different ($P \leq 0.05$)

Table 4. Coexistence of certain insect predators on different potato plant cultivars at Beheira Governorate during the summer plantation of 2018.

	C. carnea	*C. septempunctata*	*C. undecimpunctata*	*Orius sp*	General mean
Herms	1.32±0.38[b]	1.03±0.3[b]	0.67±0.22	0.74±0.2	3.75±0.97[b]
	(35.11)	(27.39)	(17.82)	(19.68)	(100%)
Banba	2.37±0.53[ab]	1.29±0.29[ab]	0.84±0.24[ab]	0.62±0.18	5.11±1.13[b]
	(46.29)	(25.2)	(16.41)	(12.11)	(100%)
Spunta	4.38±1.03[a]	2.41±0.67[a]	1.55±0.39	1.32±0.28	9.65±2.2[a]
	(45.34)	(24.95)	(16.04)	(13.66)	(100%)
Cara	2.75±0.76[ab]	1.36±0.37[ab]	1.13±0.38	0.76±0.2	6±1.58[ab]
	(45.83)	(22.67)	(18.83)	(12.67)	(100%)
Diamante	2.46±0.78[ab]	0.96±0.17[b]	0.64±0.18	1.15±0.33	5.21±1.22[b]
	(47.22)	(18.43)	(12.28)	(22.07)	(100%)
$F_{0.05}$	2.28	2.14	1.639	1.523	2.238
L.S.D.	2.08105	1.1323	2.081	0.689	4.223

Means followed by the same letter(s) within the same column are nonsignificantly different ($P \leq 0.05$)

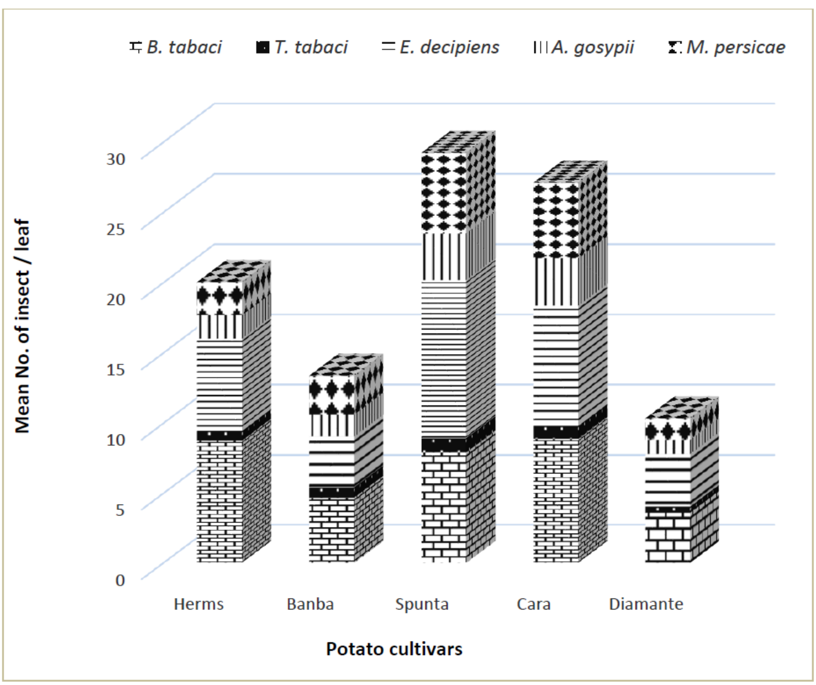

Figure 1. Susceptibility of different potato plant cultivars to certain sucking insect pests at Beheira Governorate during the summer plantation of 2017.

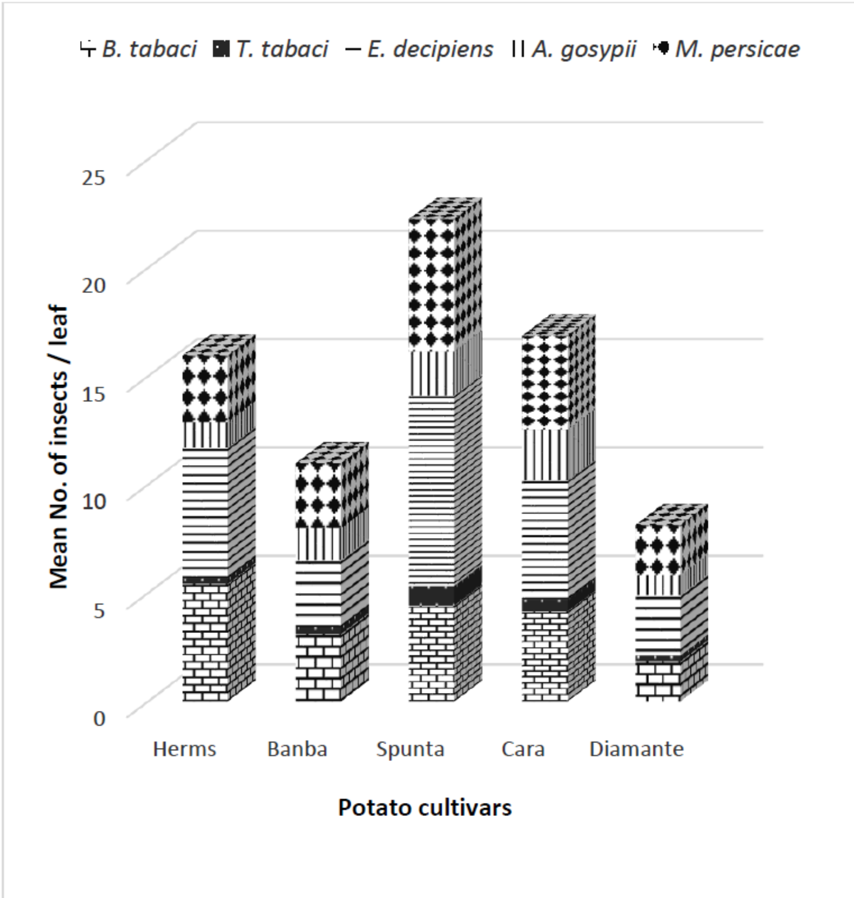

Figure 2. Susceptibility of different potato plant cultivars to certain sucking insect pests at Beheira Governorate during the summer plantation of 2018.

A LIST OF HETEROPTERA SPECIES REPORTED FROM *SALIX* SPP. IN TURKEY

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[Kıyak, S. 2019. A list of Heteroptera species reported from *Salix* in Turkey. Munis Entomology & Zoology, 14 (2): 475-477**]**

ABSTRACT: In this study, 85 species inhabiting on *Salix* as a hostplant, of 13 families in Heteroptera from Turkey are recorded.

KEY WORDS: Heteroptera, hostplant, *Salix*, Turkey

The aim of this study is presented a list of previously reported Turkish terrestrial Heteroptera species inhabiting on *Salix* spp. in Turkey according to the previous literatures as Aysev (1974), Boz (1992), Çakır (1988), Heiss & Pericart (1983), Kıyak (1990), Lodos & Önder (1980), Lodos et al. (1978), Önder & Lodos (1983), Pehlivan (1981), Seidenstücker (1966), Stichel (1956, 1957, 1958), Wagner (1971, 1973, 1976), Yardım (1990). Thus, 85 heteropteran species inhabiting on *Salix* as a hostplant, of 13 families from Turkey are determined with this work. 33 species of Miridae, 6 species of Anthocoridae, 4 species Reduviidae, 4 species of Tingidae, 2 species of Aradidae, 1 species of Aneuridae, 2 species Piesmidae, 1 species of Coreidae, 4 species Rhopalidae, 11 species of Lygaeidae, 13 species of Pentatomidae, 2 species of Acanthosomatidae, 1 species of Cydnidae are recorded.

All species are given into a list in the following table.

List of Heteroptera species inhabiting on *Salix* in Turkey

Familia/species	Host plant (s)	Cited literature (s)
MIRIDAE		
Psallus rubinicterus Sdst, 1966	*Salix* sp.	Seidenstücker, 1966; Wagner, 1976
Phytocoris ulmi (L., 1758)	*Salix* sp.	Wagner, 1971; Lodos et al., 1978; Önder & Lodos, 1983
Calocoris fulvomaculatus (Deg., 1773)	*Salix* sp.	Wagner, 1971
Miris striatus (L., 1758)	*Salix* sp.	Wagner, 1971
Orthotylus marginalis Rt., 1883	*Salix* sp.	Wagner, 1973; Lodos et al., 1978
Orthotylus nassatus (F., 1787)	*Salix* sp.	Wagner, 1973
Sthenarus roseri (H.-S., 1839)	*Salix alba*	Wagner, 1976
Deraeocoris lutescens (Schl., 1837)	*Salix* sp.	Lodos et al., 1978
Lygus reclairei Wagner, 1949	*Salix* sp.	Lodos et al., 1978; Stichel, 1956
Calocoris norvegicus ssp. *norvegicus* (Gml., 1788)	*Salix* sp.	Lodos et al., 1978
Orthops kalmi (L., 1753)	*Salix* sp.	Lodos et al., 1978
Stenodema calcaratum (Fn., 1807)	*Salix* sp.	Lodos et al., 1978
Pachytomella passerinii (C., 1841)	*Salix* sp.	Lodos et al., 1978
Pilophorus clavatus (L., 1767)	*Salix* sp.	Lodos et al., 1978
Monosynamma bohemani (Fn., 1829)	*Salix* sp., *Salix caprea, Salix cinerea, Salix alba, Salix repens, Salix viminalis*	Stichel, 1956; Lodos et al., 1978
Phylus coryli (L., 1758)	*Salix* sp.	Lodos et al., 1978
Phylidea bipunctatus Rt., 1883	*Salix* sp.	Lodos et al., 1978

Psallus ancorifer ssp. *ancorifer* (Fb., 1858)	*Salix* sp.	Lodos et al., 1978
Sthenarus roseri (H.-S., 1839)	*Salix* sp.	Lodos et al., 1978
Thermocoris munieri Pt., 1875	*Salix* sp.	Lodos et al., 1978
Deraeocoris punctulatus (Fn., 1807)	*Salix purpurea*	Stichel, 1956
Globiceps cruciatus Rt., 1879	*Salix* sp.	Stichel, 1956
Globiceps flavomaculatus (F., 1794)	*Salix* sp.	Stichel, 1956
Trigonotylus ruficornis (G., 1785)	*Salix* sp.	Stichel, 1956
Adelphocoris seticornis (F., 1775)	*Salix purpurea*	Stichel, 1956
Calocoris affinis (H.-S., 1835)	*Salix* sp.	Stichel, 1956
Calocoris quadripunctatus (Vil., 1789)	*Salix caprea*	Stichel, 1956
Calocoris fulvomaculatus (Deg., 1773)	*Salix* sp.	Stichel, 1956
Miris striatus (L., 1758)	*Salix* sp.	Stichel, 1956
Capsus ater (L., 1758)	*Salix purpurea*	Stichel, 1956
Lygus kalmi (L., 1758)	*Salix* sp.	Stichel, 1956
Lucorum lucorum (M.-D., 1843)	*Salix* sp.	Stichel, 1956
Stenodema trispinosum Rt., 1904	*Salix* sp.	Yardım, 1990
ANTHOCORIDAE		
Anthocoris confusus Reut., 1884	*Salix caprea*	Stichel, 1958
Anthocoris nemoralis (F., 1794)	*Salix* sp.	Stichel, 1958
Anthocoris gallarum-ulmi (Deg., 1773)	*Salix* sp.	Stichel, 1958
Anthocoris nemorum (L., 1761)	*Salix caprea, Salix purpurea*	Stichel, 1958
Orius majusculus (Rt., 1879)	*Salix* sp.	Stichel, 1958
Orius minutus ssp. *minutus* (L., 1758)	*Salix caprea, Salix purpurea*	Stichel, 1958
REDUVIIDAE		
Nagusta goedeli (Klt., 1856)	*Salix* sp.	Boz, 1992
Coranus aegyptius (F., 1775)	*Salix* sp.	Boz, 1992
Sphedanolestes pulchellus (K., 1830)	*Salix* sp.	Boz, 1992
Rhinocoris punctiventris (H.-S., 1846)	*Salix* sp.	Boz, 1992
TINGIDAE		
Dictiyonota strichnocera Fieber, 1844	*Salix* sp.	Önder & Lodos, 1983
Stephanitis pyri ssp. *pyri* (F., 1775)	*Salix* sp.	Önder & Lodos, 1983
Monosteira lobulifera Rt., 1888	*Salix* sp.	Stichel, 1958; Önder & Lodos, 1983
Monosteira unicostata (Ms.& Rey, 1852)	*Salix* sp.	Önder & Lodos, 1983
ARADIDAE		
Aradus crenatus Say, 1832	*Salix* sp.	Stichel, 1957
Aradus betulae ssp. *betulae* (L., 1758)	*Salix* sp.	Stichel, 1957
ANEURIDAE		
Aneurus laevis (F., 1775)	*Salix* sp.	Stichel, 1957
PIESMIDAE		
Piesma capitata (W., 1804)	*Salix* sp.	Stichel, 1957
Piesma maculata (Lp., 1832)	*Salix* sp.	Heiss & Pericart, 1983
LYGAEIDAE		
Lygaeus equestris ssp. *equestris* (L., 1758)	*Salix* sp.	Lodos et al., 1978
Lgaeus saxatilis (Scop., 1763)	*Salix* sp.	Aysev, 1974; Stichel, 1957
Melanocoryphus superbus (Pol., 1781)	*Salix* sp.	Aysev,1 974
Kleidocerys resedae (Panzer, 1797)	*Salix aurita*	Aysev, 1974
Cymus glandicolor H., 1832	*Salix* sp.	Lodos et al., 1978
Piocoris erythrocephalus (P.& S., 1825)	*Salix* sp.	Lodos et al., 1978; Çakır, 1988
Piocoris luridus (Fb., 1844)	*Salix* sp.	Çakır, 1988
Caenocoris nerii (Gm., 1847)	*Salix* sp.	Lodos et al., 1978
Leptodemus minutus Jak., 1874	*Salix* sp.	Lodos et al., 1978
Metoplax origani (Klt., 1845)	*Salix* sp.	Lodos et al., 1978

Beosus maritimus (Scop., 1763)	*Salix* sp.	Lodos et al., 1978
COREIDAE		
Coreus marginatus ssp. *marginatus* (L., 1758)	*Salix cinerea*	Stichel, 1957
RHOPALIDAE		
Coriomorpha janowskyi Jak., 1883	*Salix caprea*	Pehlivan, 1981
Rhoplaus conspersus (Fb., 1836)	*Salix* sp.	Pehlivan, 1981
Brachycarenus tigrinus (Schl., 1829)	*Salix* sp.	Pehlivan, 1981
Corizus hyoscyami ssp. *hyoscyami* (L., 1758)	*Salix caprea*	Stichel, 1957
PENTATOMIDAE		
Apodiphus amygdali (Gm., 1817)	*Salix* sp.	Kıyak, 1990
Bagrada stolata Hv., 1936	*Salix* sp.	Lodos et al., 1978
Carpocoris fuscispinus (Bh., 1851)	*Salix* sp.	Lodos et al., 1978
Carpocoris purpuripennis (De Geer, 1773)	*Salix* sp.	Lodos et al., 1978
Eurydema ventrale Klt., 1846	*Salix* sp.	Lodos et al., 1978
Nezera viridula (L., 1758)	*Salix* sp.	Lodos et al., 1978
Raphigaster nebulosa (Pd., 1761)	*Salix* sp.	Lodos et al., 1978
Palomena prasina (L., 1761)	*Salix* sp.	Stichel, 1957
Pitedia juniperia (L., 1758)	*Salix* sp.	Stichel, 1957
Dolycoris baccarum (L., 1758)	*Salix* sp.	Stichel, 1957
Eurydema oleraceum (L., 1758)	*Salix caprea*	Stichel, 1957
Pentatoma rufipes (L., 1758)	*Salix* sp.	Stichel, 1957
Arma custos (F., 1794)	*Salix caprea*	Stichel, 1957
ACANTHOSOMATIDAE		
Elasmostethus interstinctus (L., 1758)	*Salix repens*	Stichel, 1957
Elasmucha grisea (L., 1758)	*Salix* sp.	Stichel, 1957
CYDNIDAE		
Cydnus atterimus (Fst.,1771)	*Salix* sp.	Lodos & Önder, 1980

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A FAUNISTIC STUDY ON AQUATIC COLEOPTERA OF THE EASTERN MEDITERRANEAN REGION OF TURKEY

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[Bektaş, M., Taşar, G. E., İncekara, Ü. & Polat, A. 2019. A faunistic study on aquatic Coleoptera of the Eastern Mediterranean Region of Turkey. Munis Entomology & Zoology, 14 (2): 478-488**]**

ABSTRACT: This study was conducted in Gaziantep, Hatay, Kahramanmaraş, Kilis and Osmaniye provinces of the Eastern Mediterranean Region between the years of 2011 and 2013. In this study, it was attempted to describe 53 species which were determined to belong to the 3 families (Helophoridae: 25, Hydrochidae: 1 and Hydrophilidae: 27). Within these species; 24 taxa were first records for the research area. Furthermore, *Sternolophus solieri* Castelnau, 1840 was confirmed from Turkey in Hatay, Kahramanmaraş and Osmaniye provinces.

KEY WORDS: Coleoptera, aquatic beetles, new records, eastern mediterranean region, Turkey

Order Coleoptera has 176 families, 29500 genera and 386500 species (Slipinski et al., 2011). Four suborders of Coleoptera are Archostemata, Myxophaga, Adephaga and Polyphaga (Lawrence, 2016; Archangelsky et al., 2016). The Polyphaga suborder is the largest group of coleopteran families (Glime, 2015).

Family Hydrophilidae has 2932 described species in worldwide. 103 species were known from Turkey (Darılmaz & İncekara, 2011; İncekara et al., 2011; Taşar, 2014; Polat et al., 2015; İncekara et al., 2016; Taşar, 2017, 2018). Helophoridae family has 192 species in worldwide (Archangelsky et al., 2016). 52 species were known from Turkey (Taşar, 2018). Hydrochidae family includes 182 species in worldwide. Eight species were known in Turkey (Taşar, 2017).

The aim of this study is to determine the aquatic beetles in Gaziantep, Hatay, Kahramanmaraş, Kilis and Osmaniye provinces, make a contribution to the Turkish aquatic Coleoptera fauna.

MATERIAL AND METHODS

Studied materials collected by means of sieves that having 3,15x1 mm pores in summer seasons between 2011 and 2013 from Gaziantep, Hatay, Kahramanmaraş, Kilis and Osmaniye provinces, Turkey. Map of the research area were shown in Figure 1. All the specimens are collected by Mehmet Bektaş, Gani Erhan Taşar and Ahmet Polat. These specimens had firstly killed with ethyl acetate and had stored in small bottles in the research area. The specimens were cleaned with a brush before identification, and then aedeagus of the beetles was dissected under a stereo microscope in the laboratory. All the specimens deposited in the Zoological Museum, Atatürk University, Faculty of Science, Department of Biology, Erzurum, Turkey.

RESULTS

Detailed information about the locality data of studied material were shown in Table 1.

Family HELOPHORIDAE Leach, 1815

Helophorus grandis Illiger, 1798

Material examined: 1♂, 1♀, [2]; 1♂, 1♀, [63]; 49♂♂, 42♀♀, [188]; 3♂♂, [154]; 17♂♂, 15♀♀, [165]; 3♂♂, 2♀♀, [175]; 1♂, 1♀, [188]; 8♂♂, 5♀♀ [182]; 9♂♂, 3♀♀, [198]; 5♂♂, 4♀♀, [192]; 2♂♂, 5♀♀, [40]; 2♂♂, [161]; 1♂, [37]; 1♂, [201]; 4♂♂, 3♀♀, [189]; 1♂, 2♀♀, [190]; 7♂♂, 4♀♀, [176]; 1♂, 1♀, [158]; 35♂♂, 33♀♀; [164]; 2♂♂, 1♀, [166]; 1♂, [171]; 1♂, [145]; 1♂, 2♀♀, [4]; 1♂, 3♀♀, [42]; 3♂♂, 2♀♀, [43]; 1♂, 4♀♀, [80]; 1♂, [197]; 49♂♂, 82♀♀, [177]; 16♂♂, 10♀♀, [174]; 19♂♂, [170]; 1♂, [24]; 1♂, 1♀, [52]; 6♂♂, 14♀♀, [206]; 3♂♂, 3♀♀, [207]; 1♀, [204]; 4♂♂, 2♀♀, [205]; 1♂, [52]; 1♂, 3♀♀, [53]; 36♂♂, 20♀♀, [181]; 20♂♂, 12♀♀; [168]; 1♂, 1♀, [22]; 6♂♂, 7♀♀, [157]; 1♂, 2♀♀, [187]; 1♂, 1♀, [46]; 16♂♂, 10♀♀, [203]; 19♂♂, 10♀♀, [163]; 2♂♂, 2♀♀, [202]; 1♂, [183]; 1♂, 9♀♀, [155]; 3♂♂, 5♀♀, [184]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus arvernicus Mulsant, 1846

Material examined: 3♂♂, [210]; 8♂♂, 18♀♀, [190]; 1♂, [172]; 1♂, 3♀♀, [185]; 9♂♂, 18♀♀, [171]; 1♂, 3♀♀, [4]; 7♂♂, 9♀♀, [50]; 3♂♂, [169]; 1♂, [127]; 2♂♂, 5♀♀, [84]; 11♂♂, 8♀♀; [139]; 1♂, 9♀♀, [140]; 1♂, 3♀♀, [46]; 2♂♂, 5♀♀, [203]; 2♂♂, 2♀♀, [202]. **Remark:** First record for research area.

Helophorus daedalus d'Orchymont, 1932

Material examined: 9♂♂, 8♀♀, [108]; 10♂♂, 20♀♀, [133]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus aquaticus (Linnaeus, 1758)

Material examined: 1♂, 1♀, [2]; 1♂, 1♀, [63]; 49♂♂, 42♀♀, [188]; 3♂♂, [154]; 17♂♂, 15♀♀, [165]; 3♂♂, 2♀♀, [175]; 1♂, 1♀, [188]; 8♂♂, 5♀♀ [182]; 9♂♂, 3♀♀, [198]; 5♂♂, 4♀♀, [192]; 2♂♂, 5♀♀, [40]; 2♂♂, [161]; 1♂, [37]; 1♂, [201]; 4♂♂, 3♀♀, [189]; 1♂, 2♀♀, [190]; 7♂♂, 4♀♀, [176]; 1♂, 1♀, [158]; 35♂♂, 33♀♀; [164]; 2♂♂, 1♀, [166]; 1♂, [171]; 1♂, [145]; 1♂, 2♀♀, [4]; 1♂, 3♀♀, [42]; 3♂♂, 2♀♀, [43]; 1♂, 4♀♀, [80]; 1♂, [197]; 49♂♂, 82♀♀, [177]; 16♂♂, 10♀♀, [174]; 19♂♂, [170]; 1♂, [24]; 1♂, 1♀, [52]; 6♂♂, 14♀♀, [206]; 3♂♂, 3♀♀, [207]; 1♀, [204]; 4♂♂, 2♀♀, [205]; 1♂, [52]; 1♂, 3♀♀, [53]; 36♂♂, 20♀♀, [181]; 20♂♂, 12♀♀; [168]; 1♂, 1♀, [22]; 6♂♂, 7♀♀, [157]; 1♂, 2♀♀, [187]; 1♂, 1♀, [46]; 16♂♂, 10♀♀, [203]; 19♂♂, 10♀♀, [163]; 2♂♂, 2♀♀, [202]; 1♂, [183]; 1♂, 9♀♀, [155]; 3♂♂, 5♀♀, [184]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus syriacus Kuwert, 1885

Material examined: 1♂, 1♀, [66]; 8♂♂, 5♀♀, [184]. **Remark:** First record for research area.

Helophorus nubilus Fabricius, 1776

Material examined: 1♂, 2♀♀, [167]; 1♂, [45]; 1♂, 3♀♀, [75]; 3♂♂, [180]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus micans Falderman, 1835

Material examined: 2♂♂, 4♀♀, [2]; 1♂, 2♀♀, [58]; 1♂, [165]; 2♂♂, 1♀, [175]; 2♂♂, [154]; 1♂, [188]; 6♂♂, 6♀♀, [156]; 2♂♂, [182]; 1♂, 1♀, [161]; 1♂, 4♀♀, [186]; 4♂♂, 3♀♀, [47]; 3♂♂, 5♀♀, [194]; 14♂♂, 19♀♀, [201]; 81♂♂, 50♀♀, [214]; 9♂♂, 11♀♀, [38]; 4♂♂, 8♀♀, [48]; 1♂, 2♀♀, [9]; 23♂♂, 18♀♀, [170]; 3♂♂, 2♀♀, [171]; 1♂, [118]; 1♂, 1♀, [97]; 7♂♂, 6♀♀, [197]; 1♂, [208]; 1♀, [205]; 11♂♂, 14♀♀, [86]; 3♂♂, 3♀♀, [95]; 3♂♂, 6♀♀, [78]; 1♂, 3♀♀, [69]; 43♂♂, 29♀♀, [180]; 3♂♂, [160]; 1♂, [209]; 1♂, [8]; 1♂, [65]; 4♂♂, [202]; 1♂, 3♀♀, [6]; 1♂, [183]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus abeillei Guillebeau, 1896

Material examined: 1♂, [53]; 1♂, 1♀ [54]; 1♂, [55]; 1♂, [73]; 3♂♂, [80]; 1♂, 1♀, [85]; 1♂, [145]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus brevipalpis Bedel, 1881

Material examined: 11♂♂, 13♀♀, [2]; 6♂♂, 14♀♀, [210]; 1♂, 1♀, [47]; 4♂♂, 1♀, [38]; 5♂♂, 7♀♀, [59]; 1♂, [166]; 1♂, 3♀♀, [68]; 1♂, 2♀♀, [75]; 1♂, [171]; 11♂♂, 8♀, [10]; 3♂♂,8♀♀, [4]; 5♂♂, 9♀♀, [94]; 1♂, 3♀♀, [85]; 1♂, 4♀♀, [84]; 1♂, 1♀, [80]; 10♂♂, 14♀♀, [127]; 2♂♂, [139]; 3♂♂, 9♀♀, [169]; 1♂, 2♀♀, [90]; 2♂♂, 4♀♀, [53]; 1♂, 1♀, [5]; 5♂♂, 7♀♀, [89]; 1♂, 3♀♀, [78]; 1♂, 4♀♀, [69]; 4♂♂, 9♀♀, [202]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus arvernicus Mulsant, 1846

Material examined: 3♂♂, [210]; 8♂♂, 18♀♀, [190]; 1♂, [172]; 1♂, 3♀♀, [185]; 9♂♂, 18♀♀, [171]; 1♂, 3♀♀, [4]; 7♂♂, 9♀♀, [50]; 3♂♂, [169]; 1♂, [127]; 2♂♂, 5♀♀, [84]; 11♂♂, 8♀♀; [139]; 1♂, 9♀♀, [140]; 1♂, 3♀♀, [46]; 2♂♂, 5♀♀, [203]; 2♂♂, 2♀♀, [202]. **Remark:** First record for research area.

Helophorus daedalus d'Orchymont, 1932

Material examined: 9♂♂, 8♀♀, [108]; 10♂♂, 20♀♀, [133]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus montenegrinus Kuwert, 1885

Material examined: 1♂, 3♀, [63]; 5♂♂, 7♀♀, [58]; 9♂♂, 8♀♀, [47]; 4♂♂, 2♀♀, [59]; 1♂, 3♀♀, [71]; 3♂♂, 5♀♀, [4]; 3♂♂, 2♀♀, [50]; 1♂, 3♀♀, [85]; 2♂♂, 3♀♀, [7]; 2♂♂, 1♀, [56]; 1♂, 2♀♀, [207]; 1♂, 3♀♀, [54]; 2♂♂, 3♀♀, [90]; 1♂, 3♀♀, [78]; 1♂, 1♀, [6]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus lewisi Angus, 1985

Material examined: 5♂♂, 4♀♀, [58]; 4♂♂, [200]; 35♂♂, 55♀♀, [154]; 2♂♂, 2♀♀, [2]; 5♂♂, 8♀♀, [63]; 36♂♂, 55♀♀, [175]; 3♂♂, 6♀♀, [188]; 27♂♂, 27♀♀, [156]; 8♂♂, 18♀♀, [198]; 9♂♂, 15♀♀, [195]; 9♂♂, 8♀♀, [167]; 7♂♂, 5♀♀, [143]; 20♂♂, 33♀♀, [40]; 11♂♂, 6♀♀, [161]; 2♂♂, [210]; 6♂♂, 7♀♀, [194]; 24♂♂, 19♀♀, [47]; 2♂♂, 1♀, [49]; 26♂♂, 21♀♀, [194]; 22♂♂, 27♀♀, [186]; 1♂, 1♀, [48]; 3♂♂, 4♀♀, [172]; 7♂♂, 6♀♀, [100]; 52♂♂, 53♀♀, [164]; 4♂♂, 5♀♀, [59]; 8♂♂, 3♀♀, [44]; 9♂♂, 13♀♀, [158]; 9♂♂, 11♀, [1]; 7♂♂, 20♀♀, [190]; 1♂, [189]; 23♂♂, 22♀♀, [166]; 45♂♂, 62♀♀, [185]; 5♂♂,8♀♀, [9]; 8♂♂, 5♀♀, [94]; 8♂♂, 13♀♀, [97]; 28♂♂, 40♀♀, [169]; 6♂♂, 7♀♀, [140]; 4♂♂, 3♀♀, [177]; 2♂♂, 4♀, [10]; 35♂♂, 43♀♀, [4]; 3♂♂, 7♀♀, [43]; 26♂♂, 24♀♀, [127]; 28♂♂, 8♀♀, [139]; 3♂♂, 4♀♀, [7]; 8♂♂, 4♀♀, [208]; 33♂♂, 34♀♀, [204]; 74♂♂, 87♀♀, [207]; 19♂♂, 20♀♀, [205]; 30♂♂, 53♀♀, [206]; 27♂♂, 44♀♀, [208]; 8♂♂, 20♀♀, [92]; 1♂, [180]; 10♂♂, 20♀♀, [133]; 2♂♂, 4♀♀, [138]; 5♂♂, [209]; 8♂♂, 14♀♀, [103]; 51♂♂, 60♀♀, [187]; 5♂♂, 4♀♀, [41]; 8♂♂, 6♀♀, [157]; 8♂♂, 17♀♀, [8]; 6♂♂, 8♀♀, [46]; 2♂♂, 3♀, [39]; 52♂♂, 51♀♀, [163]; 17♂♂, 25♀♀, [203]; 36♂♂, 40♀♀, [202]; 1♂,1♀, [6]; 3♂♂, 2♀♀, [3]; 3♂♂, 1♀, [12]; 8♂♂, 6♀♀, [184]. **Remark:** First record for Gaziantep, Kilis and Osmaniye provinces.

Helophorus pallidipennis Mulsant and Wachanru, 1852

Material examined: 1♂, [85]; 1♂, [180]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus minutus Fabricius, 1775

Material examined: 3♂♂, [85]; 1♂, [95]. **Remark:** First record for research area.

Helophorus nanus Sturm, 1836

Material examined: 1♂, 4♀♀, [171]. **Remark:** First record for research area.

Helophorus frater d'Orchymont, 1926

Material examined: 3♀♀, [4]; 3♂♂, 3♀♀, [9]; 2♂♂, 3♀♀, [90]; 1♂, 1♂, 1♀, [94]. **Remark:** First record for research area.

Helophorus fulgidicollis Motschulsky, 1860

Material examined: 4♂♂, 5♀♀, [73]. **Remark:** First record for research area.

Helophorus hilaris Sharp, 1916

Material examined: 5♂♂, [91]; 1♂, 1♀, [63]; 25♂♂, 28♀♀, [154]; 1♂, 4♀♀, [9]; 1♂, 2♀♀, [68]; 1♂, 3♀♀, [75]; 2♂♂, 3♀♀, [171]; 4♂♂, 6♀♀, [11]; 11♂♂, 9♀♀, [93]; 14♂♂, 17♀, [94]; 99♂♂, 103♀♀, [85]; 3♂♂, 6♀♀, [73]; 2♂♂, 8♀♀, [80]; 1♂, 2♀, [77]; 1♂, [127]; 1♂, 3♀♀, [56]; 1♂, 1♀, [108]; 4♂♂, 7♀♀, [90]; 8♂♂, 8♀♀, [5]; 24♂♂, 31♀♀, [95]; 32♂♂, 28♀♀, [78]; 13♂♂, 11♀♀, [92]; 3♂♂, 7♀♀, [89]; 60♂♂, 74♀♀, [96]; 20♂♂, 70♀♀, [137]; 8♂♂, 12♀♀, [148]; 10♂♂, 22♀♀, [133]; 29♂♂, 42♀♀, [136]; 1♂, [87]; 2♂♂, 5♀♀, [187]; 5♂♂, 11♀♀, [202]; 8♂♂, 8♀♀, [183]; 1♂, 2♀, [57]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus lapponicus Thomson, 1854

Material examined: 2♂♂, 1♀, [73]. **Remark:** First record for research area.

Helophorus discrepans Rey, 1885

Material examined: 1♂, [37]; 1♂, 3♀♀, [75]; 5♂♂, 19♀♀, [145]; 1♂, [73]; 1♂, 4♀♀, [85]; 1♂, 1♀, [73]; 1♂, 2♀♀, [78]; 1♂, 2♀♀, [88]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Helophorus obscurus Mulsant, 1844

Material examined: 3♂♂, 2♀♀, [7]; 3♂♂, [35]; 2♂♂, 3♀♀, [41]; 1♂, 1♀, [56]. **Remark:** First record for research area.

Helophorus paraminutus Angus, 1986

Material examined: 2♂♂, [73]; 3♂♂, [77]. **Remark:** First record for research area.

Helophorus subarcuatus Rey, 1885

Material examined: 3♂♂, 3♀♀, [196]. **Remark:** First record for research area.

Helophorus dorsalis Marsham, 1802

Material examined: 5♂♂, 8♀♀, [134]. **Remark:** First record for research area.

Family HYDROPHILIDAE

Sternolophus solieri Castelnau, 1840

Material examined: 3♂♂, [101]; 1♂, [105]; 1♂, [113]; 1♂, [122]; 1♂, [126]. **Remark:** Confirmed from Turkey. And first detailed locality data were presented with this study.

Hydrochara caraboides (Linnaeus, 1758)

Material examined: 1♂, [25]; 1♂, [6]. **Remark:** First record for research area.

Hydrochara dichroma (Fairmaire, 1892)

Material examined: 1♂, 2♀♀, [25]; 5♂♂, 2♀♀, [165]. **Remark:** First record for Gaziantep, Kahramanmaraş, Kilis and Osmaniye provinces.

Berosus spinosus (Steven, 1808)

Material examined: 6♂♂, 10♀♀, [154]; 6♂♂, 10♀♀, [161]; 1♂, [5]; 2♂♂, 1♀, [174]; 1♂, 1♀, [125]. **Remark:** First record for research area.

Berosus signaticollis (Charpentier, 1825)

Material examined: 1♀, [171]. **Remark:** First record for research area.

Chaetarthria seminulum (Herbst, 1797)

Material examined: 1♂, 1♀, [211]. **Remark:** First record for research area.

Laccobius alternus Motschulsky, 1855

Material examined: 4♂♂, 3♀♀, [91]. 3♂♂, [104]; 2♂♂, 1♀, [105]; 1♂, [106] 9♂♂, 9♀♀, [113]; 1♂, 1♀, [121]; 21♂♂, 20♀♀, [147];. 2♂♂, [150]. **Remark:** First record for research area.

Laccobius gracilis gracilis Motschulsky, 1855

Material examined: 1♂, [58]; 1♂, [175]; 1♂, [212]; 11♂♂, 23♀♀, [154]; 4♂♂, 11♀♀, [37]; 3♂♂, 4♀♀, [61]; 2♂♂, 2♀♀, [146]; 2♂♂, 5♀♀, [143]; 1♂, [34]; 2♂♂, [30]; 1♂, [194]; 1♂, 1♀, [191]; 4♂♂, 12♀♀, [135]; 3♂♂, 2♀♀, [72]; 1♂, [142]; 3♂♂, 12♀♀, [29]; 1♂, 3♀♀, [141]; 2♂♂, 1♀, [166]; 2♂♂, [71]; 2♂♂, 2♀♀, [144]; 45♂♂, 62♀♀, [185]; 2♂♂, [27]; 1♂, [171]; 2♂♂, 2♀♀, [50]; 1♂, 3♀♀, [131]; 1♂, 1♀, [112]; 1♂, 1♀, [109]; 2♂♂, 2♀♀, [54]; 10♂♂, 9♀♀, [66]; 1♂, 4♀♀, [136]; 2♂♂, 1♀, [67]; 3♂♂, [61]. **Remark:** First record for Osmaniye province.

Laccobius syriacus Guillebeau, 1896

Material examined: 8♂♂, 8♀♀, [121]; 1♂, [58]; 2♂♂, 1♀, [156]; 1♂, 2♀♀, [63]; 6♂♂, 6♀♀, [165]; 2♂♂, 5♀♀, [175]; 4♂♂, 5♀♀, [129]; 6♂♂, 8♀♀, [152]; 19♂♂, 23♀♀, [102]; 11♂♂, 19♀♀, [149]; 6♂♂, 8♀♀, [198]; 3♂♂, 5♀♀, [143]; 9♂♂, 15♀♀, [192]; 3♂♂, 2♀♀, [129]; 2♂♂, 5♀♀, [21]; 9♂♂, 6♀♀, [135]; 5♂♂, 7♀♀, [123]; 8♂♂, 15♀♀, [107]; 5♂♂, 6♀♀, [132]; 3♂♂, 3♀♀, [191]; 5♂♂, 5♀♀, [172]; 5♂♂, 3♀♀, [100]; 5♂♂, 3♀♀, [91]; 5♂♂, 9♀♀, [111]; 5♂♂, 5♀♀, [81]; 1♂, 3♀♀, [176]; 1♂, [16]; 1♂, 1♀, [71]; 2♂♂, 3♀♀, [144]; 7♂♂, 6♀♀, [118]; 1♂, 1♀, [75]; 4♂♂, 2♀♀, [45]; 9♂♂, 9♀♀, [171]; 23♂♂, 25♀♀, [116]; 1♂, 5♀♀, [20]; 1♂, [31]; 1♂, 2♀♀, [11]; 1♂, 3♀♀, [84]; 1♂, [92]; 7♂♂, 7♀♀, [50]; 5♂♂, 4♀♀, [131]; 40♂♂, 28♀♀, [112]; 18♂♂, 10♀♀, [104]; 15♂♂, 20♀♀, [109]; 10♂♂, 17♀♀, [14]; 1♂, 1♀, [140]; 7♂♂, 2♀♀, [90]; 9♂♂, 15♀♀, [18]; 7♂♂, 2♀♀, [67]; 1♂, 2♀♀, [137]; 1♂, 1♀, [89]; 4♂♂, 11♀♀, [15]; 1♂, 1♀, [136]; 3♂♂, 1♀, [114]; 6♂♂, 4♀♀, [99]; 4♂♂, [108]; 9♂♂, 9♀♀, [55]; 1♂, [74]; 15♂♂, 8♀♀, [115]; 2♂♂, 5♀♀, [36]; 4♂, 5♀, [87]; 7♂♂, 15♀♀, [103]; 14♂♂, 7♀♀, [110]; 5♂♂, 2♀♀, [187]; 1♂, [26]; 1♂, 1♀, [65]; 4♂♂, [151]; 4♂♂, 5♀♀, [13]; 1♂, 4♀♀, [39]; 1♂, 1♀, [32]; 14♂♂, 6♀♀, [153]; 8♂♂, 8♀♀, [150]; 8♂♂, 5♀♀, [120]; 6♂♂, 10♀♀, [17]; 1♂, [57]. **Remark:** First record for Kilis provinces.

Laccobius hindukuschi Chiesa, 1966

Material examined: 7♂♂, 5♀♀, [165]; 3♂♂, 1♀, [212]; 1♂, 1♀, [143]; 3♂♂, [59]; 2♂♂, 3♀♀, [72]; 4♂♂, [166]; 1♂, 1♀, [71]; 7♂♂, 6♀♀, [144]; 2♂♂, 3♀♀, [20]; 10♂♂, 9♀♀, [112]; 1♂, 4♀♀, [127]; 1♂, 1♀, [140]; 1♂, [79]; 1♂, [74]; 1♂, 3♀♀, [41]; 1♂, [151]; 1♂, [153]; 2♂♂, 5♀♀, [13]; 1♂, 1♀, [150]. **Remark:** First record for Osmaniye and Kilis provinces.

Laccobius simulatrix D'orchymont, 1932

Material examined: 1♂, [108]. **Remark:** First record for Gaziantep and Kilis provinces.

Laccobius sculptus D'orchymont, 1935

Material examined: 2♂♂, 3♀♀, [58]. **Remark:** First record for research area.

Laccobius sulcatulus Reitter, 1909

Material examined: 1♂, [75]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Laccobius sipylus D'orchymont, 1939

Material examined: 1♂, 1♀, [121]; 2♂♂, 2♀♀, [152]. 11♂♂, [34]; 3♂♂, 3♀♀, [30]; 18♂♂, 7♀♀, [33]; 3♂♂, 3♀♀, [132]; 1♂, [107]; 1♂, 1♀, [144]; 7♂♂, 14♀♀, [27]; 3♂♂, 1♀, [116]; 1♂, [145]; 1♂, 2♀♀, [20]; 1♂, [108]; 2♂, [87]; 1♂, [79]; 2♂♂, 4♀♀, [87]; 1♂, [26]; 3♂♂, [151]; 1♂, 3♀♀, [13]; 7♂♂, 9♀♀, [32]; 1♂, 1♀, [173]. **Remark:** First record for Gaziantep, Kilis and Osmaniye provinces.

Laccobius obscuratus aegaeus Gentili, 1974

Material examined: 1♂, 1♀, [121]; 11♂♂, 1♀, [146]; 6♂♂, 4♀♀, [1]; 9♂♂, 11♀♀, [105]; 9♂♂, [111]; 2♂♂, 4♀♀, [31]; 1♂, 4♀♀, [127]; 1♂, 1♀, [104]; 1♂, 1♀, [109]; 1♂, [108]; 1♂, 3♀♀, [66]; 2♂♂, 4♀♀, [80]; 1♂, [209]; 4♂♂, 4♀♀, [87]; 5♂♂, 5♀♀, [79]; 1♂, 1♀, [41]; 1♂, 3♀♀, [120]; 1♂, 2♀♀, [62]. **Remark:** First record for Gaziantep, Kahramanmaraş and Kilis provinces.

Laccobius obscuratus obscuratus Rottenberg, 1874

Material examined: 4♂♂, 11♀♀, [15]; 10♂♂, 7♀♀, [81]; 3♂♂, [113]; 1♂, [116]; 3♂♂, [129]; 12♂♂, 15♀♀, [136]; 12♂♂, 14♀♀, [141]; 17♂♂, 16♀♀, [142]; 6♂♂, 4♀♀, [143]. **Remark:** First record for Hatay province.

Laccobius striatulus (Fabricius, 1801)

Material examined: 3♂♂, [26]; 7♂♂, 15♀♀, [27]; 3♂♂, 4♀♀, [30]; 6♂♂, 10♀♀, [32]; 10♂♂, [34]; 6♂♂, 4♀♀, [37]; 5♂♂, [54]; 2♂♂, [59]; 12♂♂, 10♀♀, [61]; 1♂, [100]; 2♂♂, [108]; 1♂, 2♀♀, [154]. 1♂, 4♀♀, [147]; 1♂, 2♀♀, [123]. **Remark:** First record for Gaziantep and Kilis provinces.

Hydrobius fuscipes (Linnaeus, 1758)

Material examined: 1♂, [176]; 8♂♂, 2♀♀, [165]; 1♂, [87]. **Remark:** First record for Gaziantep, Kahramanmaraş, Kilis and Osmaniye provinces.

Paracymus aeneus (Germar, 1824)

Material examined: 9♂♂, 10♀♀, [72]; 15♂♂, 22♀♀, [106]. **Remark:** First record for Hatay and Osmaniye provinces.

Anacaena rufipes (Guillebeau, 1896)

Material examined: 11♂♂, 16♀♀, [57]; 8♂♂, 6♀♀, [61]; 7♂♂, 8♀♀, [81]; 9♂♂, 11♀♀, [92]; 5♂♂, [140]; 7♂♂, 18♀♀, [141]; 4♂♂, 5♀♀, [143]; 7♂♂, 12♀♀, [146]. **Remark:** First record for Gaziantep, Kilis and Osmaniye provinces.

Anacaena limbata (Fabricius, 1792)

Material examined: 10♂♂, 9♀♀, [108]; 2♂♂, 2♀♀, [127]. **Remark:** First record for research area.

Anacaena lutescens (Stephens, 1829)

Material examined: 2♂♂, [119]. **Remark:** First record for research area.

Helochares lividus (Forster, 1771)

Material examined: 2♂♂, [36]; 5♂, [49]; 3♂♂, [87]; 1♂, [104]; 7♂♂, 17♀♀, [123]; 2♂♂, 2♀♀, [159]. **Remark:** First record for Gaziantep, Kilis and Osmaniye provinces.

Helochares lividoides Hansen and Hebauer, 1988

Material examined: 1♂, [34]; 8♂♂, 2♀♀, [52]; 1♂, 2♀♀, [109]. **Remark:** First record for Hatay, Gaziantep, Kilis and Osmaniye provinces.

Enochrus quadripunctatus (Herbst, 1797)

Material examined: 1♂, [124]; 2♂♂, 2♀♀, [175]; 1♂, [143]; 1♂, 1♀, [34]; 4♂♂, 8♀♀, [82]; 1♀, [199]; 1♂, 1♀, [91]; 1♂, 1♀, [72]; 8♂♂, 13♀♀, [29]; 1♂,1♀, [176]; 8♂♂, 3♀♀, [43]; 1♂, [42]; 2♂♂, 4♀♀, [94]; 1♂, [24]; 1♂, [51]; 1♂, 1♀, [205]; 1♂, 1♀, [86]; 7♂♂, 3♀♀, [5]; 1♂, [96]; 2♂♂, 3♀♀, [92]; 1♂, 2♀♀, [95]; 1♂, [136]; 1♂, [74]; 2♂♂, 2♀♀, [22]; 8♂♂, 13♀♀, [76]; 1♂, [106]; 1♂, 1♀ [178]; 1♂, [128]; 16♂♂, 10♀♀, [23]. **Remark:** First record for research area.

Enochrus fuscipennis (Thomson, 1884)

Material examined: 1♂, 1♀, [63]; 1♂, 2♀♀, [58]; 2♂♂, 2♀♀, [64]; 3♂♂, 4♀♀, [124]; 1♂, [102]; 1♂, 1♀, [82]; 1♂, [30]; 1♀, [49]; 2♂♂, [37]; 1♂, 1♀, [123]; 1♂, [100]; 2♂♂, [72]; 2♂♂, [9]; 1♂, [68]; 1♂, [16]; 1♂, 2♀♀, [118]; 12♂♂, 11♀♀, [45]; 2♂♂, [31]; 1♂, [97]; 2♂♂, [11]; 5♂♂, 3♀♀, [112]; 2♂♂, 7♀♀, [108]; 1♂, [98]; 1♂, 1♀, [53]; 1♀, [66]; 2♂♂, [54]; 1♂♂, 2♀♀, [78]; 1♂, [69]; 1♂, [95]; 1♂, [180]; 10♂♂, 20♀♀, [133]; 6♂♂, 3♀♀, [88]; 2♀♀, [115]; 1♂, [103]; 2♂♂, [26]; 1♂, 1♀, [187]; 8♂♂,7♀♀, [60]; 2♂♂, 2♀♀, [65]; 2♂♂, 5♀♀, [32]; 2♂♂, [26]; 1♂, [120]; 3♂♂, 2♀♀, [6]; 1♂, [203]; 1♂, [3]. **Remark:** First record for Gaziantep, Kahramanmaraş, Kilis and Osmaniye provinces.

Enochrus halophilus (Bedel, 1878)

Material examined: 1♂, [53]; 4♂♂, 1♀, [60]; 1♂, [70]; 2♂♂, [165]; 3♂♂, [179]. **Remark:** First record for research area.

Coelostoma orbiculare (Fabricius, 1775)

Material examined: 1♂, 3♀♀, [121]. 1♂, [143]; 1♂, [129]; 3♂♂, 1♀, [37]; 1♂, [119]; 2♂♂, 1♀, [31]; 1♂, [84]; 2♂♂, 2♀♀, [52]; 2♂♂, [56]; 1♂, [52]; 1♂, 1♀, [90]; 1♂, [26]; 1♂, [120]; 1♂, 2♀♀, [150]. **Remark:** First record for research area.

Family HYDROCHIDAE

Hydrochus nodulifer Reitter, 1897

Material examined: 1♀, [108]; 2♂♂, [209]. **Remark:** First record for research area.

DISCUSSION

In this study, the aquatic Coleoptera species that were collected from Gaziantep, Hatay, Kahramanmaraş, Kilis and Osmaniye provinces of the eastern mediterranean region (Turkey) in 2011-2013 years, were evaluated. It has totally been collected 8670 specimens. 53 species belong to 3 families (Helophoridae: 25, Hydrochidae: 1 and Hydrophilidae: 27) were detected in the research area. Within these species; 24 taxa were first records for the research area. Furthermore, *Sternolophus solieri* Castelnau, 1840 was confirmed from Turkey in Hatay, Kahramanmaraş and Osmaniye provinces with this study.

The aquatic beetle fauna of Turkey has not fully been presented; therefore, many studies are needed such as this study.

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Table 1. Detailed information about the locality data of the research area.

No	Province	County	Location	Coordinate	Elevation	Date of Collect
1	Hatay	Kırıkhan	Karaçağıl	36°34'18N 36°23'57E	105 m	27.VII.2011
2	Gaziantep	Islahiye	Yolbaşı	36°50'42N 36°38'22E	377 m	28.VII.2011
3	Osmaniye	Hasanbeyli	Kayalı	37°10'13N 36°27'34E	624 m	27.VII.2011
4	K.Maraş	Andırın	Yaylaüstü	37°34'45N 36°35'12E	1196 m	29.VII.2011
5	K.Maraş	Göksun	Göksun Plataeu	37°46'34N 36°21'36E	1393 m	29.VII.2011
6	Osmaniye	Merkez	Karataş	37°06'16N 36°37'45E	667 m	27.VII.2011
7	K.Maraş	Elbistan	Aktepe	38°06'05N 37°13'08E	1411 m	30.VII.2011
8	Kilis	Musabeyli	Haydarlı	36°50'38N 36°58'01E	510 m	28.VII.2011
9	K.Maraş	Onikişubat	Sarımollalı	37°37'40N 36°38'49E	471 m	30.VII.2011
10	K.Maraş	Andırın	Çokak	37°42'04N 36°20'41E	1153 m	29.VII.2011
11	K.Maraş	Andırın	Çokak	37°35'46N 36°21'35E	1099 m	29.VII.2011
12	Osmaniye	Kadirli	Sofular	37°36'08N 36°22'26E	1152 m	29.VII.2011
13	Kilis	Musabeyli	Haydarlı	36°50'37N 36°58'05E	515 m	04.IX.2011
14	K.Maraş	Andırın	Çokak	37°42'04N 36°20'40E	1160 m	08.IX.2011
15	K.Maraş	Göksun	Kireçköy	37°58'43N 36°29'58E	1346 m	08.IX.2011
16	K.Maraş	Onikişubat	Suçatı Dam	37°45'41N 36°44'10E	579 m	08.IX.2011
17	Osmaniye	Toprakkale	Büyük Tüysüz	37°01'48N 36°08'21E	70 m	07.IX.2011
18	K.Maraş	Ekinözü	Taşburun	38°09'35N 37°12'21E	1238 m	09.IX.2011
19	K.Maraş	Göksun	Yantepe	38°01'50N 36°33'38E	1456 m	08.IX.2011
20	K.Maraş	Afşin	Tanır	38°21'41N 36°54'37E	1220 m	09.IX.2011
21	Hatay	Hassa	Çınarbaşı	36°50'51N 36°37'24E	104 m	05.IX.2011

22	K.Maraş	Nurhak	Barış	38°02'38N 37°18'20E	1516 m	09.IX.2011
23	Osmaniye	Hasanbeyli	Kayalı	37°10'13N 36°27'34E	625 m	07.IX.2011
24	K.Maraş	Elbistan	Kuşkayası	38°18'22N 37°05'48E	1155 m	09.IX.2011
25	Kilis	Musabeyli	Üçpınar	36°52'29N 36°57'43E	618 m	22.IV.2012
26	Kilis	Merkez	Karaçavuş	36°44'51N 36°49'21E	521 m	23.IV.2012
27	K.Maraş	Afşin	Tarlacık	38°23'04N 36°58'54E	1269 m	27.IV.2012
28	Hatay	Erzin	Dörtyol Road	37°01'56N 36°08'19E	74 m	24.IV.2012
29	Hatay	Yayladağ	Samandağ Road	36°54'56N 36°03'09E	410 m	24.IV.2012
30	Hatay	Hassa	Çınarbaşı	36°50'43N 36°39'28E	373 m	23.IV.2012
31	K.Maraş	Andırın	Emirler	37°39'43N 36°26'49E	1453 m	26.IV.2012
32	Kilis	Musabeyli	Haydarlar	36°50'38N 36°58'01E	521 m	25.IV.2012
33	Hatay	Yayladağ	Narlıtopper	36°39'21N 36°27'30E	220 m	23.IV.2012
34	Hatay	Dörtyol	Beşikgölü	36°50'38N 36°17'18E	332 m	24.IV.2012
35	K.Maraş	Andırın	Gökçeli	37°35'58N 36°22'20E	1115 m	26.IV.2012
36	K.Maraş	Nurhak	Ayçoşar	38°02'38N 37°18'19E	1523 m	27.IV.2012
37	Hatay	İskenderun	Serinyol	36°22'03N 36°13'29E	115 m	24.IV.2012
38	Hatay	Samandağ	Göktepe	36°14'58N 36°30'06E	100 m	23.IV.2012
39	Kilis	Musabeyli	Deliosman	36°50'15N 36°44'39E	532 m	23.IV.2012
40	Hatay	Antakya	Maraşboğazı	36°24'09N 36°14'58E	91 m	24.IV.2012
41	Kilis	Merkez	Gözkaya	36°50'21N 36°50'38E	551 m	23.IV.2012
42	K.Maraş	Andırın	Geben	37°45'15N 36°27'18E	1258 m	26.IV.2012
43	K.Maraş	Andırın	Yeniköy	37°36'35N 36°23'34E	1124 m	26.IV.2012
44	Hatay	Yayladağ	Eğerci	35°57'50N 36°02'51E	519 m	24.IV.2012
45	K.Maraş	Afşin	Altınelma	38°21'41N 36°54'37E	1216 m	27.IV.2012
46	Kilis	Musabeyli	Gülbaba	36°49'54N 36°47'22E	666 m	23.IV.2012
47	Hatay	Hassa	Akbez	36°50'58N 36°37'21E	381 m	23.IV.2012
48	Hatay	Reyhanlı	Tayfun Sökmen	36°15'19N 36°26'26E	90 m	23.IV.2012
49	Hatay	Hassa	Safanözü	36°50'42N 36°38'21E	379 m	23.IV.2012
50	K.Maraş	Andırın	Bektaşlı	37°25'20N 36°15'26E	151 m	26.IV.2012
51	K.maraş	Elbistan	Akbayır	38°10'56N 37°15'53E	1210 m	31.V.2012
52	K.Maraş	Ekinözü	Akpınar	38°10'56N 37°15'53E	1410 m	31.V.2012
53	K.Maraş	Ekinözü	Güplüce	38°07'45N 37°12'35E	1438 m	31.V.2012
54	K.Maraş	Ekinözü	Elbistan Road	38°04'26N 37°12'47E	1310 m	31.V.2012
55	K.Maraş	Nurhak	Ağcasar	38°02'19N 37°18'31E	1520 m	31.V.2012
56	K.maraş	Elbistan	Kuşkayası	38°18'22N 37°05'48E	1158 m	31.V.2012
57	Osmaniye	Toprakkale	Büyük Tüysüz	37°01'48N 36°08'21E	70 m	28.V.2012
58	Gaziantep	Islahiye	Kaşargil	36°50'44N 36°40'16E	383 m	27.V.2012
59	Hatay	Yayladağ	Eğerci	35°57'49N 36°02'51E	527 m	28.V.2012
60	Kilis	Elbeyi	Alahan	36°40'22N 37°27'00E	520 m	27.V.2012
61	Hatay	Antakya	Serinyol Road	36°22'03N 36°13'28E	107 m	28.V.2012
62	Osmaniye	Toprakkale	Mustafabeyli	37°07'03N 36°09'21E	87 m	28.V.2012
63	Gaziantep	Islahiye	Çınarbaşı	36°50'42N 36°39'25E	375 m	27.V.2012
64	Gaziantep	Islahiye	Koruhüyüğü	36°50'45N 36°38'13E	381 m	27.V.2012
65	Kilis	Elbeyi	Yağızköy	36°39'58N 37°22'00E	500 m	27.V.2012
66	K.Maraş	Ekinözü	Taşburun	38°09'35N 37°12'21E	1238 m	31.V.2012
67	K.Maraş	Göksun	Gölpınar	37°57'25N 36°31'20E	1380 m	30.V.2012
68	K.Maraş	Onikişubat	Kurucaova	37°57'18N 36°33'35E	1441 m	30.V.2012
69	K.Maraş	Göksun	Yantepe	38°01'55N 36°33'18E	1363 m	30.V.2012
70	K.Maraş	Göksun	Kireçköy	37°58'46N 36°29'58E	1345 m	30.V.2012
71	K.Maraş	Onikişubat	Suçatı Dam	37°45'42N 36°44'09E	655 m	30.V.2012
72	Hatay	Samandağ	Yeşilyazı	36°08'49N 36°03'58E	75 m	28.VI.2012
73	K.Maraş	Andırın	Boztopraklı	37°52'40N 36°26'32E	1672 m	26.VI.2012
74	K.Maraş	Nurhak	Kapıdere	37°58'36N 37°39'29E	1028 m	25.VI.2012
75	K.Maraş	Afşin	Tanır Road	38°23'57N 36°54'26E	1226 m	25.VI.2012
76	K.Maraş	Türkoğlu	Gavur Lake	37°19'05N 36°50'58E	482 m	27.VI.2012
77	K.Maraş	Andırın	Çiçekli	37°51'43N 36°25'00E	1637 m	26.VI.2012
78	K.Maraş	Göksun	Değirmendere	37°55'06N 36°27'44E	1430 m	26.VI.2012
79	K.Maraş	Nurhak	Gölbaşı Road	37°50'58N 37°43'07E	817 m	25.VI.2012
80	K.Maraş	Andırın	Yeşilova Road	37°53'21N 36°26'58E	1553 m	26.VI.2012
81	Hatay	Yayladağ	Yeniköy	35°57'49N 36°02'52E	532 m	28.VI.2012
82	Hatay	Dörtyol	Near of Beach	36°48'06N 36°11'31E	0 m	27.VI.2012
83	Hatay	Hassa	Dörtyol Pathway	36°59'42N 36°24'03E	1332 m	27.VI.2012
84	K.Maraş	Andırın	Gökçeli	37°36'09N 36°22'28E	1123 m	26.VI.2012

85	K.Maraş	Andırın	Geben	37°48'29N 36°25'08E	1318 m	26.VI.2012
86	K.Maraş	Ekinözü	Ortaören	38°12'06N 37°05'26E	1131 m	25.VI.2012
87	K.Maraş	Nurhak	Gölbaşı Road	37°58'04N 37°37'18E	1109 m	25.VI.2012
88	K.Maraş	Nurhak	Elbistan Road	37°58'40N 37°22'50E	1528 m	25.VI.2012
89	K.Maraş	Göksun	Andırın Road	38°00'15N 36°29'08E	1343 m	26.VI.2012
90	K.Maraş	Ekinözü	Ortaören	38°06'44N 37°05'41E	1153 m	25.VI.2012
91	Hatay	Samandağ	Sutaşı	36°06'54N 35°55'33E	0 m	28.VI.2012
92	K.Maraş	Göksun	Andırın Road	38°00'55N 36°29'15E	1046 m	26.VI.2012
93	K.Maraş	Andırın	Bektaşlı	37°43'10N 36°27'38E	1277 m	26.VI.2012
94	K.Maraş	Andırın	Bektaşlı	37°45'16N 36°27'17E	1270 m	26.VI.2012
95	K.Maraş	Göksun	Fındıklıkayak	37°56'20N 36°27'53E	1383 m	26.VI.2012
96	K.Maraş	Göksun	Soğukpınar	38°03'15N 36°34'37E	1361 m	26.VI.2012
97	K.Maraş	Andırın	Bektaşlı Village	37°25'20N 36°15'26E	1510 m	26.IV.2012
98	K.Maraş	Elbistan	Söğütlü Brook	38°13'47N 37°03'01E	1146 m	03.IX.2013
99	K.Maraş	Elbistan	Ekinözü Road	38°10'09N 37°12'32E	1218 m	03.IX.2013
100	Hatay	Reyhanlı	Varışlı Village	36°15'25N 36°23'07E	93 m	01.IX.2013
101	Osmaniye	Merkez	Tecirli	37°10'36N 36°08'42E	49 m	30.VIII.2013
102	Gaziantep	Yavuzeli	Araban Road	37°27'44N 37°36'26E	568 m	02.IX.2013
103	K.Maraş	Pazarcık	Bağlama Pond	37°17'35N 37°07'53E	535 m	05.IX.2013
104	K.Maraş	Andırın	Ardışın Plateau	37°32'15N 36°22'38E	619 m	05.IX.2013
105	Hatay	Reyhanlı	Antakya Road	36°15'33N 36°18'19E	94 m	01.IX.2013
106	Osmaniye	Merkez	Cevdediye	37°07'27N 36°13'33E	99 m	30.VIII.2013
107	Hatay	Kırıkhan	Alaybey	36°51'24N 36°37'44E	382 m	01.IX.2013
108	K.Maraş	Elbistan	Sevdilli Brook	38°15'30N 37°32'00E	1350 m	09.IX.2013
109	K.Maraş	Andırın	Ardışın Plateau	37°12'17N 36°22'18E	623 m	05.IX.2013
110	Kilis	Merkez	Musabeyli Road	36°50'30N 36°58'02E	525 m	02.IX.2013
111	Hatay	Yayladağ	Leylekli	35°58'20N 36°03'25E	517 m	01.IX.2013
112	K.Maraş	Andırın	Fırnız Brook	37°45'52N 36°42'28E	663 m	04.IX.2013
113	K.Maraş	Ekinözü	Taşburun	38°09'34N 37°12'20E	1238 m	04.IX.2013
114	K.Maraş	Çağlayancerit	Değirmen Pond	37°43'32N 37°29'13E	874 m	06.IX.2013
115	K.Maraş	Nurhak	Barış	38°00'24N 37°19'38E	1388 m	02.IX.2013
116	K.Maraş	Afşin	Yazıkoyu	38°10'57N 36°46'18E	1312 m	04.IX.2013
117	K.Maraş	Göksun	Andırın Road	37°59'02N 36°30'00E	1355 m	04.IX.2013
118	K.Maraş	Afşin	Göksun Road	38°12'12N 36°51'03E	1235 m	04.IX.2013
119	K.Maraş	Andırın	Akifiye	37°42'04N 36°21'08E	1138 m	05.IX.2013
120	Kilis	Polateli	Kilis Road	36°48'48N 37°05'59E	581 m	02.IX.2013
121	Gaziantep	Araban	Adıyaman Road	37°24'04N 37°38'00E	529 m	02.IX.2013
122	Hatay	Hassa	Akbez	36°49'42N 36°32'16E	398 m	01.IX.2013
123	Hatay	Kırıkhan	Topboğazı	36°41'38N 36°28'37E	269 m	01.IX.2013
124	Gaziantep	Ilahiye	Fevzipaşa	37°03'46N 36°37'30E	516 m	31.VIII.2013
125	Osmaniye	Merkez	Zorkun Road	37°01'48N 36°08'21E	70 m	30.VIII.2013
126	Hatay	Yayladağ	Kırıkhan Road	34°54'55N 36°03'09E	409 m	01.IX.2013
127	K.Maraş	Andırın	Çokak Road	37°38'32N 36°21'26E	1116 m	25.VI.2013
128	Osmaniye	Merkez	Tecirli	37°10'36N 36°07'42E	47 m	27.VI.2013
129	Hatay	Hassa	Yolbaşı	36°51'20N 36°39'45E	385 m	29.VI.2013
130	Osmaniye	Merkez	Kaypak	37°06'37N 35°48'13E	805 m	27.VI.2013
131	K.Maraş	Andırın	Yeşilova	37°27'05N 36°19'34E	186 m	25.VI.2013
132	Hatay	Kırıkhan	Kilis Road	36°40'10N 36°25'19E	233 m	28.VI.2013
133	K.Maraş	Göksun	Çardak Pond	38°06'11N 36°48'26E	1353 m	24.VI.2013
134	K.Maraş	Nurhak	Ağcasar	38°02'38N 37°18'19E	1370 m	23.VI.2013
135	Hatay	Kırıkhan	İçada Village	36°30'29N 36°25'07E	90 m	28.VI.2013
136	K.Maraş	Göksun	Gölpınarı	37°58'05N 38°30'35E	1371 m	24.VI.2013
137	K.Maraş	Göksun	Yantepe	38°03'24N 36°34'01E	1362 m	24.VI.2013
138	K.Maraş	Göksun	Püren Alley	37°57'34N 36°33'31E	1426 m	24.VI.2013
139	K.Maraş	Andırın	Kadirli Road	37°32'37N 36°22'04E	653 m	25.VI.2013
140	K.Maraş	Andırın	Kesik	37°38'47N 36°21'59E	1076 m	24.VI.2013
141	Hatay	Yayladağ	Leylekli	35°58'21N 36°03'25E	518 m	28.VI.2013
142	Hatay	Samandağ	Sebenova	36°03'57N 36°01'07E	332 m	28.VI.2013
143	Hatay	Antakya	Belen Road	36°22'01N 36°13'41E	106 m	27.VI.2013
144	K.Maraş	Onikişubat	Avcılar Dam	37°49'38N 36°48'05E	668 m	24.VI.2013
145	K.Maraş	Afşin	Alempınarlı	38°04'23N 37°12'44E	1309 m	23.VI.2013
146	Hatay	Antakya	Reyhanlı Road	36°15'19N 36°21'15E	121 m	28.VI.2013
147	Hatay	Erzin	Osmaniye Road	37°02'08N 36°08'36E	76 m	27.VI.2013

148	K.Maraş	Göksun	Andırın Road	38°00'03N 36°29'27E	1341 m	24.VI.2013
149	Gaziantep	Nurdağı	Doruca	36°51'09N 36°53'36E	610 m	29.VI.2013
150	Kilis	Polateli	Kızılgöl	36°49'14N 37°08'15E	780 m	29.VI.2013
151	Kilis	Elbeyi	O. Sanayi Road	36°40'37N 37°22'03E	510 m	29.VI.2013
152	Gaziantep	Oğuzeli	Büyükkaracaören	36°46'37N 37°33'10E	562 m	29.VI.2013
153	Kilis	Musabeyli	Afrin Brook	36°49'01N 36°59'33E	423 m	29.VI.2013
154	Gaziantep	Islahiye	Yolbaşı	36°50'32N 36°38'38E	376 m	26.VI.2013
155	Osmaniye	Kadirli	Çiğdemli Village	37°21'34N 36°08'06E	272 m	27.VI.2013
156	Gaziantep	Islahiye	Kazıklı	36°51'06N 36°41'11E	368 m	12.V.2013
157	Kilis	Merkez	Hisarköy	36°50'13N 36°46'14E	700 m	12.V.2013
158	Hatay	Yayladağ	Yeditepe	35°57'49N 36°02'52E	521 m	13.V.2013
159	Gaziantep	Islahiye	Yolbaşı	36°50'42N 36°38'28E	382 m	12.V.2013
160	K.Maraş	Göksun	Mahmutbey	38°07'05N 36°28'16E	1438 m	17.V.2013
161	Hatay	Antakya	Maraşboğazı	36°24'39N 36°16'04E	104 m	12.V.2013
162	Gaziantep	Islahiye	Yolbaşı	36°50'43N 36°39'28E	381 m	12.V.2013
163	Osmaniye	Merkez	Çardak Village	37°06'10N 36°18'00E	131 m	14.V.2013
164	Hatay	Yayladağ	Yeniceköy	35°57'47N 36°07'03E	888 m	13.V.2013
165	Gaziantep	Islahiye	Esenler	36°54'07N 36°34'12E	446 m	14.V.2013
166	K.Maraş	Onikişubat	Çınarpınar	37°38'16N 36°38'08E	468 m	18.V.2013
167	Hatay	Altınözü	Karbeyaz	35°59'59N 36°15'15E	717 m	13.V.2013
168	K.Maraş	Göksun	Geben Road	37°44'40N 36°27'24E	1260 m	18.V.2013
169	K.Maraş	Andırın	Akifiye	37°42'27N 36°20'36E	1160 m	18.V.2013
170	K.Maraş	Andırın	Near of Tedaş	37°35'48N 36°21'35E	1120 m	18.V.2013
171	K.Maraş	Afşin	Yazıbelen	38°19'38N 36°57'55E	1173 m	18.V.2013
172	Hatay	Reyhanlı	Varışlı	36°14'46N 36°23'13E	92 m	14.V.2013
173	Osmaniye	Kadirli	Kızyusuflu	37°19'41N 36°12'01E	326 m	16.V.2013
174	K.Maraş	Andırın	Kargaçayırı	37°41'44N 36°27'13E	1315 m	18.V.2013
175	Gaziantep	Islahiye	Hanağzı	37°04'36N 36°37'33E	516 m	14.V.2013
176	Hatay	Yayladağ	Kışlak	35°58'43N 36°09'19E	651 m	13.V.2013
177	K.Maraş	Andırın	Akifiye	37°40'37N 36°20'40E	1143 m	18.V.2013
178	Osmaniye	Merkez	Tecirli	37°09'47N 36°07'19E	54 m	16.V.2013
179	Hatay	Erzin	Rafine Road	36°56'14N 36°03'47E	10 m	15.V.2013
180	K.Maraş	Göksun	Kireçköy	37°59'09N 36°29'50E	1339 m	17.V.2013
181	K.Maraş	Göksun	Bozgüney	38°15'00N 36°21'54E	1608 m	17.V.2013
182	Gaziantep	Islahiye	Karaburçlu	37°08'13N 36°42'11E	481 m	14.V.2013
183	Osmaniye	Kadirli	Karatepe Dam	37°18'32N 36°13'30E	165 m	19.IV.2013
184	Osmaniye	Kadirli	Yukarı Çiyanlı	37°21'26N 36°10'23E	417 m	19.IV.2013
185	K.Maraş	Onikişubat	Sarımollalı	37°38'14N 36°38'09E	471 m	19.IV.2013
186	Hatay	Hassa	Çınarbaşı	36°50'43N 36°38'16E	380 m	15.IV.2013
187	Kilis	Merkez	Hacipoğlu	36°48'23N 36°57'44E	638 m	15.IV.2013
188	Gaziantep	Islahiye	Türkbahçe	37°04'51N 36°37'43E	514 m	15.IV.2013
189	Hatay	Kumlu	Karaçalılık	36°22'25N 36°24'55E	81 m	16.IV.2013
190	Hatay	Kumlu	Güventaşı	36°24'24N 36°24'17E	80 m	16.IV.2013
191	Hatay	Kırıkhan	Reyhanlı Road	36°50'04N 36°48'07E	647 m	15.IV.2013
192	Hatay	Altınözü	Boynuyoğun	36°11'23N 36°21'43E	96 m	16.IV.2013
193	Hatay	Kumlu	Terzihüyük	36°18'01N 36°24'38E	82 m	16.IV.2013
194	Hatay	Hassa	Antakya Road	36°48'30N 36°32'02E	390 m	15.IV.2013
195	Hatay	Altınözü	Kamberli	36°08'50N 36°12'18E	456 m	16.IV.2013
196	Hatay	Dörtyol	Yeniyurt	36°55'52N 36°07'28E	27 m	17.IV.2013
197	K.Maraş	Andırın	Gökçeli	37°54'15N 36°37'35E	507 m	15.IV.2013
198	Gaziantep	Nurdağı	Kuzoluk	37°04'46N 36°53'03E	963 m	15.IV.2013
199	Hatay	Erzin	Rafine Road	36°56'14N 36°03'47E	10 m	15.V.2013
200	Gaziantep	Islahiye	Hamidiye	37°07'51N 36°53'07E	649 m	15.IV.2013
201	Hatay	Kumlu	Akkerpiç	36°23'00N 36°24'58E	80 m	16.IV.2013
202	Osmaniye	Bahçe	Cevdediye	37°12'28N 36°11'30E	143 m	19.IV.2013
203	Osmaniye	Merkez	Selimiye	37°14'23N 36°02'25E	40 m	19.IV.2013
204	K.Maraş	Elbistan	Bakıs	38°12'28N 37°30'04E	1172 m	14.IV.2013
205	K.Maraş	Ekinözü	Cela	38°03'24N 37°11'46E	1217 m	14.IV.2013
206	K.Maraş	Elbistan	Doğan	38°16'41N 37°09'42E	1191 m	14.IV.2013
207	K.Maraş	Elbistan	Başburun	38°09'33N 37°12'23E	1203 m	14.IV.2013
208	K.Maraş	Elbistan	Söğütlü Brook	38°13'47N 37°13'01E	1146 m	03.IX.2013
209	K.Maraş	Nurhak	Ağcasar	38°02'38N 37°18'19E	1370 m	23.VI.2013
210	Hatay	Erzin	Yumurtalık Road	36°56'14N 36°03'48E	7 m	17.IV.2013

211	Hatay	Antakya	Serinyol	36°35'00N 36°21'01E	130 m	03.X.2012
212	Gaziantep	Islahiye	Hamidiye	37°07'51N 36°53'07E	649 m	15.IV.2013
213	K.Maraş	Andırın	Dereağzı	37°53'21N 36°26'58E	1553 m	26.VI.2012
214	Hatay	Kumlu	Karaçalılık	36°22'25N 36°24'55E	81 m	16.IV.2013

Figure 1. Research Area (at Turkey map).

ECTO AND ENDO-PARASITES OF DOMESTIC PIGEONS (*COLUMBA LIVIA)* IN HAMEDAN, WEST PART OF IRAN

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ABSTRACT: The main aim of current survey was to determine the fauna and prevalence rate of ecto and endo-parasites in domestic pigeons (*Columba livia)* in Hamedan, west part of Iran. Eighteen pigeons evaluated for ecto and endo-parasites infestation between September and March 2016. The blood samples obtained from wing vein for diagnosis of haemoparasites using thin smears. The collected ectoparasites of body surface transferred to 70% ethanol for identification. At necropsy, each section of gastrointestinal and respiratory tracts of birds dissected, separately. Total isolated helminthes transferred to ethanol (70%) plus glycerin (5%) solution. Lungs, liver, kidneys and heart fixed in 10% formalin-buffer for histopathological examination. Among examined birds, 40/80 (50%) were infected with *Haemoproteus columbae*. The isolated helminthes were *Raillietina echinobothrida* (20%), *Ascaridia columbae* (25%), *Ascaridia galli* (36%) and *Hartertia gallinarum* (10%). In addition, three species of isolated ecto-parasites were *Pseudolynchia canariensis* (25%), *Columbicola columbae* (62.5%) and *Menopon gallinae* (30%). In pathological evaluation, Coli-Granoloma observed in liver of some cases. This is the first report on ecto and endo-parasites in domestic pigeons in Hamedan, West of Iran.

KEY WORDS: Pigeon, endoparasite, *Haemoproteus columbae*, ectoparasite

Pigeons and doves are distributed everywhere on Earth. Pigeons have domesticated for hundreds of years and their relationship with human is very old. Pigeons used for a long time as a food resource, pets or cultural and religious symbols. In addition, they make good laboratory animals, as in the diagnosis of fowl cholera (Cooper, 1984). They can carry some of pathogens and/or diseases to other birds such as coccidiosis, cryptococcosis, newcastle and histoplasmosis (Rehman, 1993; Opara et al., 2012) and play important role in transmission of zoonotic pathogens for human (Vucemilo et al., 2000; Karatepe et al., 2010). There are many pathogens related to hygiene and management of pigeons such as ecto and/or endo-parasites.

Different of parasite species can be infect pigeons and caused reduce of performance and increase of mortality (Rupiper, 1998; Dranzoa et al., 1999; Eckert, 2000). In Iranian pigeons, the fauna and rate of parasitic infection was reported in limit scale (Ashrafihelan et al., 2010; Radfar et al., 2012; Dik & Halajian, 2013; Khezerpour & Naem, 2013). Many studies have been recorded on birds' haemoparasites worldwide (Bensch et al., 2004; Hellgren et al., 2004; Ricklefs et al., 2005). In the different species of haemoparasites, *Haemoproteus* and *Leucocytozoon* are common and harmful for pigeons (Bernett & Perice, 1989;

Atkinson et al., 2000). Recently, few studies were done on *Haemoproteus columbae* infection rate in pigeons from Iran such as Youssefi et al. (2010) in northern Iran, Razmi & Andalibian (2006) in Mashhad (northeastern Iran), Nematollahi et al. (2012) in Isfahan (Central of Iran) and Dehghani-Samani et al. (2013) in southwestern Iran.

There was no report parasitic infection on pigeons in western Iran. Therefore, the current survey was aimed to evaluate of ecto and endo-parasite fauna and infection rate in pigeons from Hamedan, for the first time.

MATERIALS AND METHODS

This study was done on 80 pigeons from September to March 2016 in Hamedan located, west part of Iran. The caught birds were transferred to the parasitology laboratory of Veterinary Sciences School, Bu-Ali Sina University, Hamedan. All of blood smears stained with Giemsa for haemoparasites identification using light microscopy. The isolated ecto-parasites transferred to ethanol (70%) plus glycerin (5%) solution for preservation and identification (Graciolli & Carvalho, 2003). For detection of helminthic parasites, total sections of gastrointestinal and respiratory tracts dissected and inspected, separately. The isolated nematodes were placed in AFA solution (alcohol, formaldehyde, acetic acid, distilled water, and glycerin), and all of them cleared with lacto phenol (25% glycerin, 25% lactic acid, 25% phenol and 25% distilled water). Cestodes removed from small intestine stained with acidified alum/carmine and identified using diagnostic keys (Soulsby, 1986; Fowler, 1990).In all of cases, lungs, liver, kidneys and heart fixed in 10% buffered neutral formalin for histopathological examinations. The tissue samples processed embedded in paraffin wax, sectioned and stained with hematoxylin and eosin (Sol et al., 2003).

Statistical analysis performed with SPSS 18.0.0 (SPSS Incorporation) and Chi Square tests methods.

We hereby declare all ethical standards have been respected in preparation of the submitted article. All of protocols reviewed and approved by the research council of Bu-Ali Sina University, Hamedan, Iran.

RESULTS

Out of 80 pigeons (36 males and 44 female), 34 (42.5%) harbored one or more species of helminthes, 32 (40%) had one or more ecto-parasites and 40 (50%) were infected with haemoparasites (Table 1). All of infected birds had symptoms such as cachexia, diarrhea, and dehydration. The prevalence of isolated endo-parasites demonstrated in Table 2. One species of cestodes (Raillietinae: *Raillietina echinobothrida* (20%)) and three species of nematodes (Ascaridae: *Ascaridia colombae* (25%), *Ascaridia galli* (36%) and Spiruridae: *Hartertia gallinarum* (10%)) were detected (Figs. 1 and 2). Three species of ecto-parasites were *Pseudolynchia canariensis* (25%), *Columbicola columbae* (62.5%) and *Menopon gallinae* (30%) (Table 3).

The infection rate of *Haemoproteus columbae* was 50%. The parasitemia sourced by *H. columbae* was identified ≤1% in five, 1-3% in eight and ≥%3 in seven pigeons. Of the 40 positive blood smears, in 70% (28/40) 1-2 erythrocytes and in 30% (12/40) more than three erythrocytes were observed to be infected with gametocytes of *H. columbae*.

In pathological evaluation, Coli-Granuloma observed in liver of some cases. In addition, the lesions similar to tuberculous tissue were detected in the liver. In histopathology of lesions, necrotic tissues were observed surrounded by epitheloid and giant cells (Fig. 4).

DISCUSSION

In current investigation, 24/80 (30%) of pigeons were infected with helminthes; this result is considered modestly with previous surveys in Iran and other countries. In our study, *A. galli* and *H. gallinarum* were the highest and lowest of infections, respectively; parallel to Ashrafihelan et al. (2010) study in Tabriz, North-west of Iran. According to our finding, *H. gallinarum* was isolated in Iranian domestic pigeons for first time. In past study from southern Iran, *H. gallinarum* infection was reported on fowl (Eslami & Mozafarinejad,1993). Because of macroscopic similarities between the morphology of *H. gallinarum* and *A. galli*, it is much probable that poultry practitioners take one of these two species for the other. Life cycle, pathogenicity and treatment protocol can help to miss diagnosis of this two species. In our study, the prevalence of *H. gallinarum* was significantly lower than other endo-parasites ($p<0.05$). Borghare et al. (2009) displayed heavy infection with *Capillaria* spp., *Ascaridia* spp. and *Hetarakis* spp. in wild pigeons from Maharajbagh Zoo, Nagpur.

In a similar study from South of Iran, the infection rate with *R. echinobothrida*, *R. tetragona*, and *A. columbae* was reported 70%, 9% and 1%, respectively (Shayeste, 1996). *R. echinobothrida* was the most common of cestodes, which is in agreement with our finding (Naem & Eskandari, 2005; Nabavi et al., 2005; Khezerpour & Naem, 2013). *R. echinobothrida* is an important of cestodes in pigeons; but it will be interesting to study the reasons that pigeons are more susceptible to *R. echinobothrida* compared to other birds. Further investigations of health factors, blood parameters and growth rate may be indicating the role of helminthic infection in pigeons.

In this study, mixed helminthic infections were less than single infections. Our findings indicate that pigeons could be less susceptible to mixed infections compared to chickens. The changes of climate and temperature are very effective on the health and growth of birds (Msoffe et al., 2010). *Syngamus trachea* were found in pigeons in Ilam province, Southwestern Iran (Bahrami et al., 2012); which is in contrast to present study and other surveys (Radfar et al., 2011; Al-Barwari & Saeed, 2012; Musa et al., 2011; Msoffe et al., 2010; Senlik et al., 2005; Adang et al., 2009; Natal et al., 2009; Ashrafihelan et al., 2010).

Serve infection of *R. echinobothrida*, *C. columbae* and *Tetrameres* spp. was reported in gees population from Gilan province, North of Iran (Hosseini et al., 2001). In Eslami et al. (2009) study in Golestan, northern Iran, 96% of fowl harbored at least one species of parasite. According to past investigations from Iran, parasitic infections in pigeons are lower than other birds (Hoseini et al., 2001; Eslami et al., 2009). It is due to the type of host dietary habitat and immune mechanism.

Among of ecto-parasite infestation, *C. columbae* had the highest prevalence (62.5%), followed by *P. canariensis* (25%) and *M. gallinae* (20%). According to Harlin (1994), *C. columbae* is the most common mallophaga parasites in pigeons. The infestation rate of *C. columbae* is agree with other hands, but the infestation rate of *M. gallinae* was significantly lower than *C. columbae* and *P. canariensis* ($p=0.02$).

In the present study, 50% of birds were infected with *H. columbae*. *H. columbae* is the most common of heamo-protozoan parasite that transmitted by biting of Hippoboscidae (Marques et al., 2007). In addition, infestation rate of *P.*

canariensis were 25%, which is suitable biological vector of *H. columbae*. There was a noticeable relationship between the prevalence of *H. columbae* and *P. canariensis*. In similar previous surveys, infection rate of *H. columbae* was reported 17.5%, 33% and 57% in pigeons from northern, northeastern (Mashhad), and Central (Isfahan) of Iran, respectively (Razmi & Andalibian, 2006; Youssefi et al., 2010; Nematollahi et al., 2012). The prevalence of *Haemoproteus* spp. in free-living pigeons in urban regions of Santa Catarina, Brazil was detected 62.2% and 46.5% using Quick Panoptic and Giemsa methods, respectively (Marques, 2007), which are in accordance with our findings. Geographical location and climatic conditions, difference in feeding habitat and abundance of vehicles are the most reason of difference prevalence rate of *Haemoproteus*.

The differences of helminthic infections within the months are due to the availability and distribution of their intermediate hosts (Olsen & Braun, 1980). Pigeons have ability to transmit pathogenic agents to both human and birds. *Toxoplasma gondii*, an important protozoan zoonotic disease, has detected in pigeons from some regions of the world (Karatepe et al., 2011). Moreover, various bacterial and viral infections such as *Salmonella, Campylobacter* and *Paramyxovirus* can be transfer from birds to human (Vucemilo et al., 2003). According to important role of pigeons as a risk factor for human and poultry health, design the comprehensive studies are need to investigate the parasitic infection of pigeons in different regions of Iran. Neither of the referenced studies revealed the presence of ecto and/or endo-parasites that could be zoonotic to human, nor did the present study. In our work, there was no statistical significant difference between ecto and endo-parasite infestations (p=0.39).

In conclusion, this is the first report on ecto and endo-parasites in domestic pigeons in Hamedan, west part of Iran.

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CONFLICT OF INTEREST STATEMENT

We declare that there is no conflict of interests.

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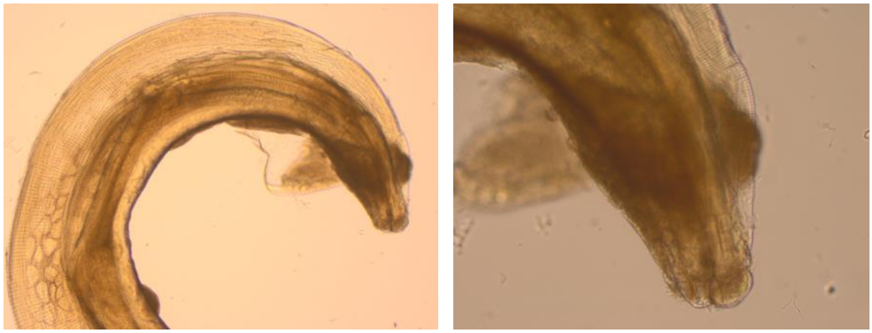

Figure 1. *Hartertia gallinarum* (male): anterior end.

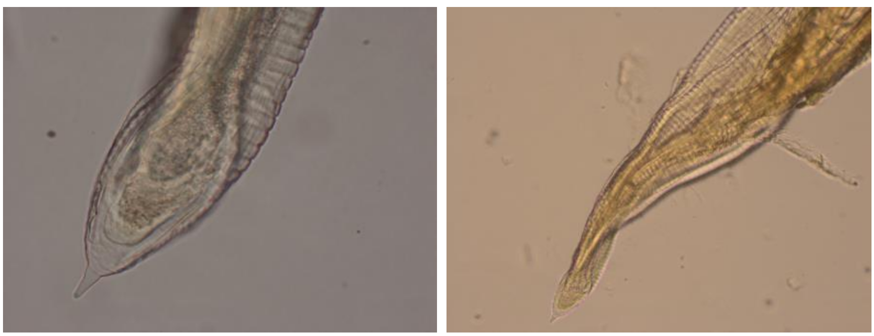

Figure 2. *Hartertia gallinarum* (male): posterior end.

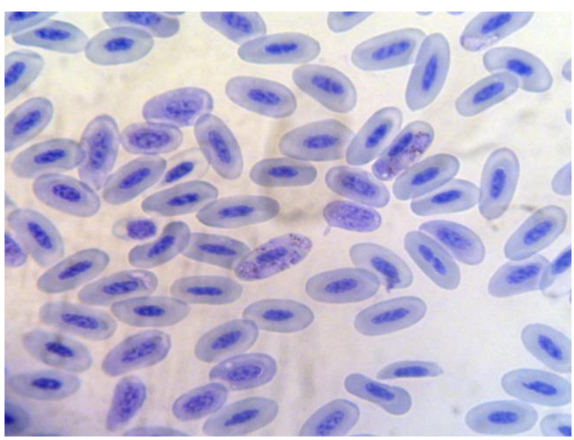

Figure 3. Macro and Microgametocytes of *Haemoproteus columbae* within RBC of pigeon, stained with Giemsa.

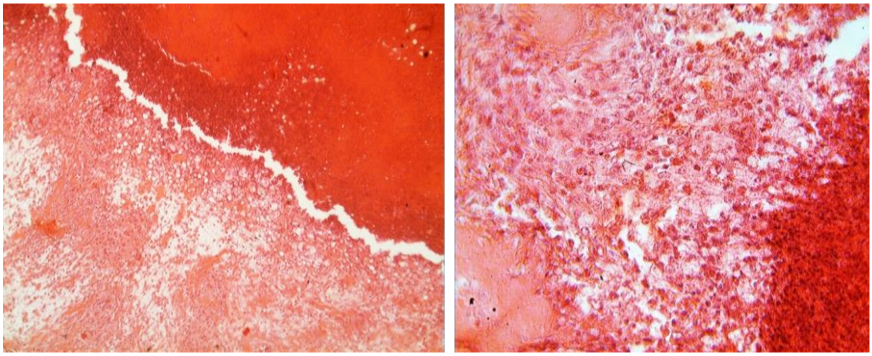

Figure 4. Haemosidrin pigment and hyperplagia of bile duct also diffuse necrosis in hepatocyte.

Table 1. The frequency of mixed infection (n=24) in examined pigeons (n=80) in Hamedan.

Mixed infection	Prevalence (%)
Ascaridia colombae + Ascaridia galli	6 (7.5)
Ascaridia galli + Hartertia gallinarum	4 (5)
Ascaridia galli + Raillietina echinobothrida	4 (5)
Menopon gallinae + Columbicola columbae	10 (12.5)

Table 2. Endoparasites recovered pigeons (n=80) in Hamedan.

Parasite spp.	No. of infection (%)	Infection range (Min-Max)
Raillietina echinobothrida	4 (5)	1-5
Ascaridia galli	8 (10)	1-11
Ascaridia columbae	5 (6.25)	1-7
Hartertia gallinarum	1 (1.25)	1-2
Haemoproteus colombae	40 (50)	3-10

Table 3. Ectoparasites recovered from pigeons (n=80) in Hamedan.

Parasite spp.	No. of infection (%)	Infection range (Min-Max)
Menopon gallinae	8 (10)	1-3
Columbicola columbae	25 (31.25)	1-12
Pseudolynchia canariensis	20 (25)	1-3

IN VITRO ASSESSMENT OF GENOTOXIC AND OXIDATIVE EFFECTS POTENTIALS OF EDIBLE BAMBOO WORMS AND WEAVER ANTS

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[Koç, K., İncekara, Ü., Türkez, H. & Çelik, K. 2019. *In vitro* assessment of genotoxic and oxidative effects potentials of edible bamboo worms and weaver ants. Munis Entomology & Zoology, 14 (2): 496-501**]**

ABSTRACT: In the present study we have assessed the genotoxic and oxidative effects of water soluble extracts of Bamboo Worms, *Omphisa fuscidentalis* (Lepidoptera: Pyralidae), and Weaver Ants, *Oecophylla smaragdina* (Hymenoptera: Formicidae), on cultured human blood cells. The extracts were added to the cultures at 12 different concentrations (0-2000 ppm). Micronucleus (MN) test was used to monitor the DNA and chromosomal damage produced by aqueous extracts *in vitro*. In addition, to assess the oxidative effects, total antioxidant capacity (TAC) and total oxidant status (TOS) levels were also measured. Our results indicated that these extracts did not show genotoxic effects at the tested concentrations. However, the extracts caused dose dependent alterations in both TAC and TOS levels. Based on the findings, it was concluded that the studied insects can be consumed safely, but it is necessary to consider the cellular damages which are likely to appear depending on oxidative stress at higher concentrations. It has been also suggested that this *in vitro* approach for oxidative and genotoxicity assessments may be useful to evaluate the potential health risks of edible insects.

KEY WORDS: Edible insects, genotoxicity, oxidative status

Insects have been consumed as an important food resource for thousands of years. Nowadays, an estimated 2086 insect species are consumed by 3071 ethnic groups (Ramos-Elorduy, 2009). Ordinarily, insects are not used as emergency food to ward off starvation, but are included as a normal part of the diet throughout the year or when seasonally available. Some of the commonly eaten species of insects include grasshoppers, crickets, termites, ants, beetle larvae, moth caterpillars, and pupae (Capinera, 2004). Insects are rich in protein and amino acids, fat and carbohydrates, nutritive elements such as iron, calcium and vitamins A, B1, B2 and D (DeFoliart, 1989; Ramos-Elorduy, 2005). Some experts are of the opinion that edible insects may be an inexhaustible protein source for humans in the future. Therefore edible insects offer an important nutritional resource for humans. Besides the nutrient content, insects have medicinal properties because they include important substances such as antimicrobial proteins and peptides, enzymes and hormones (Yamakawa, 1998). In various parts of the world, many species of insects have been used in traditional and folk medicine (Paoletti, 2005). On the other hand, edible insects constitute a very common and important food source in many developing countries although these insects may include contain vertebrate toxins (Akinnawo, et al., 2002). Very limited information is available concerning the genotoxic and oxidative effects of edible insects. Their potentially toxic effects should be investigated in more detail because eating insects may cause serious harmful effects on humans.

In order to investigate this further we used sensitive and reliable short-term genotoxicity and oxidative stress screening tests (performed in five replicates) on human whole blood cultures. Genetic alterations, mainly MN in cell cytoplasm, are the early biological effects of mutagenesis and/or carcinogenesis (Hagmar, et al., 1998). The cytokinesis block MN test also offers the advantage by providing simultaneously information on both cell cycle progression and chromosome / genome mutations (Kirsch-Volders, et al., 1997). The important oxidative parameters including TAC and TOS are used to monitor the development and extent of damage due to oxidative stress by insects in human blood.

The aim of the current study is to elucidate whether the water soluble extracts of Bamboo Worms, *Omphisa fuscidentalis* (Lepidoptera: Pyralidae), and Weaver Ants, *Oecophylla smaragdina* (Hymenoptera: Formicidae), have genotoxic and oxidative effects *in vitro*. Both insects are commonly consumed and have commercial importance. These are commonly consumed insects.

MATERIALS AND METHODS

Insect extracts

Bamboo Worms and Weaver Ants were supplied from Unique Foods Ltd., Thailand. Processed insects were triturated in a mortar. A stock solution of aqueous extract was prepared by mixing 1.4 g of processed insect powder with 200 ml of water (boiled and cooled tap water) with constant stirring on a magnetic stirrer. The suspension of dried insect powder in water was left for 4 h, and filtered through filter paper No.1 (Whatman). The filtrate was stored in an amber-colored air-tight bottle at room temperature until use. Then, stock solutions were diluted and added to cell culture tubes at different concentrations (0, 5, 10, 15, 25, 40, 75, 100, 200, 500, 1000 and 2000 ppm).

Cell cultures

Heparinized blood samples from five healthy male non-smoking donors with no history of exposure to any toxic agent were used in our experiments. Hematological and biochemical parameters were analyzed from all the volunteers, and no pathology was detected. Human peripheral blood lymphocyte cultures were set up according to a slight modification of the protocol described by Evans & O'Riordan (1975). A 0.5 mL aliquot of heparinized blood was cultured in 6 mL of culture medium (Chromosome Medium B; Biochrom, Berlin) with 5 mg/mL of phytohemagglutinin (Biochrom). The cultures were incubated in complete darkness for 72 h at 37°C. Experiments conformed to the guidelines of the World Medical Assembly (Declaration of Helsinki). MN test was carried out on lymphocytes 72 h after treatment. The TAC and TOS assays were carried out on plasma samples 2 h after treatment. Each individual lymphocyte culture without insect extract was studied as a control group.

MN assay

The MN test was performed by adding cytochalasin B (Sigma®; final concentration 6 mg/mL) after 44 h of culture. At the end of the 72-h incubation period, the lymphocytes were fixed with ice-cold methanol/acetic acid (1:1, v/v). The fixed cells were put directly on slides, using a cytospin, and stained with Giemsa solution. All slides were coded before scoring. The criteria for scoring micronuclei were as described by Fenech (1993). At least 1000 binucleated lymphocytes were examined per concentration for the presence of one, two or more micronuclei.

TAC and TOS analysis

The automated Trolox equivalent antioxidant capacity (TAC) and total oxidant status (TOS) assays were carried out in plasma samples obtained from blood cultures for 2 h using commercially available kits (Rel Assay Diagnostics®, Gaziantep, Turkey) (Erel, 2004).

Statistical analysis

Statistical analysis was performed using SPSS software (version 13.0, SPSS, Chicago, IL, USA). Duncan's test was used to determine whether any treatment significantly differed from controls or each other ($P<0.05$).

RESULTS

The results indicated that the aqueous extracts of Bamboo Worms did not alter MN/1000 cell frequencies in cultured human lymphocytes (Fig. 1). Nevertheless, the human blood cultures were found to be sterile after the application of the extracts of Bamboo Worms at concentrations of 1000 and 2000 ppm. The cytotoxic effects observed at increasing concentrations might cause the sterility. Different concentrations of Bamboo Worms (1000 and 2000 ppm) lead to significant decreases of TAC level when compared to the control values (Fig. 2). As shown from the results presented in Fig. 3, the TOS levels increased at higher concentrations of Bamboo Worms (500, 1000 and 2000 ppm).

The water soluble extracts of Weaver Ants did not cause any statistically significant difference MN/1000 cell frequencies upon concentrations tested (Fig. 1). Nevertheless, the human blood cultures were found to be sterile after the application of the extracts of Weaver Ants at a concentration of 2000 ppm. There was only one increase seen in antioxidant or "TAC" levels (at 40 ppm) for the weaver ant extract. All other TAC levels were either not significantly different from the controls (which would indicate no change in antioxidant levels) or decreased as compared to the controls. As shown from the results presented in Fig. 3, the TOS levels increased at higher concentrations of Weaver Ant (500, 1000 and 2000 ppm).

DISCUSSION AND CONCLUSION

Although the eating of insects has become widespread in parts of the world, very few studies have investigated whether this has harmful effects on humans. Adamolekun (1993) reported a seasonal ataxic syndrome associated with the consumption of the edible larva of *Anaphe venata* (Butler) in south-west Nigeria. Akinnawo, et al. (2005) studied toxicity of aqueous extracts of raw and processed larva of *Cirina forda* administered orally in mice and rats. They suggested that the processed larva of *Cirina forda* (Westwood) is neither neurotoxic nor hepatotoxic to these animals; however, the neurotoxic nature of the raw extract needs further investigation. Also, Akinnawo, et al. (2005) studied the effects of oral administration of extracts of raw and processed larvae of *Cirina forda* on morphometry and histopathology in rats. Their results indicated that the raw edible larva of *Cirina forda* was toxic to rats. The liver, kidney and to a lesser extent the heart appear to be the target organs. However, processing the larvae by boiling and sun-drying reduced the toxicity to the liver and heart but not the kidney. MacEvilly (2000) suggested that insects should not be eaten with nuts or shellfish as both have been shown to trigger allergic responses in hypersensitive individuals. Recently, three aquatic edible insect species, *Hydrophilus piceus*, *Dytiscus marginalis* and *Cybister* sp., were evaluated and found to be non-genotoxic (İncekara & Türkez, 2009). The *in vitro* genetic and oxidative effects of *Callimenus latipes* extracts (acetone, ethanol and diethyl ether) on human lymphocytes were investigated and the results suggested that C. *latipes* can be consumed safely, but it is necessary to take into consideration the cytotoxicity at increasing doses (İncekara, et al., 2010). Water-soluble extracts of grasshoppers, *Saga ephippigera ephippigera* and *Callimenus dilatatus,* were evaluated using cultured human blood cells; they were found to be non-genotoxic (Türkez, et al., 2010).

Our present findings demonstrate that water extracts of *Omphisa fuscidentalis* and *Oecophylla smaragdina* have no mutagenic potential. This suggests that these insect species can be consumed safely; however, it is advisable to take into consideration the cytotoxicity of insect extracts at increasing doses. The safe concentrations of edible insect extracts on human blood as described here are valid only for *in vitro* conditions. In order to gain greater insight *in vivo* studies are required on the absorption kinetics of these extracts from the gastrointestinal tract. The results of the present study reveal that *Oecophylla smaragdina* extract causes significantly increased levels of TAC at 40 ppm *in vitro*. The results of this study may encourage people to consume these insects as supplements of vitamins A, B_2 and C. In fact, it has been found that vitamin A, C, E and carotenoids, besides previously recognized functions of preventing particular lipido- and avitaminosis, significantly participate in the protection of the human body against oxidation stress that is characterized by balance disturbance between speed of free radical creation and reactive oxygen forms with pace of their neutralization by enzymes and antioxidants (Rutkowski, et al., 2010). And vitamin C was reported to be (together with glutathione) a major component of the non-enzymatic antioxidant system in the water-soluble compartment. Vitamin B_2 was found to be acting mainly as cofactor for glutathione reductase which keeps glutathione in the reduced state. It can therefore be considered an indirect antioxidative vitamin (Böhles, 1997). The relationship between strong antioxidant defences and the content of minerals such as Ca, Mg, Fe and P has also been reported (Kharb & Singh, 2000). Our results also revealed that aqueous extracts of *Omphisa fuscidentalis* and *Oecophylla smaragdina* lead to decreases of TAC levels at concentrations 1000 and 2000 ppm. Each extract augmented oxidative stress with an increase in its concentration. The cytotoxic effects of high levels of insect extracts could be explained by the increased levels of TOS. Therefore, we think that the similar damage may also occur in the human tissues as related over consumption. Taking all this into account, we suggest that insects can be consumed as a source of human nutrition but their appropriate amount must also be determined for human diet.

Eating insects has become more popular around the world; however, further researches are needed in order to prove their potential genotoxic effects. We suggest that the *in vitro* approach used here which includes the collaborative use of genetic endpoints and oxidative stress markers is a valuable technique for comparing the possible health risks of edible insects in relation to mutagenesis and carcinogenesis. This toxicity research may also be of much value in the formulation of novel biomedical products because it is well known that animal toxins may be effective in the treatment of diseases such as cancer.

Based on the findings, it was concluded that the Bamboo Worms and Weaver Ants can be consumed safely, but it is necessary to consider the cellular damage which is likely to appear. This depends on the extent of oxidative stress. It has been also suggested that this *in vitro* approach for oxidative and genotoxicity assessment would be very helpful for evaluating the potential health risks of edible insects.

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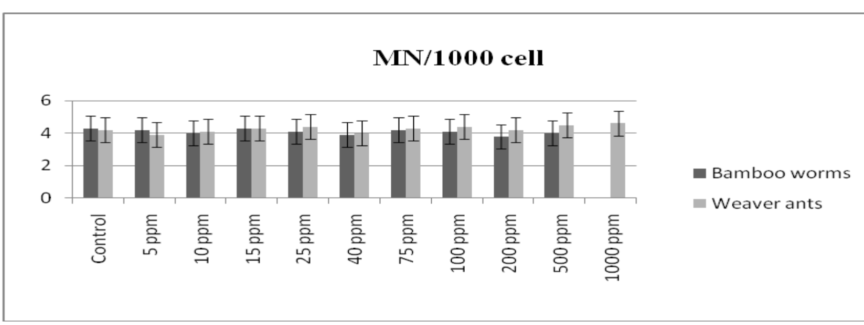

Figure 1. The effects of aqueous extracts from Weaver Ants and Bamboo Worms on MN / 1000 cell values in human blood cultures (Values are means ± standard deviation).

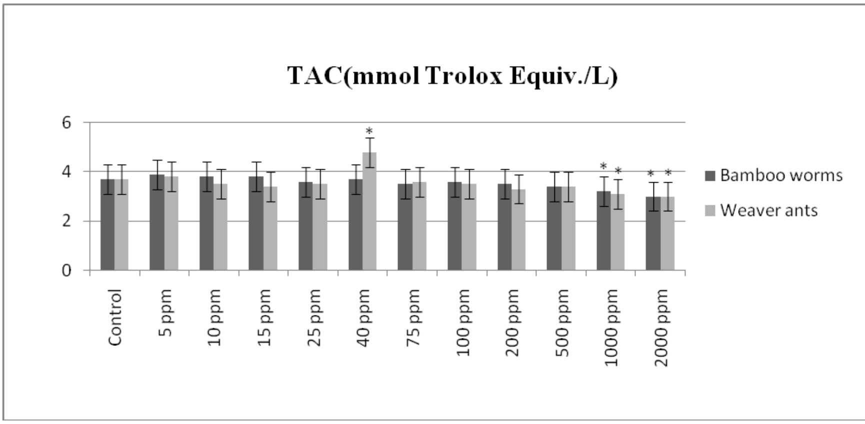

Figure 2. The effects of aqueous extracts from Bamboo Worms and Weaver Ants on TAC levels in human blood cultures (Values are means ± standard deviation, *symbol means statistically significant differences from control).

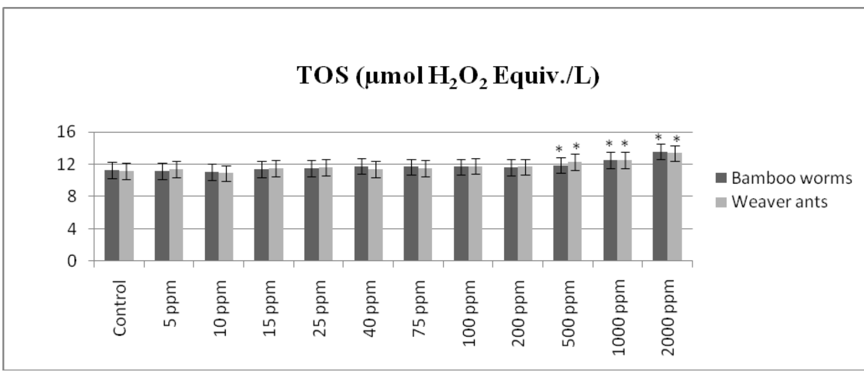

Figure 3. The effects of aqueous extracts from Bamboo Worms and Weaver Ants on TOS levels in human blood cultures (Values are means ± standard deviation, *symbol means statistically significant differences from control).

HETEROPTERA SPECIES LIST RECORDED ON *ACHILLEA* SPP. FROM TURKEY

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[Kıyak, S. 2019. Heteroptera species list recorded on *Achillea* spp. from Turkey. Munis Entomology & Zoology, 14 (2): 502-503**]**

ABSTRACT: Here, 28 species inhabiting on *Achillea* as a hostplant, of 7 families in Heteroptera from Turkey are recorded.

KEY WORDS: Heteroptera, hostplant, *Achillea*, Turkey

The aim of this study is presented a list of previously reported Turkish terrestrial Heteroptera species inhabiting on *Achillea* spp. in Turkey according to the previous literatures as Hoberlandt (1955), Stichel (1956, 1957, 1958), Wagner (1976), Aysev (1974), Lodos & Önder (1980), Pehlivan (1981), Kıyak (1990, 1993). Thus, 28 heteropteran species inhabiting on *Achillea* as a hostplant, of 7 families from Turkey are determined with this work. 9 species of Miridae, 2 species of Anthocoridae, 2 species of Coreidae, 3 species of Rhopalidae, 2 species of Lygaeidae, 9 species of Pentatomidae, 1 species of Cydnidae are recorded.

All species are given into a list in the following table.

List of Heteroptera species inhabiting on *Achillea* in Turkey

Familia/species	Host plant (s)	Cited literature (s)
MIRIDAE		
Phylidea henschi Reuter, 1888	*Achillea santolinoides*	Wagner, 1976
Chlamydatus pullus (Rt., 1870)	*Achillea* sp.	Wagner, 1976; Hoberlandt, 1955
Deraeocoris punctulatus (Fn., 1807)	*Achillea millefolium*	Stichel, 1956
Psallus ancorifer ssp. *ancorifer* (Fb., 1858)	*Achillea* sp.	Stichel, 1956
Halticus apterus (L., 1761)	*Achillea millefolium*	Stichel, 1956
Adelphocoris vandalicus (R., 1790)	*Achillea millefolium*	Stichel, 1956
Lygus kalmi (L., 1758)	*Achillea millefolium*	Stichel, 1956
Polymerus unifasciatus (F., 1794)	*Achillea millefolium*	Stichel, 1956
Polymerus vulneratus (Pz., 1806)	*Achillea millefolium*	Stichel, 1956
ANTHOCORIDAE		
Orius niger ssp. *niger* Wgn., 1804	*Achillea millefolium*	Stichel, 1958
Orius minutus ssp. *minutus* (L., 1758)	*Achillea millefolium*	Stichel, 1958
LYGAEIDAE		
Lygaeus equestris (L., 1758)	*Achillea odorada* (The name is Heterotypic synonym **Achillea nobilis* subsp. *neilreichii* (A. Kern.) Velen.)	Stichel, 1957; Aysev, 1974; Hoberlandt, 1955
Lygaeus pandurus (Scop., 1763)	*Achillea* sp.	Kıyak, 1993

COREIDAE		
Coreus marginatus ssp. *marginatus* (L., 1758)	*Achillea millefolium*	Stichel, 1957
Coriomerus denticulatus (Scop., 1763)	*Achillea* sp.	Stichel, 1957
RHOPALIDAE		
Stictopleurus crassicornis (L., 1758)	*Achillea millefolium*	Pehlivan, 1981; Stichel, 1957
Stictopleurus abutilon (L., 1790)	*Achillea millefolium*	Stichel, 1957
Rhopalus parumpunctatus Schl., 1829	*Achillea millefolium*	Pehlivan, 1981; Stichel, 1957
PENTATOMIDAE		
Staria lunata H., 1835	*Achilllea nobilis*	Stichel, 1957
Holcostethus vernalis (W., 1804)	*A.millefolium, Achillea* sp.	Stichel, 1957; Kıyak, 1990
Carpocoris fuscispinus (Bh., 1851)	*Achillea millefolium*	Stichel, 1957
Carpocoris pudicus (Pd., 1761)	*Achillea millefolium*	Stichel, 1957
Carpocoris melanocerus (Ms. & Rey, 1852)	*Achillea millefolium*	Stichel, 1957
Bagrada stolata Hv., 1936	*Achillea* sp.	Kıyak, 1993
Eurydema formosum Pt., 1895	*Achillea millefolium*	Stichel, 1957
Eurydema oleraceum (L., 1758)	*Achillea millefolium*	Stichel, 1957
Eurydema fieberi (Schr., 1836)	*Achillea* sp.	Kıyak, 1993
CYDNIDAE		
Aethus nigritus (F., 1794)	*Achillea* sp.	Lodos & Önder, 1980

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RARE OCCURRENCE OF RHINOCEROS BEETLE (*XYLOTRUPES TAPROBANES GANESHA* SILVESTRE, 2003) IN TAMILNADU, INDIA

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[Moinudheen, N., Samson Arockianadhan, A., Jayabalan, D. & Jothimani. 2019. Rare occurrence of Rhinoceros beetle (*Xylotrupes taprobanes ganesha* Silvestre, 2003) in Tamilnadu, India. Munis Entomology & Zoology, 14 (2): 504-507**]**

ABSTRACT: Rhinoceros beetle (*Xylotrupes taprobanes ganesha* Silvestre, 2003) recently recorded from Nilgiri hills,Western Ghats.

KEY WORDS: Rhinoceros beetle, Dynastinae, *Xylotrupes taprobanes ganesha,* Nilgiri hills, Western Ghats

Dynastinae is subfamily of scarab beetle (Scarabidae) rhinoceros beetles are the largest extant insects on earth. Males have horns on the head and thorax. *Xylotrupes* is under the tribe of Dynastini. In this Genus are widely spread all over world. Major works on the Dynastinae of the world were done by Burmeister (1847). Arrow (1910) revised the Dynastinae research in the Indian sub-region.

In india region *Xylotrupes* represent three species and two subspecies namely, *Xylotrupes meridionalis meridionalis* Prell, 1914: 216; India; type at ZMHB, *Xylotrupes meridionalis taprobanes* Prell, 1914: 2017; Sri Lanka; type at ZMHB, *Xylotrupes mnizechi niszechi* Thomson, 1859: 18; Himalay; type at MNHN and Two new subspecies: *X. socrates nitidus* Silvestre, 2003 from Andaman Islands. And *X. taprobanes ganesha* Silvestre, 2003 from south India.

Chandra (2000) reported that 96 species of scarab beetles which includes a single species of dynastine beetle were recorded from Madhya Pradesh. Most of the researches were done in this species in the Northern Province of India.

On 06-07-2018 Date and time we encountered the road kill specimen of *X. taprobanes ganesha* from Wellington, the Nilgiris (11.364N 76.794E), Tamil Nadu India. Silvestre (2003) generally stated the distribution of this species from Kerala and Tamil Nadu regions so far here after no works were done in this subspecies distribution so for in this region in *X. taprobanes ganesha*. This present observation shows the occurrence of *X. taprobanes ganesha* in Nilgiris since no studies were done in this species distribution this present observation ensure the occurrence of *X. taprobanes ganesha* in the Nilgiris show a light on this species ecological work in this region.

Distribution: India: South India, Kerala, Tamilnadu (Silvestre, 2003).

Description:

Its horns and its body thickness and length, colour are based on their origin. Silverstere (2003) morphologically has explored this and has researched it together with the combined species so that they could be compared to that species. So I have explained in detail the description of his morphological characters. Based on this, the species is known as *Xylotropes taprobanes ganesha*.

Male: 58 mm (up to 53 mm horn Based on this, the creature is known as slutusns included). Average height, broad shape, quite massive; glabrous, weakly shiny, dark brown, usually elytra clearer. Clypus broad, weakly emarginated, sharp angles. Canthus ocular salient, very broadly rounded, with no marked angles, punctuated on the outer edge; sinuate cheeks Mentum broad, the sides lined with a strong punctuation. Short mandibles, the very unequal apial lobes: rounded outer lobe, well developed, shorter inner lobe, thin, dentiform, more or less acuminate (Fig. 1). Cephalic quite short and thin, very broadly flared into a V-shaped apical fork with widely diverging branches, barely bent; the posterior surface is not careened at the base, but generally presents a small projection at the birth of the fork, at the point of convergence of the internal hulls of this one, the external hulls extending on the sides of the come decreasing; width total apical fork approximately equal to ¾ of its length. Pronotum large (about 1.3 wider than long), more or less trapezoidal, the lateral edges barely curved or slightly sinuate, posterior angle broadly rounded; slightly satiny appearance shining, regularly punctuated average punctuation, with an undisclosed lateral zone of round points larger and tighter, often umbilicated; anterior side practically smooth, glowing (Fig. 2). Short to medium thoracic horn implanted high on the disc, thin and slightly compressed laterally, the edges parallel or slightly flared towards the apex notched the triangle; a thin groove is frequently visible along the axis of the come; basal hulls slightly marked, not salient. Scutellum matte, punctuated-punctuated, clearly reborde. Elytres weakly shiny, broad and convex (about 1.13 times longer than their common width) (Fig. 3), finely and irregularly punctuated (some points often more clearly aligned) on a more or less chaotic background; sutural streak consisting of dots spaced a little bigger. Pygidium densely punctuated except at the apex, the bearing very dense silks. Short and dense enough, not very visible. Parameters of the landscape strongly sinate in lateral view, the apex is short and spatulate, the descending part has a small depression and a slight angulation on the inner edge (Fig. 4) (Silvestre, 2003).

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Figure 1. Short mandibles, broad shape, dark brown.

Figure 2. The lateral edges barely curved or slightly sinuate anterior side practically smooth, glowing.

Figure 3. Short to medium thoracic horn, broad and convex.

Figure 4. Pygidium densely punctuated except at the apex, the bearing very dense silks.

DIVERSITY OF INSECT PEST, NATURAL ENEMIES AND OTHER BENEFICIALS ARTHROPODS COMMUNITY IN SELECTED BRINJAL VARIETIES/LINES

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[Amin, S. M. R., Alam, M. Z., Rahman, M. M., Hossain, M. M. & Mian, I. H. 2019. Diversity of insect pest, natural enemies and other beneficials arthropods community in selected Brinjal varieties/lines. Munis Entomology & Zoology, 14 (2): 508-512**]**

ABSTRACT: Five brinjal varieties viz., BL099, BARI brinjal-6,BL117,BL072 BARI brinjal-1 were grown in replicated trial laidout in randomized block design at experimental farm and Entomology laboratory of BSMRAU for the measurement of diversity and equitability of arthropod community during 2005. The finding indicated that lower abundance of insect family in resistance variety/lines while a higher number of families are available in susceptible variety/line. All the resistant varieties showed higher equitability compare to that of susceptible one. A positive relationship was evident between the number of fswmilies and diversity index at all the crop growth stages (r=0.77). A negative relationship was observed between the number of families and equitability at all crop stages. (r= 0.31).

KEY WORDS: Insect pest, arthropod community, Brinjal varieties/lines

Brinjal (*Solanum melongena*) is one of the most popular and principal vegetable crop grown in Bangladesh and other part of the world. The major constraints of the brinjal production is that the crop is attacked by a large number of insect pests among which Brinjal shoot and fruit borer BSFB, *Lencinodes orbonalis* Guenee is most destructive pest of brinjal in Bangladesh (Alam, 1969; Cattopadhy, 1987) and India (Tewari & Sandana, 1990) and also a major pest in other country of the world. For controlling insect pest of brinjal, farmer's usually spray chemical pesticide many times during the crop season which leads to environmental pollution and consequent increase in health hazard to the growers and consumers. Moreover, it also leads to the development of resistance to target pests (David & Kumaraswami, 1989) and also had a negative effect on natural enemies and other beneficial and causes disruption of biodiversity. The growing awareness of the shortcoming of the chemical insecticides has necessitated the exploration of alternative method of pest control which is relatively free from adverse side effects. Among the various alternatives, the exploitation of host plant resistance is perhaps the most effective, convenient, economical and environmentally acceptable method of insect control (Dhaliwal & Dilawary, 1993). Varieties of brinjal with some morphological and physiological bases provide resistance against different brinjal pests. Different varieties of brinjal showed different reaction to different insect pests.

For better understanding and identifying suitable resistant variety of brinjal it is important to measure the species diversity that gives us clear idea about herbivore load of a variety. Therefore the present study was undertaken with the following objectives:

1. to determine the diversity and equitability of insect communities in different brinjal varieties/lines and

2. to find out the relationship between species richness of taxonomic categories with the diversity index and equitability in brinjal grown with different varieties/line

MATERIALS AND METHODS

The experiment was conducted using 5 brinjal varieties/ lines viz., BL 099, BARI brinjal-6, BL 117, BL 072 and BARI brinjal -1 in the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during the period from April 2005 to September 2005. The experiment was laid out in a randomized block design with three replications. The individual plot size was 3mX3m. The distance between plots and blocks were 0.5 meter and 1 meter, respectively. The seedling were transplanted at spacing of 1 m between lines and 60 cm between plants. The crop was grown following the recommended practices except application of insecticide.

Data collection for the measurement of diversity index and equitability

The simplest measure of species diversity is to count the number of species present. The concept was extended to order and family level. Capturing the insects was performed using two relative methods viz., pitfall trapping and sweep netting.

Pitfall trap method

This method was used for the species that roam in the soil surface such as ground beetles, spiders, collembola etc. Small plastic pots having 6 cm diameter and 8 cm deep were used as pitfall traps each of which was filled with water. Three traps were placed in soil in each of the plots at early, mid and late stage of crops to trap the insects. The trap mouth of the pot was kept with the ground level so as avoid obstruct insect movement. After 48 hours of setting traps, insects were collected from each plot/treatment and kept separately.

Sweeping net method

This method was used for counting flying and stationary insects on host plants to know the abundance pattern of insects in the present study. Five (5) times return sweeping was done in each plot to make a composite sample by a sweeping net at early, mid and late crop stages. Each sample was examined separately without killing the insects and released them immediately after counting in the same plot. The individuals of each sample were counted by family.

On the basis of phenotypic similarity, trapped and sweep net caught insects were then sorted and further identified to family and order they belong to with the help of identified specimens kept with the museum of the dept. of Entomology, BSMRAU and other standard taxonomic keys. Data were recorded against each treatment.

Measurement of diversity index and equitability

To assess both the abundance pattern and the species richness, Simpson's diversity index was used (After Simpson's, 1949).

Simpson's Index, (D) $= \dfrac{1}{\sum_{i=1}^{s} P_i^{\,2}}$

Where, Pi is the proportion of individual for the ith insect family and S is the total numbers of insect family in the community (i.e., the richness).

Equitability was quantified by expressing Simpson's index, D as a proportion of the maximum possible value of D.

$$\text{Equitability, } E = \frac{D}{D_{max}} = \frac{1}{\sum_{i=1}^{s} P_i^{\,2}} \times \frac{1}{S} \quad [\text{As } D_{max} = S]$$

Insect pests and their natural enemies i.e., predators and parasitoids, as well as other beneficial insects like pollinators and spiders were taken into account.

Statistical analysis

Linear regression analysis was performed to explore the relationships between the number of taxonomic categories with diversity index and equitability.

RESULTS AND DISCUSSION

Diversity of arthropod /insect community

Trends of diversity pattern of insect roaming in different brinjal resistance and susceptible varieties using pitfall and sweep net at early. mid and late stage of crop growth are shown in Table 1.1 , 1.2. Some insects which were not regarded as crop pest , were also found in the trap incidentally in both the method. They were also included in data because the relative significance of their presence in a particular ecosystem is not clearly known.

Diversity of arthropod /insect community measured by pitfall trap at different stage of crop growth

From Table 1.1 it is evident that the higher richness and also the higher diversity index were observed in BARI brinjal-6 and BARI brinjal-1 with the equitability of 0.55 and 0.33, respectively. In the mid stage of crop growth the highest equitability (0.80) was observed in BL117 with lower species richness. On the other hand BL099, BARI brinjal-6 produce higher equitability with relatively lower species richness. BARI brinjal -1 showed comparatively higher richness but low equitability (Table 1.1). The result indicated that lower abundance of insect family in resistant varieties/lines of brinjal while a higher number of families were found in susceptible BARI brinjal-1 variety.

In the late stage of crop growth the higher diversity index was found in all the varieties/lines except BL 099 (Table 1.1). But all the resistant varieties showed higher equitability. Brinjal variety, BARI brinjal-1 showed lowest equitability and BARI brinjal -6 showed highest equitability (0.79).

Diversity of arthropod/insect community measured by sweeping net at different stage of crop growth

Table 1.2 indicated that the early stage of crop growth the higher richness and also the higher diversity index were observed in BL 117 and BARI brinjal-6 with the equitability of 0.23 and 0.25, respectively. In the mid stage of crop growth the highest equitability (0.46) was observed in BL 099 with lower species richness. And BARI brinjal -1 showed highest richness but lowest equitability (0.20) (Table 1.2). The result indicated that lower abundance of insect family in resistant varieties/lines of brinjal while a higher number of families were found in susceptible BARI brinjal-1 variety.

In the late stage of crop growth the diversity index was found similar in all the varieties/lines (Table 1.1). But all the resistant varieties showed higher equitability. Brinjal variety BARI brinjal-1 showed lowest equitability (0.19) and BL099 showed highest equitability (0.58).

Relationship between species richness , diversity index and equitability

The relationship between richness with diversity index and equitability of insect/arthropod community under different brinjal varieties/line at different growth stage are presented in Table 1.3.

Relationship between number of insect/ arthropod families with diversity index

A positive relationship was found between the number families and diversity index in all the crop growth stage (Table 1.3). In all stages of crop growth except the early stage, significant relationship between richness and diversity index of insect/arthropod community was observed (r=0.71-0.96). Assessment of the whole crop period revealed significant positive relationship between richness and diversity index. It is clearly evident that diversity index of insect/arthropod community influenced by the number of insect family (e. i., species richness).

Relationship between number of insect/ arthropod families with equitability

A negative relationship was observed between the number of families with equitability in all the crop stages (r=0.31)(Table 1.3). However the result during the late stage of crowth revealed a strong significant negative relationship (r=-0.97) between richness and equitability. The value of diversity index depends on the species richness and the evenness (equitability) with which individual are distributed among the species. For a given richness 'D' increases with equitability and for a given equitability 'D" increases with richness (Begon et al., 1990).

In the present study, when diversity was assessed by relative method, BARI brinjal-1 showed higher diversity index in all the growth stages but resistant varieties showed comparatively lower diversity index. The results indicated that the pest insect were less abundant in resistant varieties / lines of brinjal and greater number belongs to different natural enemies and benificials. May (1975) reported that diversity index is strongly influenced by species richness. A completely novel concept of Tailor et al. (1976) of viewing diversity as a reflection of basic environmental structure, the two meaningfull characteristics are not species richness and evenness but (1) diversity as represented by the common, the slope of the line is dominated by the moderately common species and (2) the fluctuation in number from occasion to occasion (eg., year to year).

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Table 1.1. Diversity and equitability of arthropod community of different resistant and susceptible brinjal varieties/lines recorded in pitfall trap at early, mid and late stages of crop during summer 2005.

Variety /line	Early stage			Mid stage			Late stage		
	No. of insect families recorded	Diversity index	Equitability	No. of insect families recorded	Diversity index	Equitability	No. of insect families recorded	Diversity index	Equitability
BL-099(R)	4	2.07	0.52	6	4.62	0.77	4	2.85	0.71
BARI brinjal6(R)	5	2.74	0.55	8	5.52	0.69	4	3.17	0.79
BL-117(R)	4	2.29	0.57	9	7.19	0.80	5	3.59	0.72
Bl-072(R)	5	1.79	0.36	9	4.79	0.53	5	3.83	0.77
BARI brinjal-1(S)	7	2.32	0.33	11	5.08	0.46	6	3.02	0.50

R=Resistant S= Susceptible

Table 1.2. Diversity and equitability of arthropod community of different resistant and susceptible brinjal varieties/lines recorded in sweeping net at early, mid and late stages of crop during summer 2005.

Variety /line	Early stage			Mid stage			Late stage		
	No. of insect families recorded	Diversity index	Equitability	No. of insect families recorded	Diversity index	Equitability	No. of insect families recorded	Diversity index	Equitability
BL-099(R)	5	1.52	0.30	10	4.55	0.46	5	2.89	0.58
BARI brinjal-6(R)	7	1.73	0.25	12	4.89	0.41	6	2.78	0.46
BL-117(R)	8	1.83	0.23	14	4.60	0.33	7	2.83	0.40
Bl-072(R)	7	1.46	0.21	13	4.26	0.33	5	2.16	0.43
BARI brinjal-1(S)	9	1.56	0.16	15	3.04	0.20	11	2.14	0.19

R=Resistant S= Susceptible

Table 1.3. Relationship between number of families (x) and diversity index (y), equitability (y) at different plant growth stages of brinjal during summer 2005.

Relationship between	Crop growth stages			
	Early stages	Mid stages	Late stages	Whole crop period
No. of insect families (x) and diversity index(y)	Y= 0.13x +1.44 r = 0.71	Y= 0.25x +3.82 r = 0.87	Y= 0.26x +3.25 r = 0.96	Y= 0.39x +0.25 r = 0.77
Probability (p)	NS	0.01	0.05	NS
No. of insect families (x) and equitability (y)	Y=-0.008x+0.35 r = 0.58	Y= -0.023x+0.87 r = 0.80	Y= -0.05x +1.02 r = 0.97	Y= 0.008x+0.49 r = 0.31
Probability (p)	NS	NS	0.05	NS

THE SPIDER FAUNA OF KÜTAHYA PROVINCE IN TURKEY

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[Seyyar, O., Harmanşah, İ. & Demir, H. 2019. The spider fauna of Kütahya province in Turkey. Munis Entomology & Zoology, 14 (2): 513-518**]**

ABSTRACT: This study was done Kütahya province in Inner Part of Western Anatolia of Turkey. Spiders were collected from field by using aspirator, sweep net and pitfall traps in study area during two years, beginning from April 2015 to October 2016. A total of 147 spider species in 23 families were recorded from study area. All specimens were labelled and preserved as museum materials in Arachnology Museum of Niğde Ömer Halisdemir University.

KEY WORDS: Spider, fauna, Kütahya, Turkey

The spider fauna of Turkey is poorly known compared to other countries of the world. Up to now, 47309 species of 4076 genera of spiders have been described in the world (World Spider Catalog, 2018). There are only 1117 species, belonging to 52 families known from Turkey (Demir & Seyyar, 2017). In this study, we determined the spider diversity of Kütahya provinces and have contributed to Turkish spider fauna.

MATERIALS AND METHODS

All specimens were collected from field by using aspirator, sweep net and pitfall traps from 37 localities (Fig. 1). in Kütahya (Fig. 2) province during two years, beginning from April 2015 to October 2016. The identification was made by means of a SZX61 Olympus stereomicroscope. Museum materials were used for the species identification. The specimens which were labelled and preserved as museum materials in Arachnology Museum of Niğde Ömer Halisdemir University (NOHUAM).

RESULTS

Totally 147 spider species in 23 families determined from study area (Table 1). Most species rich families were Gnaphosidae, Salticidae and Lycosidae (Fig. 3). According to the result of this study, the spider diversity in Kütahya Province contains 40,4% at the family level, and 13,2% at the species level of all Turkish spiders.

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Table 1. The spider list of Kütahya province.

SPIDER LIST		♀	♂
FAM. AGELENIDAE			
1	*Agelena labyrinthica* (Clerck, 1757)	+	+
2	*Agelena orientalis* C.L.Koch, 1837	+	+
3	*Agelescape gideoni* Levy, 1996	+	+
4	*Maimuna vestita* (C. L. Koch, 1841)	+	+
5	*Tegeneria argaeica* (Nosek, 1905)	+	+
6	*Textrix denticulata* (Olivier, 1789)	+	+
FAM. ARANEIDAE			
1	*Aculepeira armida* (Audouin, 1826)	+	+
2	*Aculepeira ceropegia* (Walckenaer, 1802)	+	+
3	*Agalenatea redii* (Scopoli, 1763)	+	+
4	*Araneus diadematus* (Clerck, 1757)	+	+
5	*Araniella cucurbitina* (Clerck, 1757)	+	+
6	*Argiope lobata* (Pallas, 1772)	+	+
7	*Cyclosa conica* (Pallas, 1772)	+	+
8	*Gibbaranea bituberculata* (Walckenaer, 1802)	+	+
9	*Larinioides cornutus* (Clerck, 1757)	+	+
10	*Neoscona adianta* (Walckenaer, 1802)	+	+
FAM. CLUBIONIDAE			
1	*Clubiona caerulescens* L. Koch, 1867	+	-
FAM. DICTYNIDAE			
1	*Dictyna uncinata* (Thorell, 1856)	+	+
2	*Emblyna annulipes* (Blackwall, 1846)	+	+
3	*Lathys humilis* (Blackwall, 1855)	+	+
FAM. EUTICHURIDAE			
1	*Cheiracanthium erraticum* (Walckenaer, 1802)	+	+
2	*Cheiracanthium pennyi* O. P.-Cambridge, 1873	+	+
FAM. GNAPHOSIDAE			
1	*Aphantaulax trifasciata* (O. P.-Cambridge, 1872)	+	-
2	*Berinda hakani* Chatzaki & Seyyar, 2010	+	-
3	*Civizelotes caucasius* (L.Koch, 1866)	+	+
4	*Cryptodrassus creticus* Chatzaki, 2002	+	-
5	*Drassodes lacertosus* (O. P.-Cambridge, 1872)	+	+
6	*Drassodes lapidosus* (Walckenaer, 1802)	+	+
7	*Drassodes lutescens* (C.L.Koch, 1839)	-	+
8	*Drassodes pubescens* (Thorell, 1856)	+	+
9	*Drassyllus crimeaensis* Kovblyuk, 2003	+	+
10	*Drassyllus praeficus* (L.Koch, 1866)	+	+
11	*Gnaphosa opaca* Herman, 1879	+	-
12	*Haplodrassus dalmatensis* (L. Koch, 1866)	+	+
13	*Haplodrassus invalidus* (O. P.-Cambridge, 1872)	-	+
14	*Haplodrassus morosus* (O. P.-Cambridge, 1872)	-	+
15	*Haplodrassus signifer* (C.L.Koch, 1839)	+	+
16	*Micaria albovittata* (Lucas, 1846)	+	-
17	*Micaria coarctata* (Lucas, 1846)	+	-
18	*Nomisia aussereri* (L.Koch, 1872)	+	+

19	*Nomisia conigera* (Spassky, 1941)	+	+
20	*Nomisia exornata* (C.L.Koch, 1839)	+	+
21	*Nomisia ripariensis* (O.P.-Cambridge, 1872)	+	+
22	*Parasyrisca turkenica* Ovtsharenko, Platnick & Marusik, 1995	+	-
23	*Phaeocedus braccatus* (L. Koch, 1866)	+	+
24	*Poecilochroa variana* (C. L. Koch, 1839)	+	+
25	*Pterotricha kochi* (O.P.-Cambridge, 1872)	+	-
26	*Scotophaeus scutulatus* (L. Koch, 1866)	+	+
27	*Trachyzelotes malkini* (Platnick ve Murphy, 1984)	+	-
28	*Zelotes cingarus* (O. P.-Cambridge, 1874)	+	+
29	*Zelotes longipes* (L.Koch, 1866)	+	+
30	*Zelotes puritanus* (Chamberlin, 1922)	+	-
31	*Zelotes subterraneus* (C.L.Koch, 1833)	+	+
FAM. LIOCRANIDAE			
1	*Mesiotelus scopensis* Drensky, 1935	+	-
FAM. LIYNIPHIIDAE			
1	*Erigone atra* Blackwall, 1833	+	+
2	*Frontinellina frutetorum* (C.L.Koch, 1834)	+	+
3	*Lepthyphantes leprosus* (Ohlert, 1865)	+	+
4	*Linyphia triangularis* (Clerck, 1757)	+	+
5	*Megalepthyphantes nebulosus* (Sundevall, 1830)	+	+
6	*Neriene peltata* (Wider, 1834)	+	+
FAM. LYCOSIDAE			
1	*Alopecosa accentuata* (Latreille, 1817)	+	+
2	*Alopecosa cursor* (Hahn, 1831)	+	+
3	*Alopecosa pulverulenta* (Clerck, 1757)	+	+
4	*Arctosa cinerea* (Fabricius, 1777)	+	-
5	*Arctosa leopardus* (Sundevall, 1833)	+	-
6	*Arctosa tbilisiensis* Mcheidze, 1946	+	+
7	*Geolycosa vultuosa* (C.L.Koch, 1838)	+	+
8	*Hogna radiata* (Latreille, 1817)	+	-
9	*Lycosa praegrandis* C.L.Koch, 1836	+	-
10	*Pardosa agrestis* O.P.-Cambridge, 1895	+	+
11	*Pardosa agricola* (Thorell, 1856)	+	-
12	*Pardosa proxima* (C.L.Koch, 1847)	+	+
13	*Piratula latitans* (Blackwell, 1841)	+	-
14	*Trochosa hispanica* Simon, 1870	+	-
15	*Trochosa spinipalpis* (O. P.-Cambridge, 1895)	+	-
16	*Wadicosa fidelis* (O. P.-Cambridge, 1872)	+	+
FAM. OECOBIDAE			
1	*Oecobius rhodiensis* Kritscher, 1966	+	+
2	*Uroctea durandi* (Latreille, 1809)	+	+
FAM. OXYOPIDAE			
1	*Oxyopes heteropthalmus* (Latreille, 1804)	+	+
2	*Oxyopes lineatus* Latreille, 1806	+	+
3	*Oxyopes ramosus* (Martini & Goeze, 1778)	+	+
FAM. PALPIMANIDAE			
1	*Palpimanus uncatus* Kulczyński, 1909	+	+
2	*Palpimanus orientalis* Kulczyński, 1909	+	+
FAM. PISAURIDAE			
1	*Pisaura mirabilis* (Clerck, 1757)	+	-
FAM. PHILODROMIDAE			
1	*Philodromus cespitum* (Walckenaer, 1802)	+	+
2	*Thanatus atratus* Simon, 1875	+	-
3	*Thanatus formicinus* (Clerck, 1757)	+	-

4	*Thanatus oblongiusculus* (Lucas, 1846)	+	+
5	*Thanatus pictus* L.Koch, 1881	+	+
6	*Thanatus vulgaris* Simon, 1870	+	-
FAM. PHOLCIDAE			
1	*Holocnemus pluchei* (Scopoli, 1763)	+	+
2	*Pholcus opilionoides* (Schrank, 1781)	+	+
3	*Pholcus phalangioides* (Fuesslin, 1775)	+	-
FAM. SALTICIDAE			
1	*Aelurillus luctuosus* (Lucas, 1846)	+	+
2	*Ballus chalybeius* (Walckenaer, 1802)	+	+
3	*Chalcoscirtus infimus* (Simon, 1868)	+	-
4	*Chalcoscirtus nigritus* (Thorell, 1875)	-	+
5	*Cyrba algerina* (Lucas, 1846)	+	+
6	*Heliophanus cupreus* (Walckenaer, 1802)	+	-
7	*Heliophanus dampfi* Schenkel, 1923	+	+
8	*Heliophanus dubius* C.L.Koch, 1835	+	-
9	*Heliophanus edentulus* Simon, 1871	-	+
10	*Heliophanus flavipes* (Hahn, 1832)	-	+
11	*Leptorchestes sikorskii* Prószyński, 2000	-	+
12	*Pellenes geniculatus* (Simon, 1868)	+	-
13	*Philaeus chrysops* (Poda, 1761)	+	+
14	*Phlegra bresnieri* (Lucas, 1846)	+	-
15	*Phlegra fasciata* (Hahn, 1826)	-	+
16	*Salticus scenicus* (Clerck, 1757)	+	-
17	*Talavera aequipes* (O. P.-Cambridge, 1871)	+	-
FAM. SCYTOTIDAE			
1	*Scytodes thoracica* (Latreille, 1802)	+	+
FAM. SPARASSIDAE			
1	*Eusparassus walckenaeri* (Audouin, 1825)	-	+
2	*Micrommata virescens* (Clerck, 1757)	+	+
FAM. TETRAGANATHIDAE			
1	*Tetragnatha obtusa* C.L.Koch, 1837	+	+
FAM. THERIDIIDAE			
1	*Asagena phalerata* (Panzer, 1801)	+	-
2	*Enoplognatha oelandica* (Thorell, 1875)	-	+
3	*Enoplognatha mandibularis* (Lucas, 1846)	-	+
4	*Enoplognatha mordax* (Thorell, 1875)	-	+
5	*Enoplognatha thoracica* (Hahn, 1833)	-	+
6	*Episinus truncatus* Latreille, 1809	+	-
7	*Kochiura aulica* (C. L. Koch, 1838)	+	-
8	*Neottiura herbigrada* (Simon, 1873)	+	-
9	*Simitidion simile* (C. L. Koch, 1836)	+	+
10	*Steatoda albomaculata* (De Geer, 1778)	+	-
11	*Steatoda paykulliana* (Walckenaer, 1805)	+	+
12	*Steatoda triangulosa* (Walckenaer, 1802)	+	-
13	*Theridion melanurum* (Hahn, 1831)	+	-
FAM. THOMISIDAE			
1	*Heriaeus graminicola* (Doleschall, 1852)	+	-
2	*Misumena vatia* (Clerck, 1757)	+	-
3	*Synema globosum* (Fabricius, 1775)	+	-
4	*Thomisus onustus* Walckenaer, 1805	+	+
5	*Ozyptila atomaria* (Panzer, 1801)	+	-
6	*Runcinia grammica* (C.L.Koch, 1837)	+	-
7	*Xysticus abramovi* Marusik & Logunov, 1995	+	+
8	*Xysticus caperatus* Simon, 1875	+	+

9	*Xysticus edax* (O. P.-Cambridge, 1872)	+	+
10	*Xysticus kaznakovi* Utochkin, 1968	+	+
11	*Xysticus kempeleni* Thorell, 1872	+	-
12	*Xysticus ninnii* Thorell, 1872	+	+
13	*Xysticus pseudorectilineus* (Wunderlich, 1995)	+	-
14	*Xysticus striatipes* L.Koch, 1870	+	-
FAM. TITANOCIDAE			
1	*Nurscia albomaculata* (Lucas, 1846)	+	+
2	*Titanoeca quadriguttata* (Hahn, 1833)	+	+
FAM. ZODARIDAE			
1	*Pax islamita* (Simon, 1873)	+	+
2	*Zodarion kossamos* Bosmans, 2009	+	+
3	*Zodarion thoni* Nosek, 1905	+	+

LOCALITIES			
1	Kütahya, Dumlupınar, Büyükoturak	19	Kütahya, Domaniç, Muhacirler
2	Kütahya, Dumlupınar Şehitliği	20	Kütahya, Domaniç, Çamlıca- Küçükköy
3	Kütahya, Dumlupınar, Ağaç	21	Kütahya, Tavşanlı- Emet on road1
4	Kütahya, Dumlupınar-Altıntaş on road1	22	Kütahya, Tavşanlı- Emet on road 2
5	Kütahya, Dumlupınar-Altıntaş on road 2	23	Kütahya, Tavşanlı- Emet on road 3
6	Kütahya, Altıntaş, Pusan- Doğanlar on road	24	Kütahya, Tavşanlı- Emet (in valley 1)
7	Kütahya, Aslanapa, Haydarlar	25	Kütahya, Tavşanlı- Emet Yolu 4
8	Kütahya, Aslanapa, Ada village	26	Kütahya, Emet, İkibaşlı
9	Kütahya, Koçak	27	Kütahya, Emet, Esentepe
10	Kütahya, Gelinkaya	28	Kütahya, Hisarcık
11	Kütahya, Göynükören	29	Kütahya, Tavşanlı- Simav road
12	Kütahya- Uşak road	30	Kütahya, Tavşanlı- Simav (in valley 1)
13	Kütahya, Kumanı	31	Kütahya, Tavşanlı- Simav (in valley 2)
14	Kütahya, Aydoğdu	32	Kütahya, Simav, Kapıkaya
15	Kütahya- Tavşanlı on road 1	33	Kütahya, between Simav- Şaphane
16	Kütahya- Tavşanlı on road 2	34	Kütahya, Şaphane
17	Kütahya, Tavşanlı	35	Kütahya, Gediz, Pınarbaşı
18	Kütahya, Tunçbilek	37	Kütahya, Çavdarhisar

Figure 1. Localities in Kütahya province.

Figure 2. Location of Kütahya province in Turkey.

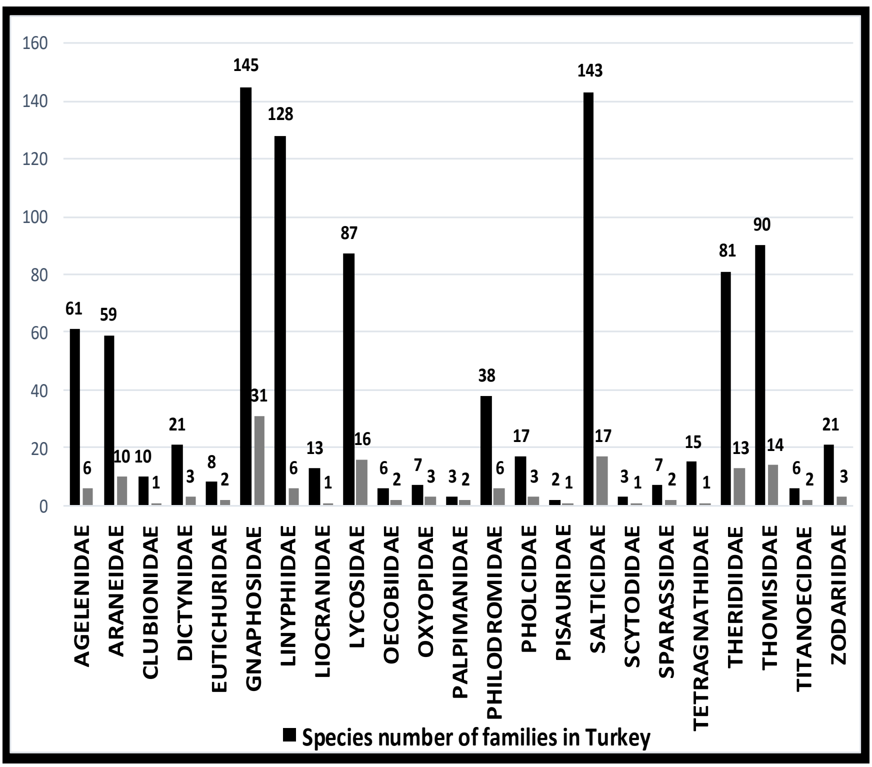

Figure 3. Comprasion of species numbers of 23 spider families in Turkey and Kütahya province (Black column: Turkey, grey column: Kütahya).

A SEM STUDY ON AEDEAGUS AND SPERMATHECA OF *CASSIDA HABLITZIAE* MOTSCHULSKY, 1838 (COLEOPTERA: CHRYSOMELIDAE: CASSIDINAE) FROM TURKEY

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ABSTRACT: The paper presents ultrastructures observed by SEM of aedeagus and spermatheca of *Cassida hablitziae* Motschulsky, 1838 (Coleoptera: Chrysomelidae: Cassidinae) from Turkey for the first time. Male genitalia are not diagnostic, spermathecae are partly diagnostic within the genus *Cassida* Linnaeus, 1758. Accordingly, ultrastructural investigations of aedeagus and spermatheca are very important to obtain new diagnostic characters in the genus *Cassida*. Photos in SEM as weel as photos in stereo microscope are also given in the text. *Cassida hablitziae* Motschulsky, 1838 is the first record for Düzce province in Turkey.

KEY WORDS: *Cassida hablitziae*, SEM, ultrastructures, aedeagus, spermatheca, Turkey

Cassida hablitziae Motschulsky, 1838 is in the subgenus *Alledoya* Hincks, 1950 of the genus *Cassida* Linnaeus, 1758 (Chrysomelidae: Cassidinae).

The Cassidinae fauna of Turkey includes 51 species of 6 genera. The genus *Cassida* Linnaeus, 1758 numbers 41 species (Ekiz et al., 2013; Özdikmen et al., 2014; Özdikmen & Kaya, 2014).

The Western Palaearctic subgenus *Alledoya* Hincks, 1950 numbers only two species. It includes both species in Turkey as *Cassida seraphina* Ménétries, 1836 and *Cassida hablitziae* Motschulsky, 1838 (Ekiz et al., 2013; Özdikmen et al., 2014; Özdikmen & Kaya, 2014).

The aim of this work, ultrastructures observed by SEM of aedeagus and spermatheca of *Cassida hablitziae* Motschulsky, 1838 (Coleoptera: Chrysomelidae: Cassidinae) from Turkey reveal for the first time.

MATERIAL AND METHODS

The available specimens (a total of 11 specimens) for the present work were collected from Bolu and Düzce provinces in Turkey in 2001, 2003. The specimens are deposited at Gazi University (Turkey, Ankara).

The spermathecae and aedeagi were dissected from abdomen, remaining tissue were removed with fine tweezers.

For light microscopic examination after cleaning, the samples were placed 70% ethanol and examined with Olympus SZX7 stereomicroscope.

For scanning electron microscopy (SEM), cleaned samples were dehydrated using an ascending series of ethanol (70%, 80%, 90%, and 100%) and then air dried. After that the specimens were mounted onto SEM stubs using a double-sided adhesive tape, coated with gold using a Polaron SC 502 Sputter Coater, and examined with a JEOL JSM 6060 Scanning Electron Microscope (SEM) at 10 kV.

RESULTS

Cassida hablitziae Motschulsky, 1838

Cassida hablitziae Motschulsky, 1838 is a SW-Asiatic species. It is distributed in Armenia, Georgia, South European Russia, Kazakhstan and Turkey of Western Palaearctic region (Borowiec, 2007a,b; Warchalowski, 2010; Borowiec & Sekerka in Löbl & Smetana (2010)).

The species is distributed only in North Turkey. It has been recorded only from 4 provinces in 2 (Marmara and Black Sea regions) of 7 Turkish regions. It is reported only from Bolu, İstanbul, Trabzon and Zonguldak provinces in Turkey (Ekiz et al., 2013; Özdikmen & Kaya, 2014).

Material examined: Turkey, Bolu prov.: Yedigöller, waterfall, 11.VIII.2001, 5 specimens, **Düzce prov.:** Exit of Dutlar village, 8 km to Yığılca, 12.V.2003, 170 m, 1 specimen. **Remark:** New to Düzce province.

According to Bordy & Doguet (1987), Borowiec & Świętojańska (2001) and Borowiec (2007a), male genitalia are not diagnostic within the genus *Cassida* Linnaeus, 1758. Spermathecae in the genus *Cassida* are partly diagnostic. With this reason, ultrastructural investigations of aedeagus and spermatheca are very important in the genus *Cassida*.

Aedeagus and spermatheca of *Cassida hablitziae* Motschulsky, 1838 were studied with both stereo microscope and SEM for the first time. Obtaining observations on ultrastructures of them are presented as follows:

Aedeagus: In lateral view, median lobe distinctly curved median foramen to apex. More or less sharpened towards to apex (Figs. 1, 3, 11).

In dorsal view, median lobe at the apex curved to backward and so apex seems like truncated (Figs. 1, 10-13). Upper and lateral margins of orifice more or less rounded (Figs. 1, 11-13). Dorsal plate distinct and largish bipartite basally (Figs. 1, 11-13). Median lobe in lateral parts and fore part of orifice thickened. Thickening in lateral parts smaller than the fore part (Figs. 1, 11-14). Median lobe behind the dorsal plate more or less elevated medially (Figs. 1, 6, 8, 11-13). The area behind orifice broadly closed basally (Figs. 1, 11-13).

Median lobe especially in anterior half with scattered, irregular and sparsely ultrastructural pits (Figs. 6-9, 12-14). The pits on ventral parts of median lobe much more than on dorsal parts (Figs. 6-9, 12-14). The pits located only in lateral parts of terminal part of median lobe in dorsal view (Figs. 12-14). Dorsal plate and the area behind it without ultrastructural pits in dorsal view (Figs. 12-14). Also the terminal area from upper margin of orifice to aedeagal apex without ultrastructural pits in dorsal view (Figs. 10-13).

Spermatheca: General view of spermatheca falcate like a fish hook (Figs. 2, 15). Cornu C-shaped. Cornu gradually narrowed towards to apex and apex of cornu strongly sharpened (Figs. 2, 15). Nodulus swollen like a thigh (Figs. 2, 15-17). Collum + ramus reduced and hardly visible (Figs. 2, 15-19, 21). Ductus spermatheca long, thick and distinctly spiral (Figs. 2, 15-18, 21-23). Spermathecal gland ruptured (Figs. 15-18, 21). Nodulus, cornu, collum + ramus with scattered, irregular and sparsely ultrastructural pits (Figs. 15-21, 26). Ductus spermatheca without ultrastructural pits (Figs. 18, 21-23).

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Figure 1. Aedeagus in streo microscope, Lateral view (left), Dorsal view (right).

Figure 2. Spermatheca in streo microscope, Lateral view.

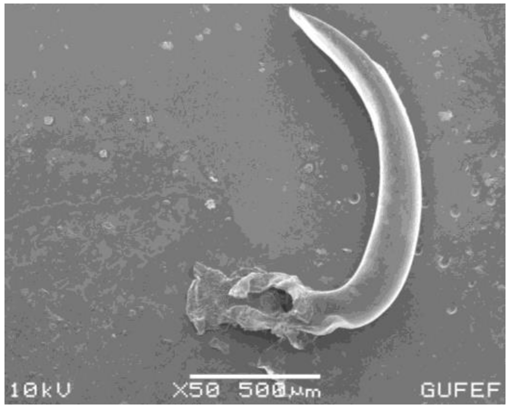

Figure 3. Aedeagus, lateral view.

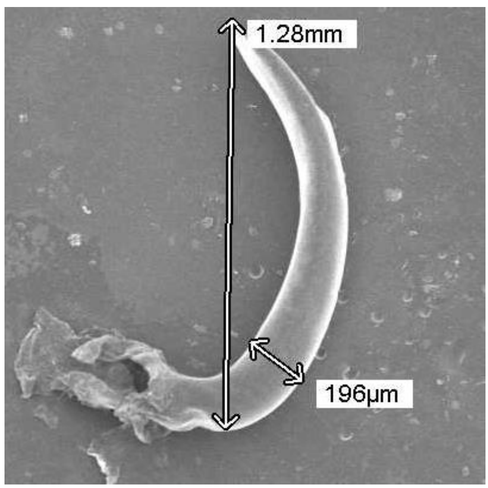

Figure 4. Aedeagus, lateral view.

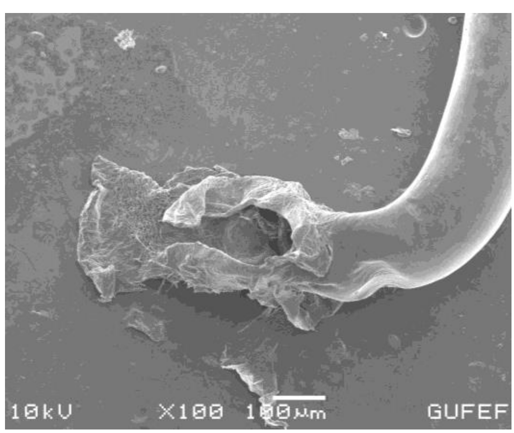

Figure 5. Aedeagus, lateral view of basal part.

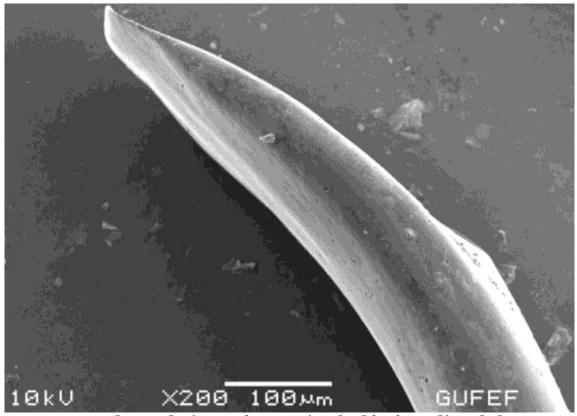

Figure 6. Aedeagus, ventro-lateral view of anterior half of median lobe.

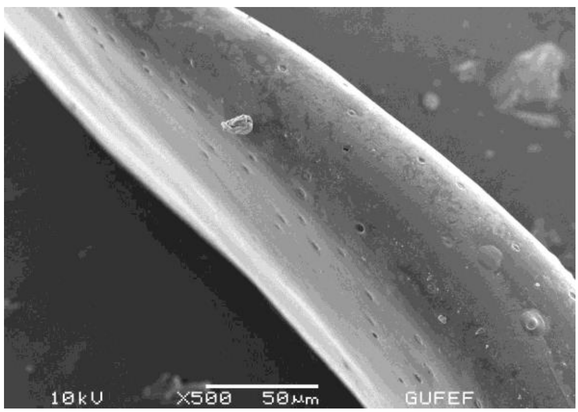

Figure 7. Aedeagus, ventro-lateral view of terminal part of median lobe.

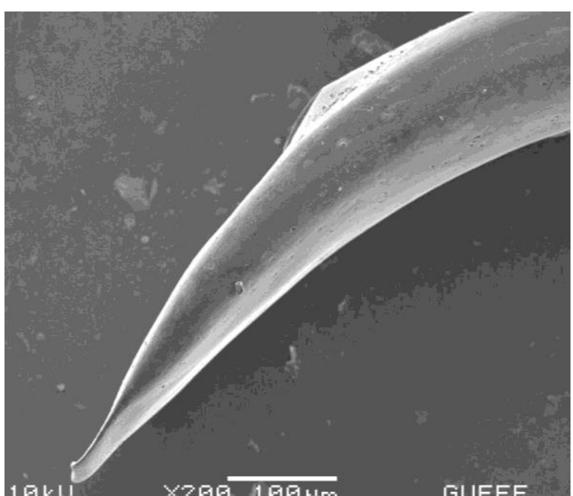

Figure 8. Aedeagus, lateral view of terminal part of median lobe.

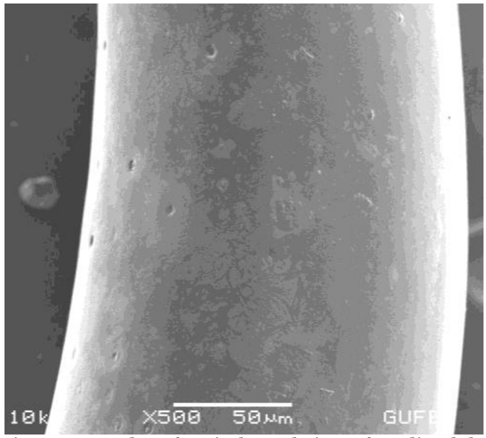

Figure 9. Aedeagus, pits on ventral surface in lateral view of median lobe.

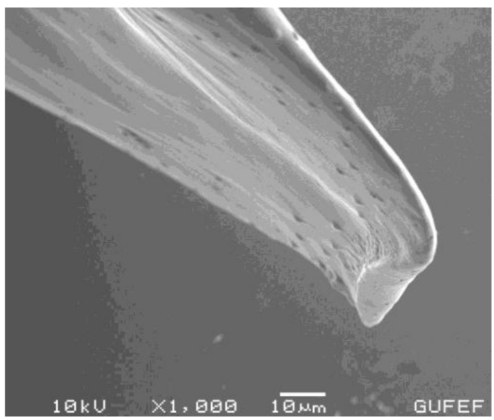

Figure 10. Aedeagus, dorsal view of flexure at apex of median lobe.

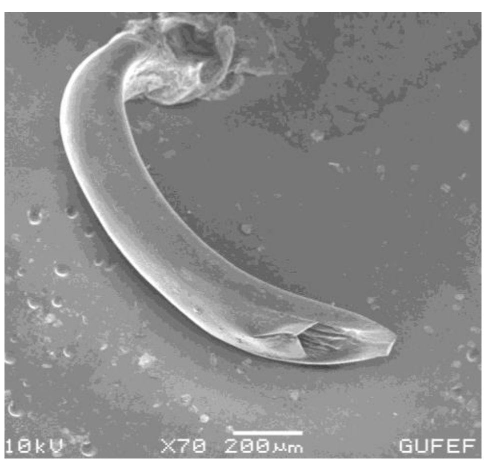

Figure 11. Aedeagus, dorso-lateral view.

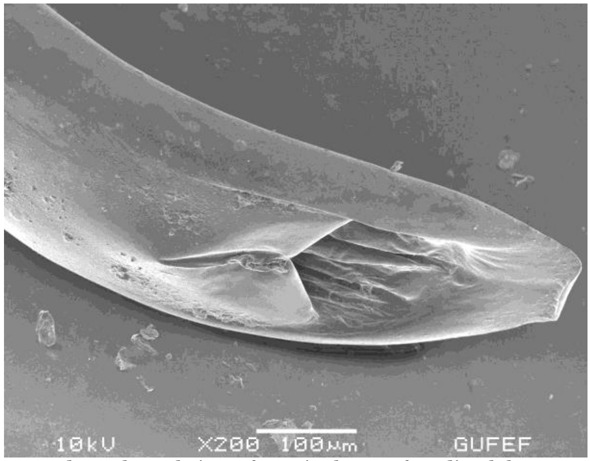

Figure 12. Aedeagus, dorso-lateral view of terminal part of median lobe.

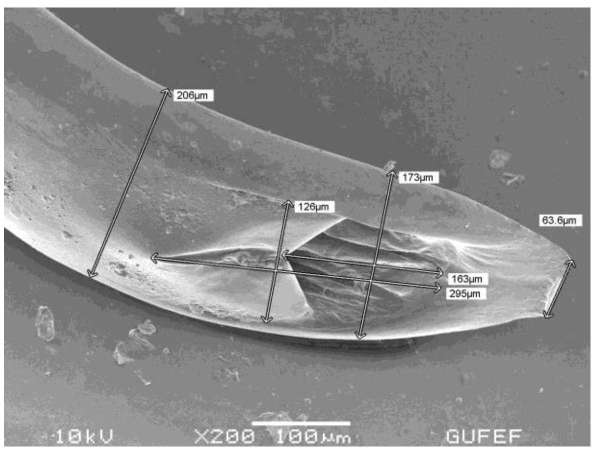

Figure 13. Aedeagus, dorso-lateral view of terminal part of median lobe.

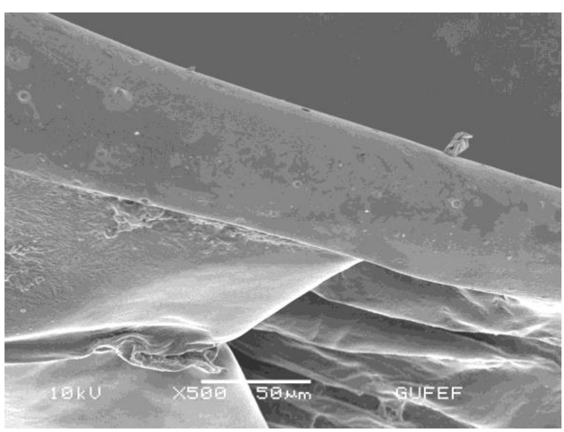

Figure 14. Aedeagus, the pits on lateral part of terminal part of median lobe in dorsal view.

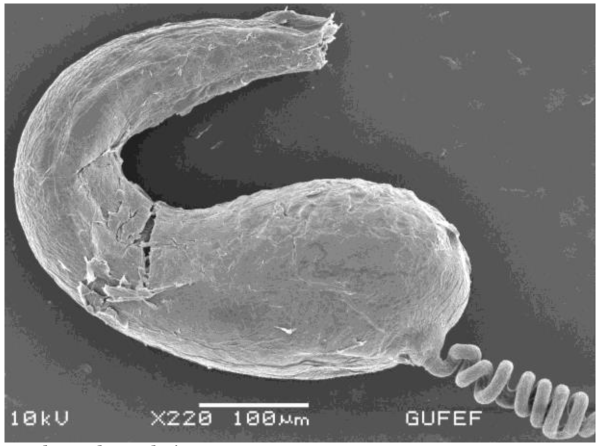

Figure 15. Spermatheca, lateral view.

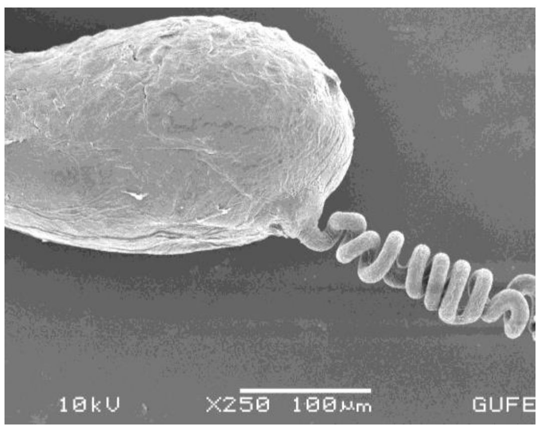

Figure 16. Spermatheca, nodulus, reduced collum + ramus, ruptured spermathecal gland, ductus spermatheca.

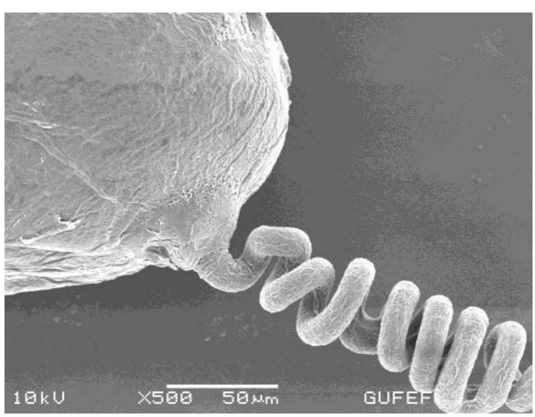

Figure 17. Spermatheca, nodulus, reduced collum + ramus, ruptured spermathecal gland, ductus spermatheca.

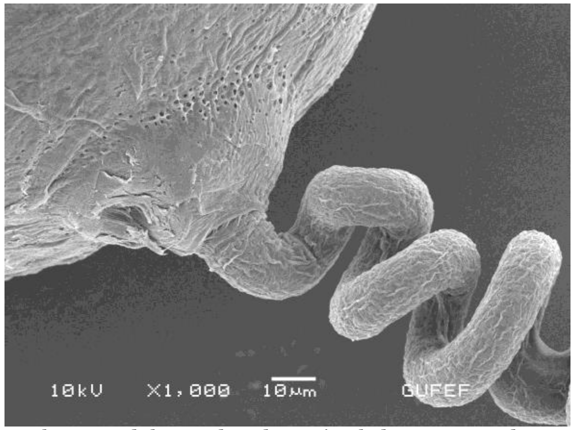

Figure 18. Spermatheca, nodulus, reduced proximal duct, ruptured spermathecal gland, ductus spermathecal and pits on reduced collum + ramus.

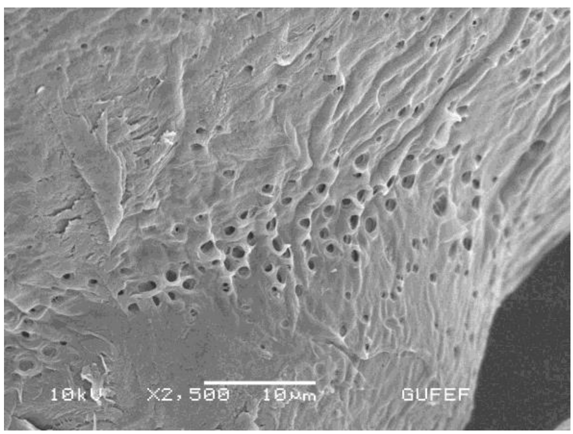

Figure 19. Spermatheca, pits on reduced collum.

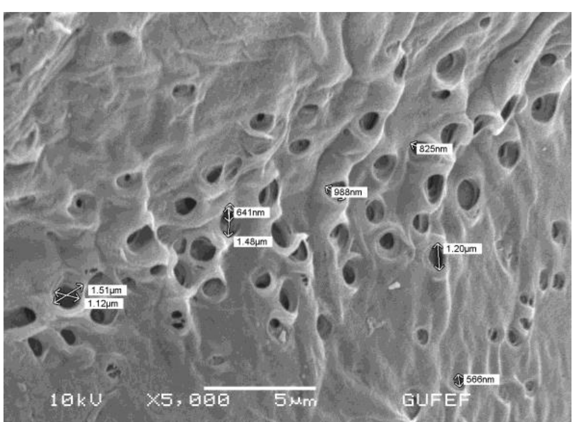

Figure 20. Spermatheca, pits on reduced collum.

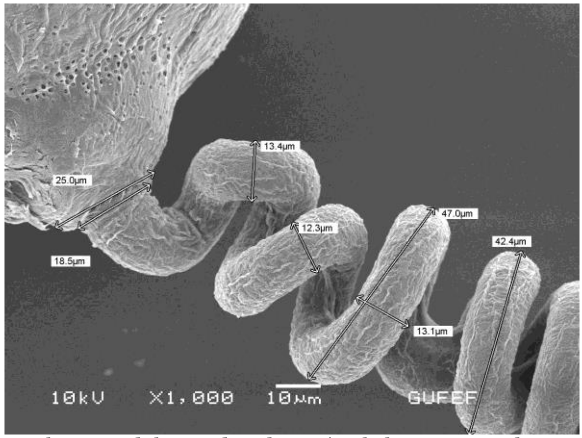

Figure 21. Spermatheca, nodulus, reduced proximal duct, ruptured spermathecal gland, ductus spermathecal and pits on reduced collum + ramus.

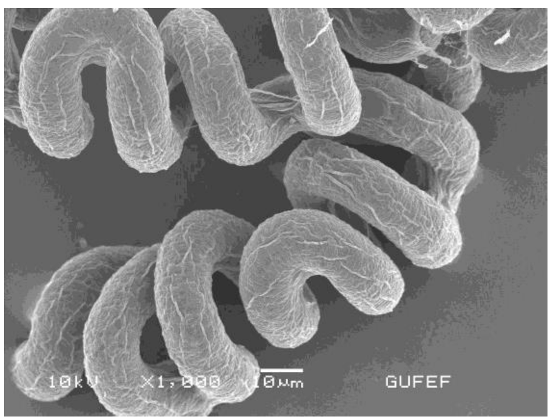

Figure 22. Spermatheca, ductus spermatheca.

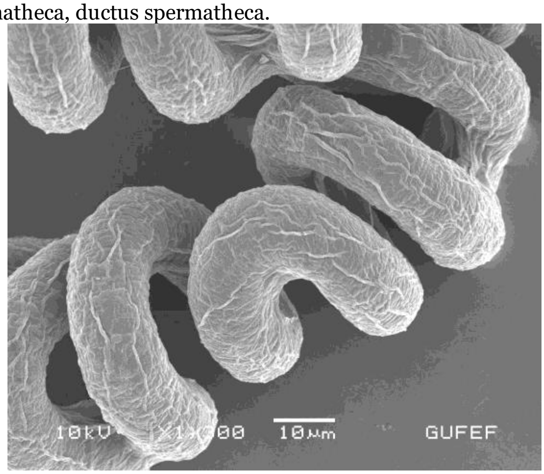

Figure 23. Spermatheca, ductus spermatheca.

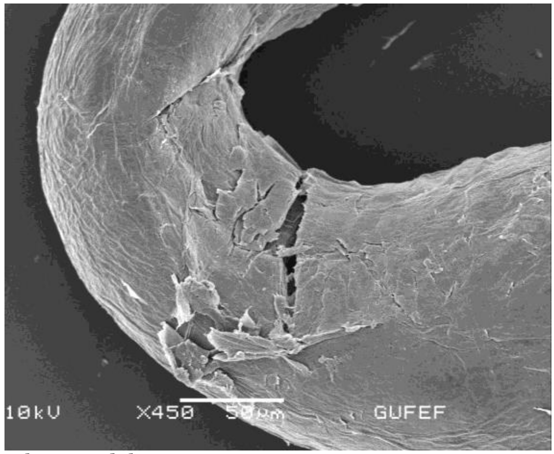

Figure 24. Spermatheca, nodulus, cornu.

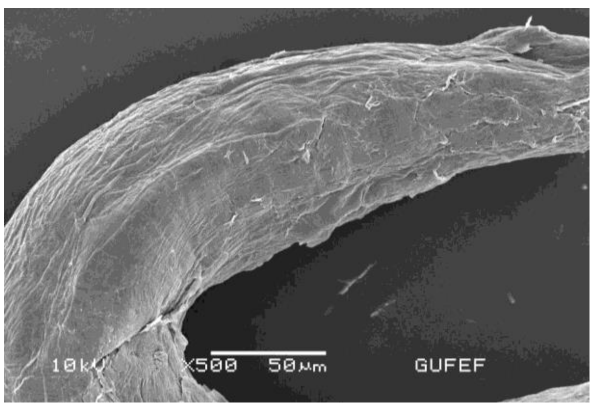

Figure 25. Spermatheca, cornu.

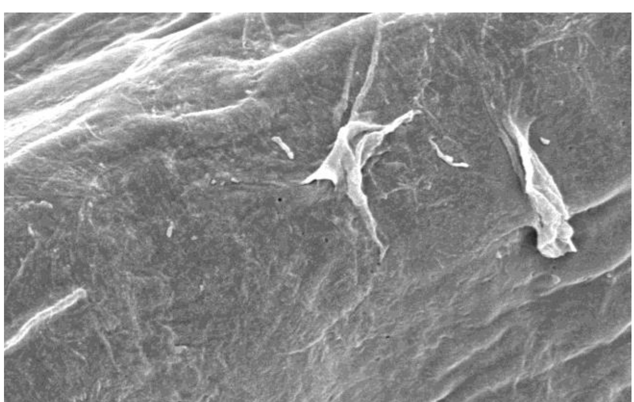

Figure 26. Spermatheca, pits on cornu.

CONTRIBUTION TO THE KNOWLEDGE OF THE GENUS *OTIORHYNCHUS* GERMAR, 1822 (COLEOPTERA: CURCULIONIDAE) FAUNA OF UKRAINE. PART 2.

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ABSTRACT: New records of the genus *Otiorhynchus* Germar, 1822 species (Coleoptera, Curculionidae, Etiminae) in Ukraine is represented: *O. kollari* (Gyllenhal, 1834); *O. reichei* Stierlin, 1861; O. *carinatopunctatus* (Retzius, 1783); *O. coecus coecus* Germar, 1823; *O. lirus* Schoenherr, 1834; O. *multipunctatus* (Fabricius, 1792); *O. tenebricosus* (Herbst, 1784); *O. pinastri* (Herbst, 1795); *O. morio morio* Fabricius, 1781; *O. nodosus* (Müller, 1764); *O. krattereri* Boheman, 1842; *O. obsidianus* Boheman, 1842; *O. lithantracius* Boheman, 1842. Updated information regarding geographical distribution of these species in Ukraine and the Palearctic Region is provided. In the present paper we report the first records of *O. kollari* and *O. krattereri* in Lviv Region of Ukraine. Also, we recommend including *O. reichei* and *O. lithantracius* in The Red List of Ukraine, The Red Lists of Kyiv Region (*O. reichei*), the Ukrainian Carpathians, and Zakarpatska Region (*O. lithantracius*) of Ukraine.

KEY WORDS: Coleoptera, Curculionidae, Entiminae, *Otiorhynchus*, Palearctic Region, Ukraine

The genus *Otiorhynchus* comprises over 1500 species distributed in the Palaearctic Region and introduced to other regions (Alonso-Zarazaga et al., 2017). The genus *Otiorhynchus* fauna of Ukraine comprises about 100 species (Alonso-Zarazaga et al., 2017; Yunakov et al., 2018a) and in last 20 years was reviewed in a few publications of Yunakov and coauthors (Yunakov, 1998; 2003a,b; Yunakov et al., 2018a), and other important papers and internet databases as well (Mazur, 2002; Nazarenko & Sheshurak, 2003; Zhygalin & Sirenko, 2007; Sirenko, 2013; Nazarenko & Parhomenko, 2016; Yunakov et al., 2018b). This paper is the next in a series of publication containing new faunistic information on the distribution of the genus *Otiorhynchus* in Ukraine and notes on its distribution in the Palearctic Region. The present paper is devoted to the species which inhabiting mainly in the western regions of the country.

In the western part of Ukraine the highest mountains in the country, the Ukrainian Carpathian Mountains (altitude up to 2061 m) and adjoining Volynian and Podolian Uplands (Volynska and Podilska Vysochyna), and Transcarpathian Lowland (Zakarpattia) are situated. In general, the Carpathian Mountains have a fairly close contact with the Alpine and Balkan mountain systems. The Ukrainian Carpathian Mountains form the central part of the Eastern Carpathians. The borders of the Middle European, Central Russian, Carpathian and Dunarevo-Moldavian biogeographic sub-provinces cross the territory of Western Ukraine (Rivas-Martínez et al., 2004) (Fig. 1). In the western part of Ukraine the most of the genus *Otiorhynchus* representatives inhabit the Carpathian Mountains and 24 of them are reported to be endemic or sub-endemic to the Carpathians (Yunakov et al., 2018a).

MATERIALS AND METHODS

The study material is deposited in the Kizub I.V. private collection (Kyiv, Ukraine). The photographs were taken using the Nikon D90 camera with Sigma EX 150mm 1:2.8 APO Macro DG HSM + Raynox DCR MacroScan Conversion lens. Nomenclature of taxa and synonymy for the species names are given according to The Cooperative Catalogue of Palaearctic Coleoptera Curculionoidea (CCPCC) (Alonso-Zarazaga et al., 2017). Biogeographic division is given according to Rivas-Martínez et al. (2004).

RESULTS AND DISCUSSION

Otiorhynchus (*Magnanotius*) *kollari* (Gyllenhal, 1834) (Fig. 5)

Material examined: Lviv Region: 1 male and 1 female, Skole District, Slavske vill. environs, Trostian Mt., h = 600-1230 m, 20-22 V 2006, Kizub I.V. leg.; 4 males and 4 females, idem, 02-04 VI 2012, Kizub I.V. leg.

Distribution: Ukraine: Ivano-Frankivsk, Zakarpatska (Yunakov, 2003; Yunakov et al., 2018a,b), and Lviv Regions. This is the first record of this species in Lviv Region of Ukraine. Europe: the Czech Republic (Benedikt et al., 2010; Vit et al., 2018), Hungary (Podlussány, 1996; Proches, 1999; Kocs, 2010; Vit et al., 2018), Poland (Smreczyński, 1966; Knutelski & Witkowski, 1995; Knutelski, 2005; Petyszak & Radwanski, 2006; Skalski et al., 2012; Biodiversity..., 2018; Vit et al., 2018; Wanat & Mokrzycki, 2018), Romania (Guşă & Blaga, 2006; Teodor & Crişan, 2006; Merkl et al., 2011; Teodor, 2011; Kocs, 2012; Teodor & Milin, 2014; Teodor et al., 2017; Nitzu et al., 2018; Vit et al., 2018;), Slovakia (Holecová et al., 1997; Knutelski, 2005; Benedikt et al., 2010; Alziar, 2018; Vit et al., 2018), and Ukraine (Gyllenhal, 1834; Mazur, 2002; Yunakov, 2003; Kovalchuk et al., 2007; Vit et al., 2018; Yunakov et al., 2018a,b).

The species is an endemic to the Sudeten and the Carpathians Mountains (Smreczyński, 1966; Yunakov, 2003; Knutelski, 2005; Yunakov et al., 2018a) and has been described from Western Ukraine ("Buccovina") (Gyllenhal, 1834).

Biology: Mesophilic species inhabiting montane deciduous forests (Yunakov, 2003; Yunakov *et al.*, 2018a). The species is a chorobiotic and polyphagous, feeds on *Adenostyles alliariae*, *Dryopteris filix-mas, Hieracium auranthiacum*, *Rubus* sp., *Senecio* sp., *Urtica dioica* (Yunakov, 2003), *Alchemilla* sp., *Doronicum austriacum*, *Aruncus sylvestris*, *Petasites kablikianus*, and *Petasites albus* (Knutelski, 2005).

Otiorhynchus (*Magnanotius*) *reichei* Stierlin, 1861 (Figs. 1, 6)

Material examined: Kyiv Region: 5 males and 3 females, Brovary District, Letochki vill., 24 IV 2006, Kizub I.V. leg.

Distribution: Cherkasy, Dnipro, Kherson, Kyiv, and Zakarpatska Regions (Nazarenko, 2010; Yunakov et al., 2018a, 2018b). Europe: Belarus (Ioannisiani, 1972; Alexandrovitch et al., 1996; Knutelski, 2005; Kachanovsky et al., 2015; Sautkin & Meleshko, 2016), Bulgaria (Alonso-Zarazaga et al., 2017), Croatia (Knutelski, 2005), Hungary (Podlussány, 1996; Podlussány, 1998; Podlussány, 2001; Knutelski, 2005; Podlussány & Kutasi, 2011), Poland (Knutelski, 2005;

Wanat, 2005; Wanat & Mokrzycki, 2018), Romania (Stierlin, 1861; Knutelski, 2005), Slovakia (Purkyně, 1957; Frieser, 1981; Knutelski, 2005; Benedikt et al., 2010; Šeršeň J. 2012; Cunev, 2013), Ukraine (Ioannisiani, 1972; Yunakov, 2003; Knutelski, 2005; Nazarenko, 2010; Yunakov et al., 2018a,b).

Despite the species has been listed for the Czech Republic in the CCPCC (Alonso-Zarazaga et al., 2017), its occurrence in the territory of this country is doubtful (Benedikt et al., 2010). The species has been described from Transylvania, Romania (Stierlin, 1861). *O. reichei* is rare throughout its entire range. The species has been included in The Red Lists of the Republic of Belarus as a species requiring additional study, attention, and preventive protection measures (Kachanovsky et al., 2015).

Biology: Nocturnal, mesophilic, cryptobiotic species inhabiting deciduous forests (Yunakov, 2003; Yunakov et al., 2018a). The species is a polyphagous and phyllophagous feeding on the grassy vegetation of undergrowth, trees and shrubs (Yunakov, 2003; Yunakov et al., 2018a). *O. reichei* has been recorded on *Fagus* sp., *Quercus* sp., *Salix* sp., *Malus* sp., and *Lythrum salicaria* (Yunakov, 2003; Knutelski, 2005; Šeršeň J. 2012).

Taxonomic notes: *O. reichei* by some authors is regarded as belonging to the subgenus *Amosilnus* Reitter, 1912 (Yunakov et al., 2018a).

***Otiorhynchus* (*Nihus*) *carinatopunctatus* (Retzius, 1783) (Fig. 7)**
=*scaber* Linnaeus, 1758

Material examined: Lviv Region: 3 females, Skole District, Slavske vill. environs, Trostian Mt., h = 700-1230 m, 20-22 V 2006, Kizub I.V. leg.; 1 female, idem, 04 X 2009, Kizub I.V. leg.; 1 female, idem, 02-04 VI 2012, Kizub I.V. leg.

Distribution: Ukriane: Cherkasy, Ivano-Frankivsk, Khmelnytskyi, Lviv, and Zakarpatska Regions (Globova, 1963; Mazur, 2002; Yunakov, 2003; Chumak et al., 2006; Mateleshko et al., 2009; Nazarenko & Parhomenko, 2016; Yunakov et al., 2018a, 2018b). Europe: Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Hungary, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Romania, European part of Russia, Serbia, Slovakia, Slovenia, Sweden, Switzerland, and Ukraine (Alonso-Zarazaga et al., 2017). Introduced in Canada (Warner & Negley, 1976; McNamara, 1991) and the USA (O'Brien & Wibmer, 1982).

Biology: Partenogenetic dendro-tamno-chortobiotic species inhabiting deciduous and mixed forests (Yunakov, 2003; Yunakov et al., 2018a, 2018b). Dendrobiotic polyphagous species, feeds on *Abies alba*, *Achillea* sp., *Fagus sylvatica*, *Geum* sp., *Larix polonica*, *Picea abies*, *Rubus* sp., (Yunakov, 2003; Knutelski, 2005; Yunakov et al., 2018a), *Alchemilla* sp., *Corylus* sp., *Daucus* sp., *Pinus* sp., *Potentilla* sp., *Rumex* sp., *Salix* sp., *Tussilago* sp. (Delbol, 2010), *Alnus incana*, *Betula pendula, Chaerophyllum hirsutum*, *Cirsium* sp., *Geranium* sp., *Sorbus aucuparia*, and *Vaccinium myrtillus* (Knutelski, 2005). Beetles may heavily damage needles and young shoots of *Abies alba*, and buds of *Malus* sp. (Yunakov, 2003). The bisexual populations of *O. carinatopunctatus* are known from the Balkan Peninsula (Yunakov, 2003).

***Otiorhynchus* (*Otiorhynchus*) *coecus coecus* Germar, 1823 (Fig. 8)**

Material examined: Zakarpatska Region: 2 males and 1 female, Hoverla – Petros Mts., h ~ 1700 m, 15 VI 2010, Uspenskiy I. leg.; 1 male, Rakhiv environs,

Pip-Ivan Mt., h ~ 1900 m., 11-13 VI 2011, Klymenko K.I. leg.; 1 male and 1 female, idem, 19 VII 2017, Kyriak M.V. leg.
Distribution: Ukraine: Chernivtsi, Ivano-Frankivsk, Lviv, Ternopil, and Zakarpatska Regions (Tveritina, 1953, 1957, 1958; Yunakov, 2003; Chumak et al., 2006; Yunakov et al., 2018a,b). Introduced in Kyiv Region (Yunakov, 2003; Yunakov et al., 2018 a). Europe: Austria, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Denmark, France, Germany, Hungary, Italy, Lithuania, Poland, Romania, Slovakia, Slovenia, Sweden, Switzerland, Ukraine (Alonso-Zarazaga et al., 2017). The species was introduced in Great Britain (Alonso-Zarazaga et al., 2017).
Biology: Dendrobiotic, mesophilic species inhabiting montane deciduous and mixed forests (Yunakov, 2003; Yunakov et al., 2018a). Polyphagous species feeding on *Abies alba*, *Acer pseudoplatanus*, *Alnus glutinosa*, *Betula verrucosa*, *Picea abies*, *Pinus mugo*, *Pseudotsuga taxifolia*, *Rubus idaeus*, *Sorbus aucuparia* (Yunakov, 2003; Knutelski, 2005), *Adenostyles aliariae*, *Aruncus dioicus*, *Chaerophyllum hirsutum*, *Geum rivale*, *G. urbanum*, *Heracleum sphondylium*, *Petasites albus, Polygonum bistorta*, *Salix caprea*, and *Veratrum lobelianum* (Knutelski, 2005). Beetles can seriously damage young shoots and needles of *Abies alba* and *Picea abies*, as well as shoots of *Alnus glutinosa* (Yunakov, 2003).
Taxonomic notes: Except for the nominative one, the subspecies *mequignoni* A. Hoffmann, 1938 has been described from France (Alonso-Zarazaga et al., 2017).

***Otiorhynchus* (*Otiorhynchus*) *lirus* Schoenherr, 1834 (Fig. 9)**
=*cornicinus* Stierlin, 1861

Material examined: Ternopil Region: 1 female, Dniester Canion, Vozyliv – Ustechko vill. 25-28 VI 2016, Kizub I.V. leg.; **Zakarpatska Region:** 1 female, Vynohradiv environs, Cherna Mt. 13 VI 2009, Kurennyi D. leg.; 1 male, Uzhgorod District, Stuzhytsia vill. environs, 16 VI 2009, Kurennyi D. leg.
Distribution: Ukraine: Chernivtsi, Ivano-Frankivsk, Khmelnytskyi, Lviv, Odesa, Rivne, Ternopil, Vinnytsia, Volyn, and Zakarpatska Regions (Endrodi, 1960; Mazur, 2002; Yunakov, 2003; Yunakov et al., 2018a). Europe: Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, France, Germany, Hungary, Italy, Moldova, the Netherlands, Norway, Poland, Romania, Slovakia, Slovenia, Switzerland, and Ukraine (Alonso-Zarazaga et al., 2017).

Despite the species has been mentioned for European and West-Siberian parts of Russia in The Cooperative Catalogue of Palaearctic Coleoptera Curculionoidea (CCPCC) (Alonso-Zarazaga et al., 2017) it is not occurred in there (Zabaluev, 2017).
Biology: Mesophilic, tamno-chortobiotic species inhabiting montane and lowland deciduous forests (Yunakov, 2003; Knutelski, 2005; Yunakov *et al.*, 2018a). Polyphagous species feeding on *Fragaria viridis*, *Potentilla verna*, *Prunus spinosa*, *Quercus robur*, *Rosa* sp., *Sanguisorba minor*, *Thymus* sp. (Yunakov, 2003).

***Otiorhynchus* (*Otiorhynchus*) *multipunctatus* (Fabricius, 1792) (Fig. 10)**

Material examined: Zakarpatska Region: 6 ex., Vynohradiv District, Vynohradiv environs, Chorna Gora Reserve, 13 VI 2009, Kurennyi D. leg.; 1 ex., Mizhhirria District, Podobovets vill. environs, 28 VI 2009, Kravchenko I.S. leg.

Distribution: Ukraine: Chernivtsi, Ivano-Frankivsk, Khmelnytskyi, Lviv, Rivne, and Zakarpatska Regions (Tveritina, 1953; 1956; Endrodi, 1960; Mazur, 2002; Yunakov, 2003; Yunakov et al., 2018a,b). Europe: Austria, Bosnia and Herzegovina, Belarus, Croatia, Czech Republic, Germany, Hungary, Italy, Moldova, Poland, Romania, Serbia, Slovakia, Slovenia, Switzerland, and Ukraine (Alonso-Zarazaga et al., 2017).
Biology: Mesophylic, dendro-tamno-chortobiotic species inhabiting montane and lowland deciduous forests (Yunakov, 2003; Yunakov et al., 2018a). Polyphagous, phyllophagous species feeding on *Alnus* sp., *Betula* sp., *Carpinus betulus*, *Corylus avellana*, *Dryopteris filix-mas*, *Fagus sylvatica*, *Juglans regia*, *Picea abies*, *Quercus* sp., *Rubus* sp., *Salix* sp., *Urtica dioica*, and cereals (Yunakov, 2003).

Otiorhynchus (*Otiorhynchus*) *tenebricosus* (Herbst, 1784) (Fig. 11)

Material examined: Lviv Region: 1 male, Skole District, Slavsko vill. environs, Trostian Mt., h = 700-1230 m, 02-04 VI 2012, Kizub I.V. leg.; **Ivano-Frankivsk Region:** 1 male, Nadvirna District, Nature Reserve Gorgany, polonyna Bystra, 03-04 VIII 2015, Kizub I.V. leg.; 1 female, Nadvirna District, Nature Reserve Gorgany, polonyna Serednia – Borevka Pass, 03-04 VIII 2015, Kizub I.V. leg.; **Zakarpatska Region:** 4 males and 4 females, Rakhiv District, Dilove vill. – Pip-Ivan Mt., h = 500-1930 m, 17-24 VII 2017, Kizub I.V. leg.
Distribution: Ukraine: Chernivtsi, Ivano-Frankivsk, Khmelnytskyi, Lviv, and Zakarpatska Regions (Mazur, 2002; Yunakov, 2003; Yunakov et al., 2018a,b). Europe: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Great Britain, Hungary, Ireland, Italy, Liechtenstein, Luxembourg, Netherlands, Poland, Romania, Slovakia, Spain, Switzerland, and Ukraine (Alonso-Zarazaga et al., 2017). Introduced in the Nearctic Region (Alonso-Zarazaga et al., 2017).
Biology: Mesophylic, dendrobiotic species inhabiting montane deciduous and mixed forests (Yunakov, 2003; Yunakov *et al.*, 2018a). Polyphagous species feeding on young shoots of *Abies alba*, *Acer pseudoplatanus*, *Alnus glutinosa*, *Betula verrucosa*, *Picea abies*, *Pseudotsuga taxifolia*, *Sorbus aucuparia*, *Petasites albus* (Yunakov, 2003; Knutelski, 2005), *Aucuba* sp., *Corylus* sp., *Ligustrum* sp., *Lonicera* sp., *Prunus laurocerasus*, *Syringa* (Delbol, 2010), *Adenostyles alliariae*, *Alchemilla* sp., *Cirsium* sp., *Geranium* sp., *Pinus mugo*, and *Sorbus aucuparia* (Knutelski, 2005). Larvae develop on the roots of conifers (Yunakov, 2003). Recently, in the Czech Republic, the species has been found damaging *Rubus* sp., *Rosa* sp., and *Solanum tuberosum* (Hrabovský, 2014).

Otiorhynchus (*Padilehus*) *pinastri* (Herbst, 1795) (Fig. 12)

Material examined: Zakarpatska Region: 3 females, Rakhiv District, Bilyn environs, h = 600-1200 m, 20-30 VII 2004, Uspenskiy I. leg.
Distribution: Ukraine: Ivano-Frankivsk, Khmelnytsky, Lviv, Ternopil, and Zakarpatska Regions (Tveritina, 1958; Lazorko, 1963; Yunakov, 1998; Mazur, 2002; Yunakov, 2003; Yunakov et al., 2018a,b). Europe: Austria, Bosnia and Herzegovina, Croatia, Czech Republic, Denmark, Germany, Hungary, Italy, Poland, Romania, Slovakia, Slovenia, and Ukraine (Alonso-Zarazaga et al., 2017). Introduced in Switzerland (Germann, 2004; Alonso-Zarazaga et al., 2017).
Biology: Nocturnal, mesophylic, chortobiotic species inhabiting mountaine deciduous and mixed forests (Yunakov, 2003; Yunakov et al., 2018a). The

Ukrainian populations of the species are parthenogenetic and the bisexual population of *O. pinastri* is known from the Alps in Northern Italy only (Yunakov, 2003; Yunakov et al., 2018a). *O. pinasri* is believed to be monophagous on *Vincetoxicum hirundinaria* (Lazorko, 1963; Tewksbury, et al., 2002), however, in Ukraine it has also been found on *Geum* sp. (Yunakov, 2003).

***Otiorhynchus* (*Phalantorhynchus*) *morio morio* Fabricius, 1781 (Fig. 13)**

Material examined: Ivano-Frankivsk Region: 1 male, Hoverla – Petros Mts., h ~ 1700 m, 15 VI 2010, Uspenskiy I. leg.; **Zakarpatska Region:** 2 males and 2 females, Rakhiv District, Pip-Ivan Mt., h ~ 1900 m, 11-13 VI 2011, Klimenko K.I. leg.; 1 female, Rakhiv District, Dilove vill. – Pip-Ivan Mt., h = 500-1930 m, 17-24 VII 2017, Kizub I.V. leg.
Distribution: Ukraine: Chernivtsi, Ivano-Frankivsk, and Zakarpatska Regions (Tveritina, 1953; 1957; 1958; Mazur, 2002; Yunakov, 2003; Zhygalin & Sirenko, 2007; Sirenko, 2013; Korotyaev & Zabaluev, 2014; Yunakov et al., 2018a,b). Europe: Andorra, Austria, Belgium, Bulgaria, Croatia, Denmark, Estonia, France, Germany, Hungary, Italy, Latvia, Poland, Romania, Slovakia, Spain, Switzerland, Ukraine (Alonso-Zarazaga et al., 2017), the Czech Republic (Zicha, 2018), and Great Britain (Duff, 2012).
Biology: Nocturnal, mesophylic, tamno-chortobiotic species inhabiting mountain deciduous and mixed forests of subalpine zone (Yunakov, 2003; Yunakov et al., 2018a). Polyphagous species feeding on *Nardus stricta*, *Hieracium auranthiacum*, *Arnica montana*, *Veratrum album*, *Rubus* sp. (Yunakov, 2003; Yunakov et al., 2018a), *Petasites* sp., *Rumex alpines,* and *Senecio ovatum* (Seják & Dejmal, 2003; Knutelski, 2005; Delbol, 2010).
Taxonomic notes: Except for the nominative one, 5 other subspecies of *O. morio* has been described from France (ssp. *cabroli* Costessèque, 2007, ssp. *diversesculptus* Pic, 1920d, ssp. *navaricus* Gyllenhal, 1834, and ssp. *sublaevigatus* Zumpt, 1934), Spain (ssp. *navaricus* Gyllenhal, 1834), and Portugal (ssp. *estrellaiensis* Zumpt, 1934) (Alonso-Zarazaga et al., 2017).

***Otiorhynchus* (*Postaremus*) *nodosus* (Müller, 1764) (Fig. 14)**

Material examined: Zakarpatska Region: 1 female, Rakhiv District, Dilove vill. – Pip-Ivan Mt., h = 500-1930 m, 17-24 VII 2017, Kizub I.V. leg.
Distribution: Ukraine: Ivano-Frankivsk, Zakarpatska, and Lviv Regions (Endrodi, 1960; Yunakov, 2003; Yunakov et al., 2018a,b). Europe: Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Faeroe Islands, Finland, France, Germany, Great Britain, Iceland, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Romania, European part of Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, and Ukraine (Alonso-Zarazaga et al., 2017). Asia: West-Siberian parts of Russia (Alonso-Zarazaga et al., 2017). Introduced in Greenland (Warner & Negley, 1976; O'Brien & Wibmer, 1982).
Biology: *O. nodosus* is a boreomontane, wingless species inhabiting subalpine belt and montane forests (Yunakov, 2003; Knutelski, 2005; Yunakov et al., 2018a). The species is polyphagous, phillophagous on herbaceous plants feeding on *Potentilla* sp. (Yunakov, 2003; Yunakov et al., 2018a), *Rumex* sp., *Saxifraga* sp., *Trifolium* sp., and *Vaccinium* sp. (Delbol, 2010).

O. nodosus is a parthenogenetic in most of its range including Ukraine (Yunakov, 2003; Germann et al., 2017; Yunakov et al., 2018a). The bisexual form of the species has been found in the Balkans, the Alps and the Ural, and the Ukrainian Carpathians mountains (Yunakov, 2003).

***Otiorhynchus* (*Prilisvanus*) *krattereri* Boheman, 1842 (Figs. 3, 15)**
=*rugosus* Hummel, 1827

Material examined: Lviv Region: 8 ex., Skole District, Slavske environs, Trostian Mt., h = 600-1200 m, 20-22 V 2006, Kizub I.V. leg.; 4 ex., idem, 02-04 VI 2012, Kizub I.V. leg.
Distribution: Ukraine: Ivano-Frankivsk, Zakarpatska (Miller, 1868; Lokay, 1912; Yunakov et al., 2018a,b), and Lviv Regions. This is the first record of this species in Lviv Region of Ukraine. Europe: Bulgaria (Angelov, 1976; Knutelski, 2005), Czech Republic (Benedikt et al., 2010), Hungary (Alonso-Zarazaga et al., 2017), Poland (Smreczyński, 1966; Knutelski & Witkowski, 1995; Knutelski, 2005; Bonk et al., 2012; Skalski et al., 2012; Biodiversity..., 2018; Wanat & Mokrzycki, 2018), Romania (Grunack, 1897; Podlussány & Kocs, 1996; 1997; Knutelski, 2005; Kocs, 2010; 2011; Teodor & Crişan, 2010; Merkl et al., 2011; Teodor et al., 2017), northern European territory of Russia (Stierlin, 1861; Köppen, 1880; Korotyaev, 2011; Zabaluev, 2016; Korotyaev et al., 2018), Slovakia (Holecová et al., 1997; Knutelski, 2005; Benedikt et al., 2010; Majzlan, 2015), and Ukraine (Boheman, 1842; Miller, 1868, 1870; Tveritina, 1953, 1957, 1958; Mazur, 2002; Yunakov, 2003; Zhygalin & Sirenko, 2007; Sirenko, 2013; Yunakov et al., 2018a,b).

Occurrence of this species in Slovenia (Alonso-Zarazaga et al., 2017), central and southern European, and Siberian part of Russia (Roschinenko, 1972; Korotyaev, 2011; Yunakov et al., 2012; Alonso-Zarazaga et al., 2017) is doubtful and needs confirmation (Knutelski, 2005). The mention of the species for Turkey in the CCPCC (Alonso-Zarazaga et al., 2017) should be a mistake. This could have occurred due to the fact that Boheman (1842), when describing *O. krattereri*, mentioned the find of this species in Turkey by *Lefèvre*. Stierlin (1861) also followed this. Apparently in fact this record belonged to the territory of modern Bulgaria, which at that time was part of Turkey (the Turkish Ottoman Empire). *O. krattereri* has been included in The Red Lists of Russian Leningrad Region and Russia as endangered species and a relic of the Early Quaternary fauna (Danilov-Danilian, 2001; Noskov et al., 2002; Korotyaev, 2011; Korotyaev et al., 2018).
Biology: The species is mesophylic, polyphagous and inhabits in montane mixed forests of deciduous and coniferous trees (Yunakov, 2003; Teodor & Crişan, 2010; Yunakov et al., 2018a). Dendro-chortobiotic, phyllophagous species feeding on *Adenostyles alliariae*, *Carpinus betulus*, *Corylus avellana*, *Dryopteris filix-mas, Gentiana* sp., *Hieracium* sp., *Larix polonica*, *Petasites albus*, *Picea abies*, *Salix* sp., *Senecio* sp., *Sorbus* sp., *Urtica dioica*, *Veratrum album*, (Yunakov, 2003; Knutelski, 2005), *Abies alba, Alchemilla* sp., *Cirsium* sp., *Geranium* sp., *Geum* sp., *Lonicera nigra, Senecio* sp., and *Rubus idaeus* (Knutelski, 2005).

The Ukrainian population of the species is bisexual (formerly treated as *O. rugosus krattereri* Boheman, 1843). Parthenogenetic populations of this species, formerly regarded as nominotypic *O. rugosus rugosus* Hummel, 1827, are known from the north of European part of Russia (Yunakov, 2003; Korotyaev, 2011; Zabaluev, 2016; Korotyaev et al., 2018), and Bieszczady Mauntains and Beskid Niski Mountains in Poland (Wanat & Mokrzycki, 2018).

***Otiorhynchus* (*Prilisvanus*) *obsidianus* Boheman, 1842 (Figs. 4, 16)**

Material examined: Lviv Region: 10 ex., Skole District, Slavske environs, Trostian Mt., h = 600-1200 m, 20-22 V 2006, Kizub I.V. leg.; 6 ex., idem, 02-04 VI 2012, Kizub I.V. leg.; **Zakarpatska Region:** 8 ex., Rakhiv District, Dilove vill. – Pip-Ivan Mt., h = 500-1930 m, 17-24 VII 2017, Kizub I.V. leg.
Distribution: Ukraine: Ivano-Frankivsk, Zakarpatska, and Lviv Regions (Miller, 1868; Lokay, 1912; Mazur, 2002; Yunakov, 2003; Zhygalin & Sirenko, 2007; Korotyaev & Zabaluev, 2014; Yunakov et al., 2018a,b). Europe: Austria (Redtenbacher, 1847; Alonso-Zarazaga et al., 2017), Hungary (Stierlin, 1861; Alonso-Zarazaga et al., 2017), Poland (Knutelski & Witkowski, 1995; Pawlowski, 2000; Taszakowski et al., 2017; Biodiversity..., 2018; Wanat & Mokrzycki, 2018); Romania (Grunack, 1897; Podlussány & Kocs, 1996; Guşă & Blaga, 2006; Kocs, 2010; Teodor & Crişan, 2010; Kocs et al., 2011; Yunakov et al., 2018b), Slovakia (Majzlan & Ondrejková, 2008; Benedikt et al., 2010), and Ukraine (Yunakov et al., 2018a).

Distribution of the species in the territories of modern Austria and Hungary (Redtenbacher, 1847; Stierlin, 1861; Alonso-Zarazaga et al., 2017) needs confirmation. The species is endemic to the Sudeten and the Carpathian Mountains.

Biology: The species is mesophylic, dendro-tamno-chortobiotic and inhabits in montane and sub-montane mixed forests of deciduous and coniferous trees (Yunakov, 2003; Teodor & Crişan, 2010; Yunakov et al., 2018a). It is polyphagous species feeding on *Acer pseudoplatanus*, *Adenostyles alliariae*, *Carpinus betulus*, *Corylus avellana*, *Dryopteris filix-mas*, *Fagus sylvatica*, *Larix polonica*, *Mentha* sp., *Petasites albus*, *Picea abies*, *Plantago* sp., *Rubus* sp., *Rumex* sp., *Salvia* sp., *Sambucus* sp., *Urtica dioica*, and *Veratrum album* (Yunakov, 2003).

***Otiorhynchus* (*Stupamacus*) *lithantracius* Boheman, 1842 (Fig. 17)**
=*denigrator* Boheman, 1842

Material examined: Zakarpatska Region: 1 male and 1 female, Rakhiv District, Dilove vill. – Pip-Ivan Mt., h = 500-1930 m., 17-24 VII 2017, Kizub I.V. leg.
Distribution: Ukraine: Zakarpatska Region (Mazur, 1993; Mazur, 2002; Yunakov, 2003; Yunakov et al., 2018a,b). Europe: Austria (Schoenherr, 1843; Redtenbacher, 1847; Mazur, 1993; Knutelski, 2005), Bosnia and Herzegovina (Mazur, 1993), Bulgaria (Apfelbeck, 1896, 1899; Angelov, 1979; Behne, 1989; Mazur, 1993; Pešić, 2003), Croatia (Mazur, 1993), Greece (Apfelbeck, 1896, 1899; Bahr et al., 2018), Romania (Stierlin, 1861; Frivaldszky, 1875; Mazur, 1993; Knutelski, 2005; Kocs, 2012), Serbia (Pešić, 2002, 2003), Slovakia (Mazur, 1993; Benedikt et al., 2010), Slovenia (Mazur, 1993), and Ukraine (Mazur, 1993, 2002; Yunakov, 2003; Yunakov et al., 2018a,b).

Occurance of the species in the territory of Hungary (Stierlin, 1861; Mazur, 1993; Knutelski, 2005; Alonso-Zarazaga et al., 2017), Italy (Alonso-Zarazaga et al., 2017), and Macedonia (Apfelbeck, 1896; Alonso-Zarazaga et al., 2017) needs confirmation (Podlussány, 1996; Colonnelli, 2003; Mihajlova & Pešić, 2006). The mention of the species for Turkey in the CCPCC (Alonso-Zarazaga et al., 2017) should be a mistake and probably refers to the territory of Macedonia (Apfelbeck, 1896). The species is quite rare throughout its range (Mazur, 1993; Knutelski, 2005).

Biology: This is geobiotic, apterous species inhabiting in grass litter of subalpine and alpine zones, mainly under stones and in turf (Yunakov, 2003, Yunakov et al., 2018a). Phyllophagus species feeding on herbaceous plants (Yunakov, 2003).

Thus, of the 13 Ukrainian species of the genus *Otiorhynchus* reviewed in this paper, only two species, *O. carinatopunctatus* and *O. nodosus* are widely distributed in the Western Palearctic Region. However, both species are not common in the territory of Ukraine, where eastern borders of their ranges pass. A few species has Hemiboreal Baltico-Middle-Europeo-Pannonio-Carpathio-Bulgarian (*O. krattereri*), Atlantico-Central Europeo-Appenino-Balkano-Pannonio-Carpathian (*O. morio morio* and *O. tenebricosus*), Central Europeo-Appenino-Balkano-Pannono-Carpathian (*O. pinastri, O. coecus coecus*, *O. lirus*, and *O. multipunctatus*), Middle-Europeo-Pannonio-Carpathio-Central Russio-Dobrujan (*O. reichei*), Middle-Europeo-Pannonio-Carpathian (*O. kollari*), and Appenino-Balkano-Pannonio-Carpathian (*O. lithantracius*) ranges. Some species discussed here are endemic to the Sudeten and the Carpathians Mountains (*O. kollari* and O. *obsidianus*) or quite rare throughout their range (*O. reichei* and *O. lithantracius*).

In our opinion *O. reichei* and *O. lithantracius* should be included in The Red Lists of Ukraine, The Red Lists of Kyiv Region (*O. reichei*), the Ukrainian Carpathians, and Zakarpatska Region of Ukraine (*O. lithantracius*) as rare species on the border of their ranges. The data presented suggest that in the territory of Ukraine, *O. kollari, O. morio morio,* and *O. lithantracius* inhabit in the Carpathians only and *O. coecus coecus* has been introduced to Kyiv Region. *O. reichei* inhabits in Ukraine in the Carpathian Mountains but also along the Dnieper valley. Also, in the present paper we report the first records of *O. kollari* and *O. krattereri* in Lviv Region of Ukraine.

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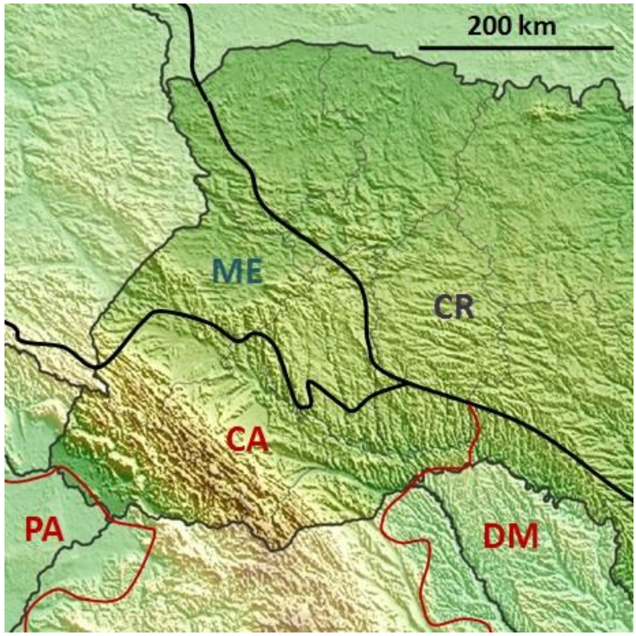
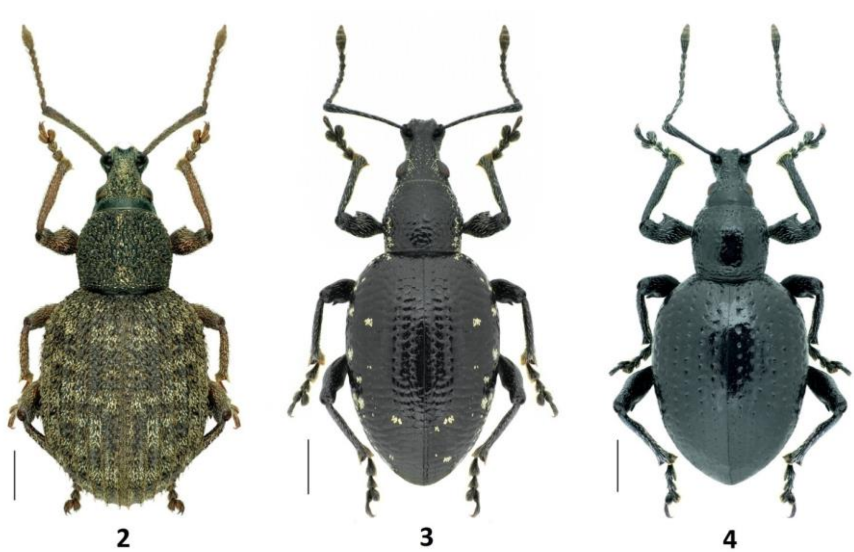
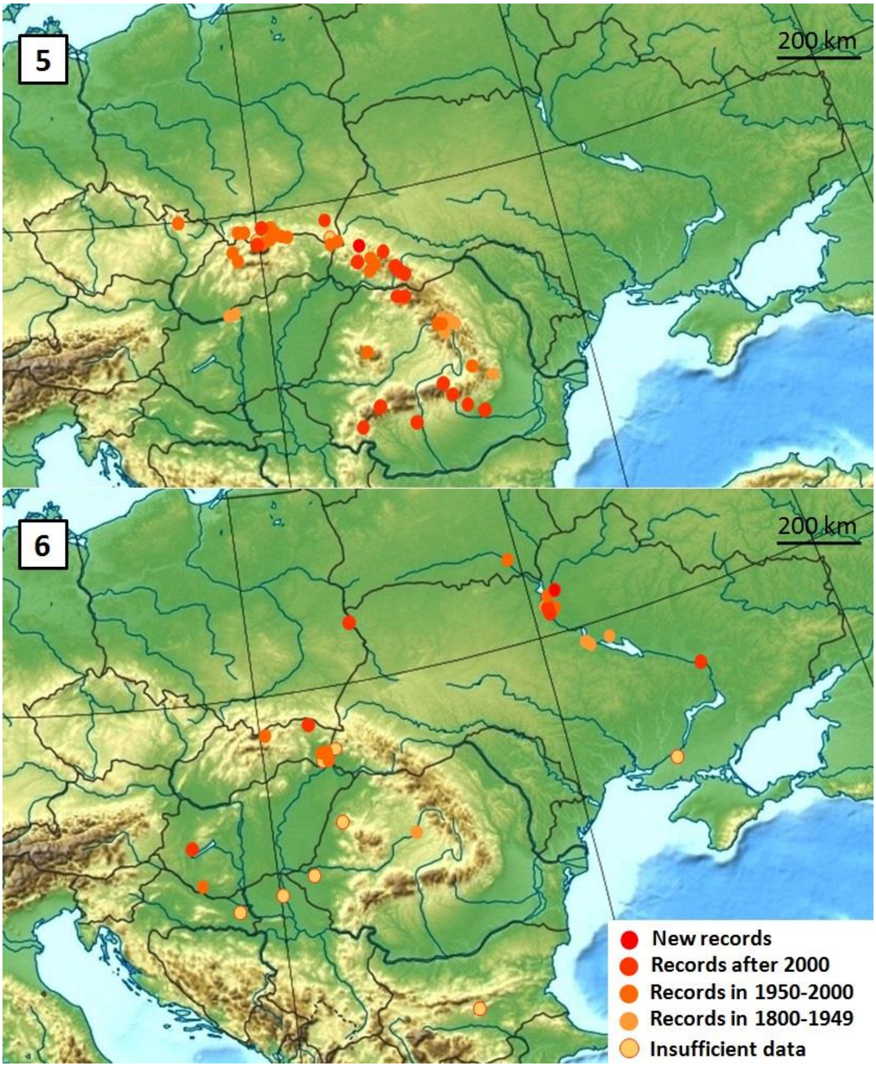


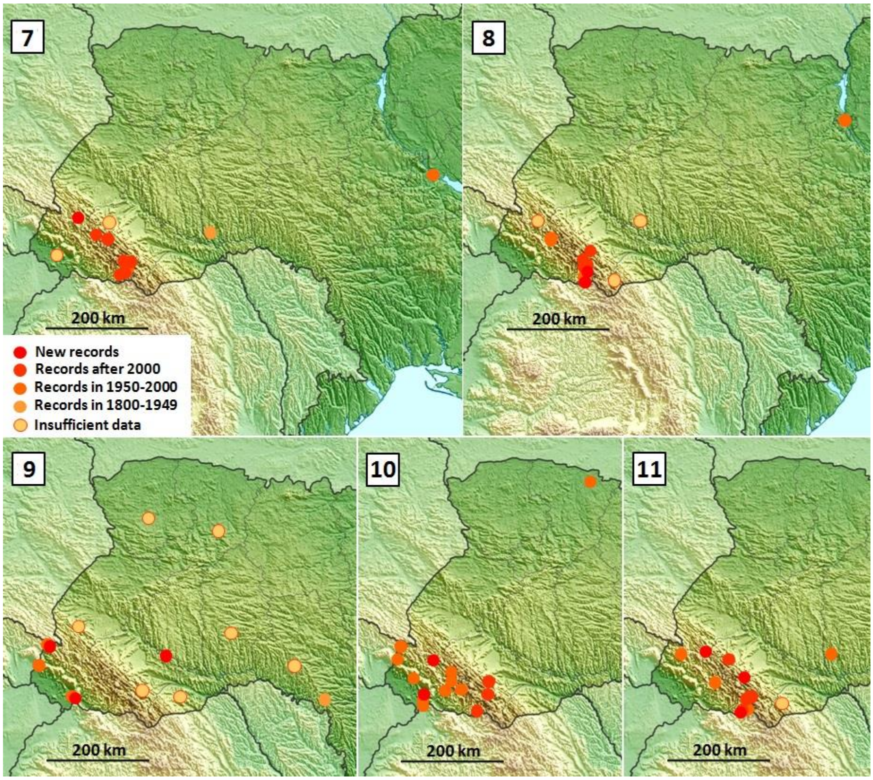
Figure 1. Borders of biogeographic sub-provinces on the territory of western Ukraine (according to Rivas-Martínez et al., 2004). ME – Middle-European Sub-Province of Central European Province; CR – Central Russian Sub-Province of Sarmatian Province; PA – Pannonian Sub-Province of Pannonio-Carpathian Province; CA – Carpathian Sub-Province of Pannonio-Carpathian Province; DM – Dunareo-Moldavian Sub-Province of Pannonio-Carpathian Province.



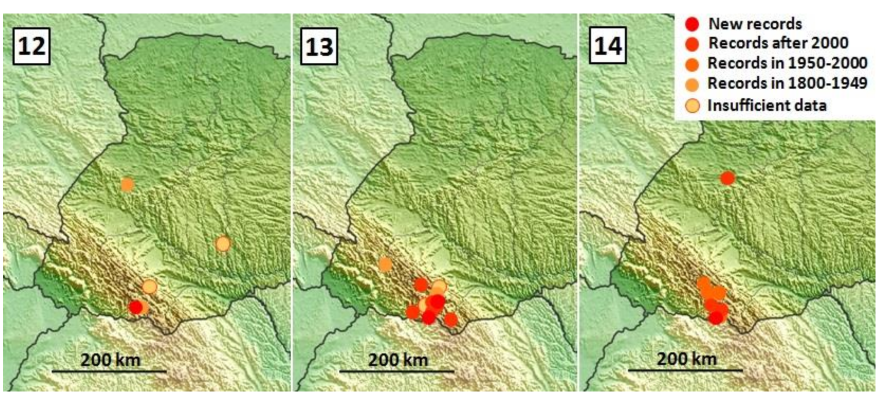
Figures 2-4. Weevils of the genus *Otiorhynchus* of Ukraine, general view dorsally: 2) *O. reichei;* 3) *O. krattereri;* 4) *O. obsidianus*. Scale bars = 5 mm.



Figures 5-6. Maps of the genus *Otiorhynchus* distribution in the Palearctic Region: 5) *O. kollari*; 6) *O. reichei*. Insufficient data – records with no date and/or coordinates with low precision.



Figures 7-11. Maps of the genus *Otiorhynchus* distribution in Ukraine: 7) *O. carinatopunctatus*; 8) *O. coecus coecus*; 9) *O. lirus*; 10) *O. multipunctatus*; 11) *O. tenebricosus*. Insufficient data – records with no date and/or coordinates with low precision.



Figures 12-14. Maps of the genus *Otiorhynchus* distribution in Ukraine: 12) *O. pinastri*; 13) *O. morio morio*; 14) *O. nodosus*. Insufficient data – records with no date and/or coordinates with low precision.

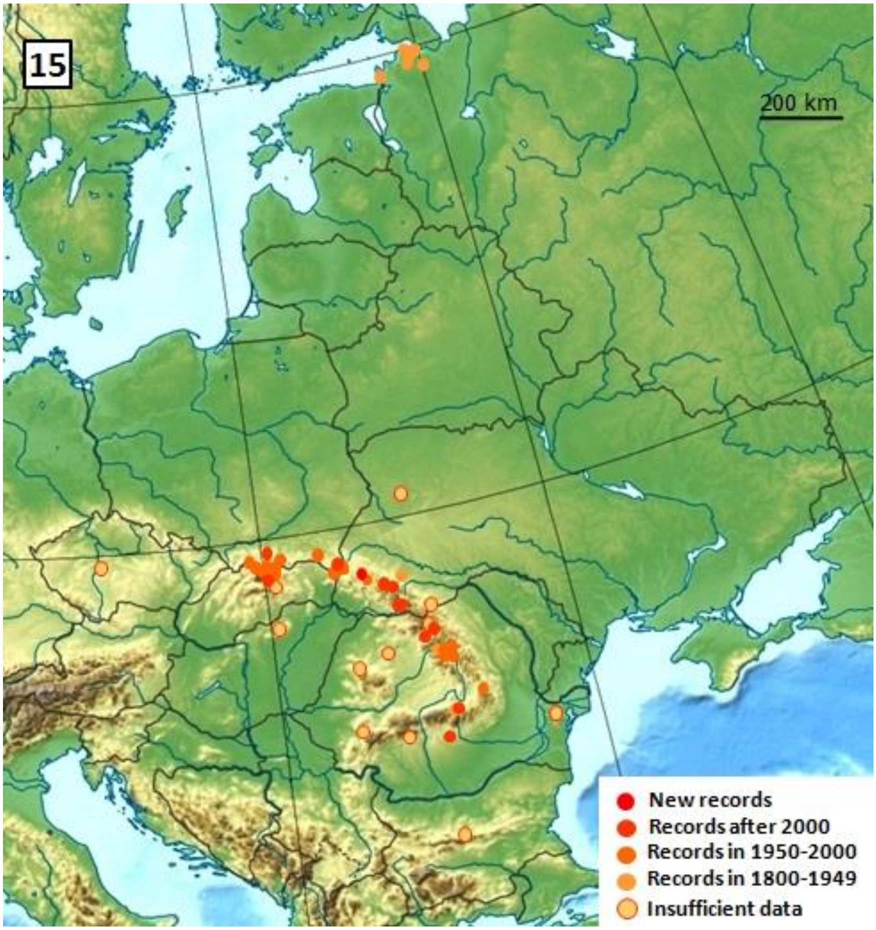
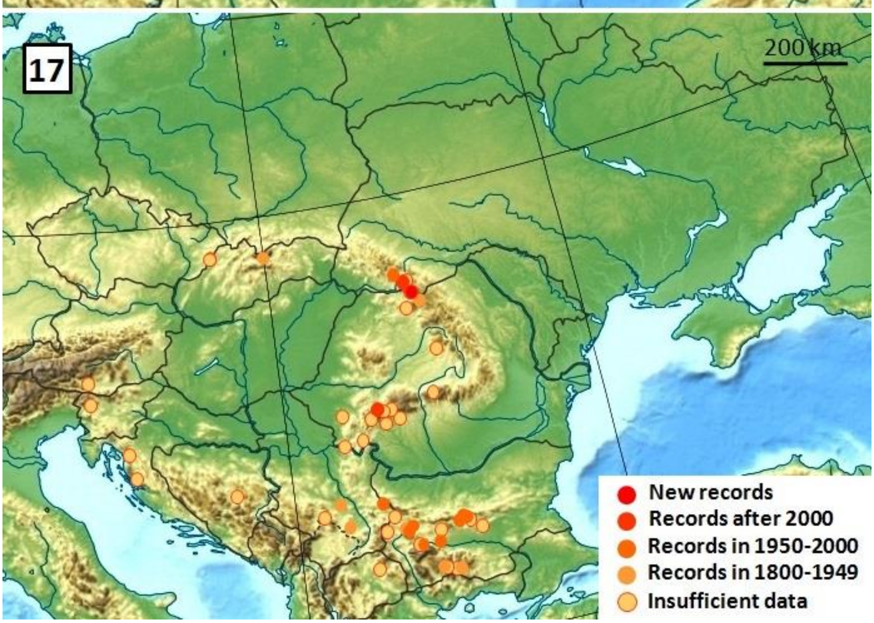


Figure 15. Map of *Otiorhynchus krattereri* distribution in the Palearctic Region. Insufficient data – records with no date and/or coordinates with low precision.



Figures 16-17. Maps of the genus *Otiorhynchus* distribution the Palearctic Region: 16) *O. obsidianus*; 17) *O. lithantracius*. Insufficient data – records with no date and/or coordinates with low precision.

DETERMINATION OF CYTOCHROME *B* GENE OF *ROUSETTUS AEGYPTIACUS* (MAMMALIA: CHIROPTERA) IN TURKEY

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ABSTRACT: This study is based on the detection of cytochrome b gene of individuals from four population of Egyptian fruit bat, *Rousettus aegyptiacus* distributed four different locations (Harbiye near Hatay Provice, Tarsus near Mersin Province, Adana Province and Hassa near Hatay Province) in the Mediterranean Region. Natural habitats of Egyptian fruit bat was investigated and some biological characteristics were recorded. 3 mm ear tissue was used for DNA isolation. Mitochondrial cytochrome b gene amplified by PCR and 350 base pair partial sequences were obtained. When the analyses results compared between each other and Genbank records, up to 99% homology was detected.

KEY WORDS: Fruit bat, Mediterranean Region, *Rousettus aegyptiacus*, cytochrome *b* gene, Turkey

Classis Mammalia is represented by 29 ordo, 153 families, 1229 genera and 5416 species (Wilson & Reader, 2005). Order Chiroptera is divided into two suborders; Megachiroptera (Big bats) and Microchiroptera (Small bats). Seventy percent of the bats are fed insect (Insectivorous) and fruit (Frugivorous) 23% and the rest are fed with some vertebrate and invertebrate animals (Carnivorous), fish (Psivorous), blood (Sanguivorous), nectar and pollen (Aellen, 1939; Yalden & Morris, 1975; Nowak & Paradiso, 1993).

Pteropodidae, a single family of Megachiroptera, is represented by 42 genera, including *Rousettus* with Ethiopian origin. Of the total 39 species, only one is fruit bat that also exists in Turkey, namely *Rousettus aegyptiacus*, Egyptian fruit bat.

While the studies conducted on mammalian animals have numerously been intensified with taxonomic, systematic, ecological, karyological and zoogeographic, studies at the molecular level have recently gained considerable importance.

In a study carried out in US on the evolution of the cytochrome *b* gene in mammals, 1140 bp 20 in different mammalian animals were studied and the results of phylogenetic analysis and variations on amino acids were compared (Irwin et al., 1991). In a molecular study conducted on the phylogeny of fruit bats in the US, the species belonging to 6 Microchiroptera and 43 Megachiroptera suborders compared and the differences between the populations were evaluated (Giannini & Simmons, 2003).

In Egypt, molecular phylogenetic relationships between *Rousettus aegyptiacus aegyptiacus* and *Rhinopoma hardwickei arabium* subspecies were investigated (Ramadan, 2011). Study of cytochrome *b* gene concerning 17 *Rousettus madagascariensis* from Madagasgar in the West Indian Ocean and 8 *Rousettus obliviosus* from Comoros provided a good comparison between their phylogenies and biogeographies (Goodman et al., 2010).

The taxonomical status, distribution, feeding and karyological values of *Rousettus aegyptiacus* living in the Mediterranean region of Turkey were recorded (Albayrak et al., 2008). Some researches were made on rabies viruses in western, central and northeastern Turkey (Albayrak et al., 2011; Ün et al., 2013).

The aim of this work is to contribute to the systematics of fruit bat which is represented by only one species, *Rousettus aegyptiacus* in Turkey, by revealing the cytochrome *b* gene of this species.

MATERIAL AND METHODS

This research is based on the replication by Polymerase Chain Reaction (PCR) agarose gel electrophoresis imaging and DNA sequence analysis of the cytochrome *b* gene in *Rousettus aegytptiacus*. In order to update the existence of this species in its habitats, field studies were conducted in the provinces of Hatay, Kilis, Kahramanmaras, Adana, Mersin and Antalya between July 2012 and November 2013. Ear tissue samples of specimens from Hatay Province in 1977 and Mersin Province in 2000 which is preserved in the bat collection and an additional specimen from Adana Province in 2003 during this study were used (Fig. 1).

To explore whether there were different inter and intra-population variations along the distribution area of the species. Ear tissue samples taken from a total of 5 bats belonging to 4 populations were used. Tissue samples from fruit bat specimens were stored at -80 ^{o}C until used in the test.

Total DNA was isolated from fruit bat *Rousettus aegyptiacus* samples using a commercial kit (DNeasy Tissue Kit, Qiagen, Germany), following the 'Purification of Total DNA from Animal Tissue' protocol. For the PCR and sequence application, previously published primers were used (Irwin et al., 1991). L14724 (5'– CGAGATCTGAAAAACCATCGTTG-3'), H15915(5'–GGAATTCATCTCTCCGG TTTACAAGAC-3'), L14841 (5'– AAAAAGCTTCCATCCAACATCTCAGCATGATGA AA-3'), H15149 (5'– AAACTGCAGCCCCTCAGAATGATATTTGTCCTCA-3') primer pairs were used to amplify cytochrome *b* gene. The primer, distilled water, polymerase enzyme, target DNA and buffer solution were prepared into the eppendorf tube and put into PCR Thermalcycler (PTC100 MJ Research, USA). In PCR steps, the temperature, time and cycle numbers specified by Martin and Gerlach (2000) (2 minute at 94 ° C, 1 minute at 52 ° C, 2 minutes at 72 ° C; 40 cycles) were recorded and run by adjusting the thermalcycler. The PCR products were purified on a commercial agarose gel using the commercial kit (QIAquick® Gel Extraction Kit, Qiagen GmbH, Hilden, Germany). Purified samples DNA sequences were obtained using the automated DNA analyzer, ABI PRISM® 310 Genetic Analyzer (Applied Biosystems, Foster City, USA). Sequences were analyzed using the CLC Main Workbench program and the phylogenetic trees were created using Weighbor (Weighted Neighbor Joining: A Likelihood-Based Approach to Distance-Based Phylogeny Reconstruction). Sequences were aligned and compared with Clustal X 1.83 software (Thompson et al., 1997) by using the NCBI basic local alignment search tools BLAST program.

RESULTS

Samples of 5 *R. aegyptiacus* from four different habitats were evaluated in terms of mitochondrial cytochrome *b* gene.

Rousettus aegyptiacus (Geoffroy, 1810) Egyptian Fruit Bat

1810. *Pteropus egyptiacus* E. Geofroy, Ann. Mus. Hist. Nat., Paris, 15:96. (misprint) corecred to *aegyptiacus* in 1818. Desciription de I'Egypte Hist. Nat., 2:134.

Type locality: Great Pyramid, Giza, Egypt.
1902. *Rousettus aegyptiacus*, Anderson and de Winton, Zool. Egypt, Mam., London, 84.

Diagnostic characters: Premaxilla is well developed and its terminals contacted each other anteriorly, occipital region is narrow, forearm length 87.0-93.6 mm, greatest length of skull 41.3-44.8 mm, condylobasal length 41.2-43.7 mm, zygomatic breath 26.0-28.7 mm, upper tooth length 16.1-17.1 mm, lower tooth length 16.1-17.1 mm, 17.1-18.8 mm (Albayrak et al., 2008).
Specimen examined and collection localities: Hatay Provice: Harbiye cave, 1 (♀, 02.05.1977), Demre near Hassa, Karamağara, 1 (♀, 11.07.2006); Adana Province, Cumhuriyet Flour Factory, 2 (♂♂, 14.03.2003; ? 13.11.2013); Mersin Province: Say Village near Tarsus, 1 (♀, 22.04.2000) (Fig. 2).
Interpretation of PCR Studies Results: Considering the expected positivity as a result of PCR amplification, it was found that specific bands were formed at about 1000 bp regions for the primer pair H15915 and H15149 of about 100 bp for the L14724 and L14841 primer pair. The results were recorded by taking a polaroid photograph (Fig. 3).

Cytochrome *b* gene sequences of the specimens from four different populations of *Rousettus aegyptiacus* distributed in Mediterranean Region in Turkey showed similarity to some other bat species at different rates. Two primer sets (I. and II.) were used to determine the cytochrome *b* gene of the specimens which were collected from four populations.

The samples from the provinces of Hatay (Harbiye and Hassa) and Mersin (Tarsus) yielded better results with the primer base pairs. When the data were compared with the gene bank, the specimens of the province of Hatay (Harbiye) was similar to *Eumops patagonicus* at 78% of the family Pteropodidae of Megachiroptera; at 77% to *Hipposiderus* sp. and *Emballonura beccarii* of Microchiroptera. Specimens of Tarsus (Mersin) were similar to *Eumops patagonicus* 78%, *Hipposiderus* sp., *Emballonura beccarii* at 77% and to *Pipistrellus pipistrellus* at 72%. Specimens from the province of Hatay (Hassa) were similar to *Pipistrellus kuhlii* and *Platyrrhinus aurarius* and *Vampyrodes caraccidi* belonging to the Microchiroptera at % 83.

The sample of Adana was renewed and two primer sets were used again and the first primer set was taken into account due to better results attained. The specimen from Adana province showed similarity to *Rousettus aegyptiacus* at 99%, to *Rousettus leschenaultii* at 99% and to *Rousettus madagascariensis* at 93%, which were belonging to the family Pteropodidae of Megachiroptera. The results obtained in this study seem to be compatible with the findings obtained by Irwin et al., (1991) in terms of cytochrome *b* gene.

The results of the research which was carried out with the longest base pair possible reveal more conclusive results concerning the cytochrome *b* gene. This research emphasizes the need for conservation of the Egyptian fruit bat for the biodiversity and the maintenance of this gene resource. The first condition of this is to ensure that the habitats are not destroyed and that this species, which is always considered vulnerable with its large bodies, is protected under national and international regulations.

With the results of this research at the molecular level, the differences inter populations of the species will be better monitored. Thus, protection action plans on the species should be carried out by considering these characteristics.

Note: This study is a part of the Master Thesis of first author, Esra Topaktaş.

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Figure 1. A *Rousettus aegyptiacus* found in an empty hangar.

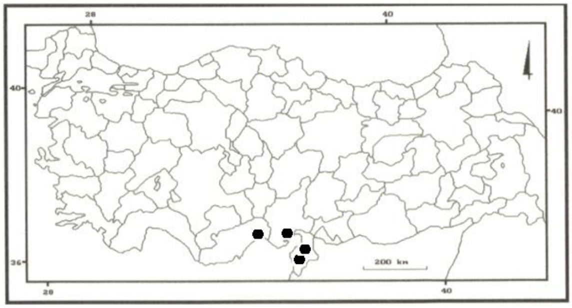

Figure 2. Recorded localities of *Rousettus aegyptiacus* (•).

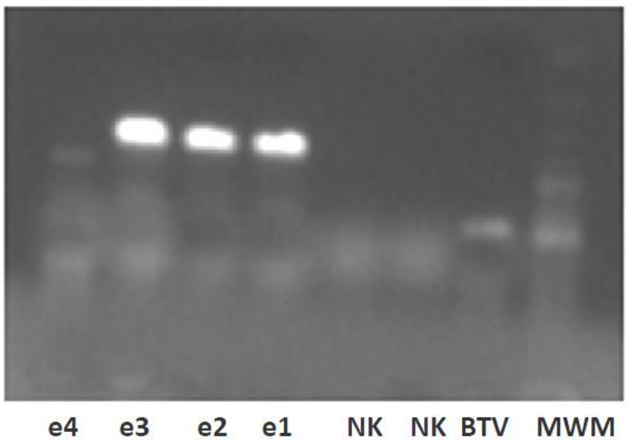

Figure 3. View of the reaction with primer L and Primer H in the agarose gel (e4: *R.aegyptiacus* (Adana), e3: *R.aegyptiacus* (Tarsus), e2: *R.aegyptiacus* Hassa), e1: *R. aegyptiacus* (Harbiye), NK: Negative control MWM: DNA ladder).

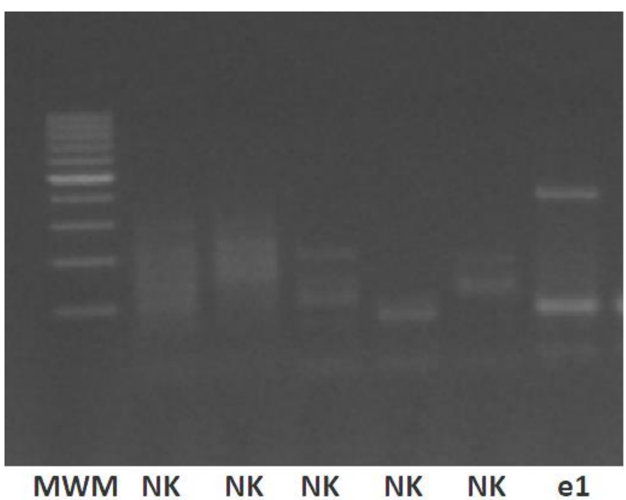

Figure 4. (continued) The reaction image of primer L and Primer H on a agarose gel (MWM: DNA ladder, NK: Negative control, e1: *R.aegyptiacus* (Adana).

GALL FORMING CYNIPINI (HYMENOPTERA: CYNIPIDAE) SPECIES IN ISPARTA OAK FORESTS

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[Bayrak, S. & Avcı, M. 2019. Gall forming Cynipini (Hymenoptera: Cynipidae) species in Isparta Oak Forests. Munis Entomology & Zoology, 14 (2): 552-564**]**

ABSTRACT: This study was performed from 2017 to 2018 in Isparta province to determinate gall forming Cynipini species on oak. Gall samples were collected from different parts (trunk, young shoots, leaves, acorns and flowers) of several oak species (*Quercus cerris, Q. ithaburensis, Q. vulcanica, Q. robur, Q. petraea, Q. trojana, Q. infectoria* and *Q. coccifera*). We identified a total of 51 gall wasp species, 27 species were new records for Isparta province and two species (*Andricus miriami* and *Cynips israeli*) were new records for Turkish fauna. Number of gall wasp species was largest on *Q. infectoria* (24 species) and lowest on *Q. coccifera* (1 species).

KEY WORDS: Cynipini, oak gall wasp, fauna, oak, Isparta, Turkey

Cynipidae is the largest family of Cynipoidea (Hymenoptera). With roughly 1,400 species, they are the second most species rich group of gall inducers after the gall midges (Cecidomyiidae) (Csóka et al., 2005; Ronquist et al., 2015). The most species-rich tribe within the family is the Cynipini (oak gall wasps), with more than 1000 described species in approximately 40 genera worldwide. The Cynipini are restricted to plants of the family Fagaceae, predominantly oaks (*Quercus* spp.), on which they induce galls of diverse structures in leaves, buds, stems, flowers, fruits and roots (Stone et al., 2002; Melika, 2006).

Azmaz & Katılmış (2017a) listed 148 gall wasp species belonging to 9 tribe and 25 genera for Turkey. 110 of these species belong to Cynipini tribe. *Andricus*, with its 77 species, is the most species-rich genus of the tribe. Studies on Cynipidae fauna of Turkey have accelerated during the last decade (Kıyak et al., 2008; Katılmış & Kıyak, 2008, 2009a,b, 2011; Katılmış, 2010; Mutun & Dinç, 2011; Mete & Demirsoy, 2012; Azmaz et al., 2012, Katılmış & Azmaz, 2015; Eş et al., 2017 and Azmaz & Katılmış, 2017a).

The study area which located in Lakes Region of Turkey is floristically an interesting region of the country. It is included both in the Mediterranean and Irano-Turanian phytogeographical regions. In a previously focusing on gall wasp species in the region, 30 species were determined in forests of Isparta (Azmaz & Katılmış, 2017a).

MATERIAL AND METHODS

Field trips were conducted on April and November of 2017 and 2018, and cynipid gall specimens which develop on host plants (*Quercus* spp.) were collected. The coordinates (WGS84) and altitudes were recorded using a Garmin GPS device. We also recorded locality names and sampling time, together with identification information for the host species. Gall specimens were placed into glass jars and they were kept under laboratory conditions to provide the emergence of adult gall wasps. The emerging adult gall wasps were preserved in 70% ethanol. For the identification of specimens, both gall and adult gall wasp morphologies were used. All studied wasps and gall materials were deposited at the Isparta University of Applied Sciences, Faculty of Forestry, Department of Forest Engineering, Entomology Museum, Isparta, Turkey.

RESULTS

The list of oak gall wasps of Isparta;

Andricus amenti Giraud, 1859

Material examined: Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 27.09.2017, 37°44'32''N, 30°49'43''E, 1555 m.
Distribution in Turkey: Artvin, İstanbul, Van, Malatya (Acatay, 1943; Baş, 1973; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017b).
Host: *Quercus vulcanica*.

Andricus aries (Giraud, 1859)

Material examined: Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 27.09.2017, 37°44'32''N, 30°49'43''E, 1555 m.
Distribution in Turkey: Antalya, Bitlis, Çanakkale, Isparta, Malatya, Van (Baş, 1973; Kılıç, 2003; Kıyak et. al., 2008; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017b).
Host: *Quercus vulcanica*.

Andricus burgundus Giraud, 1859

Material examined: Yalvaç, Sücüllü village, 18.03.2017, 38°21'43''N, 31°08'44''E, 1161 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59''N, 30°50'56''E, 959 m.
Distribution in Turkey: Afyon, Kütahya, Uşak (Katılmış, 2010).
Host: *Quercus cerris*.

Andricus caputmedusae (Hartig, 1843)

Material examined: Eğirdir, Yuvalı village, 24.02.2017, 37°41'37''N, 30°56'48''E, 1234 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37''N, 30°59'29''E, 1217 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21''N, 30°56'26''E, 994 m; Eğirdir, Aşağıgökdere village, Cumali district, 03.02.2017, 37°33'07''N, 30°45'44''E, 345 m; Yalvaç, Sücüllü village, 18.03.2017; 21.10.2017, 38°21'43''N, 31°08'44''E, 1161 m; Sütçüler, Yeşilyurt village, 17.03.2017, 37°32'08''N, 30°51'52''E, 666 m; Sütçüler, Çandır village, 17.03.2017, 37°27'18''N, 30°54'26''E, 298 m; Güneyce village, 21.08.2017, 27°39'43''N, 30°43'23''E, 699 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59''N, 30°50'56''E, 959 m; Uluborlu, 10.09.2017, 38°04'19''N, 30°25'19''N, 1083 m; Yalvaç, Eğirler village, 02.06.2017, 38°11'36''N, 31°06'09''E, 1016 m; Eğirdir, Kasnak Oak Nature Protection Area, 27.09.2017, 37°42'27''N, 30°50'55''E, 1048 m; Eğirdir, Ağılköy, 24.02.2017, 37°48'26''N, 30°55'15''E, 1130 m; Eğirdir, Kovada Lake Nature Park, 30.04.2017, 37°38'16''N, 30°51'51''E, 932 m; Şarkikaraağaç, Salur village, 09.09.2017, 38°17'18''N, 31°08''53''E, 1069 m.
Distribution in Turkey: Afyon, Amasya, Ankara, Antalya, Balıkesir, Bolu, Burdur, Bursa, Denizli, Düzce, Erzincan, Gümüşhane, Isparta, İstanbul, İzmir, Kırklareli, Kütahya, Kocaeli, Konya, Malatya, Muğla, Sakarya, Sinop, Tokat, Uşak, Van (Acatay, 1943; Schimitschek, 1953; Çanakçıoğlu, 1956; Baş, 1973; Bayram et. al., 1999; Özkazanç, 2000; Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011; Mutun & Dinç, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur 2015; Azmaz & Katılmış, 2017a,b).
Host: *Quercus cerris*, *Q. petraea*, *Q. infectoria*, *Q. pubescens* and *Q. vulcanica*.

Andricus cecconii Kieffer, 1901

Material examined: Eğirdir, Kırıntı village, 30.04.2017, 37°39'03''N, 30°51'36''E, 991 m; Gelendost, Afşar village, 09.09.2017, 38°06'34''N, 30°57'50''E, 985 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06''N, 31°04'10''E, 1007 m; Gelendost, Balcı village, 13.09.2017, 38°09'08''N, 31°04'59''E, 1032 m; Gelendost, Madenli village, 18.03.2017, 38°11'12''N, 31°05'59''E, 1005 m; Senirkent, Gençali village, 21.10.2017, 38°14'24''N, 30°45'51''E, 947 m; Keçiborlu, Aydoğmuş village, 23.05.2017, 37°56'33''N, 30°16'18''E, 1043 m; Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54''N, 30°51'03''E, 1244 m.
Distribution in Turkey: Afyon, Antalya, Burdur, Denizli, Isparta, İstanbul, Kütahya, Uşak (Azmaz & Katılmış, 2017a,b).
Host: *Quercus cerris, Q. ithaburensis.*

Andricus coriarius (Hartig, 1843)

Material examined: Eğirdir, Kırıntı village, 30.04.2017, 37°39'03"N, 30°51'36"E, 991 m; Gelendost, Afşar village, 09.09.2017, 38°06'34"N, 30°57'50"E, 985 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Gelendost, Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m; Gelendost, Madenli village, 18.03.2017, 38°11'12"N, 31°05'59"E, 1005 m; Senirkent, Gençali village, 21.10.2017, 38°14'24"N, 30°45'51"E, 947 m; Keçiborlu, Aydoğmuş village, 23.05.2017, 37°56'33"N, 30°16'18"E, 1043 m; Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54"N, 30°51'03"E, 1244 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37"N, 30°59'29"E, 1217 m; Eğirdir, 09.09.2017, 37°54'15"N, 30°54'23"E, 1053 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Uluborlu, 10.09.2017, 38°04'19"N, 30°25'19"E, 1083 m; Sütçüler, Yeşilyurt village, 03.02.2017, 37°32'05"N, 30°51'41"E, 647 m; Yalvaç, Eğirler village, 02.06.2017, 38°11'36"N, 31°06'09"E, 1016 m; Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 27.09.2017, 37°44'32"N, 30°49'43"E, 1555 m; Eğirdir, Kovada Lake Nature Park, 30.04.2017, 37°38'16"N, 30°51'51"E, 932 m; Sütçüler, Yeşilyurt village, Gökbüvet location, 17.03.2017, 14.04.2017, 37°33'42"N, 30°52'30"E, 734 m; Sütçüler, Yeşilyurt village, 17.03.2017, 37°32'08"N, 30°51'52"E, 666 m; Eğirdir, Yuvalı village, 24.02.2017, 37°41'37"N, 30°56'48"E, 1234 m; Şarkikaraağaç, Salur village, 09.09.2017, 38°17'18"N, 31°08"53"E, 1069 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m.

Distribution in Turkey: Afyon, Ankara, Antalya, Balıkesir, Bitlis, Burdur, Bursa, Denizli, Erzincan, Gümüşhane, Isparta, İstanbul, Kırklareli, Kütahya, Malatya, Tokat, Uşak (Acatay, 1943; Baş, 1973; Katılmış & Kıyak, 2008; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).

Host: *Quercus infectoria, Q. pubescens* and *Q. vulcanica.*

Andricus coronatus (Giraud, 1859)

Material examined: Sütçüler, Yeşilyurt village, 03.02.2017, 37°30'49"N, 30°52'50"E, 650 m; Yalvaç, Madenli village, 02.06.2017, 38°11'12"N, 31°05'59"E, 1005 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37"N, 30°59'29"E, 1217 m; Eğirdir, Yukarıgökdere village, 30.04.2017, 37°42'19"N, 30°51'01"E, 1003 m.

Distribution in Turkey: Afyon, Amasya, Antalya, Denizli, Isparta, İstanbul, Kütahya, Malatya, Muğla, Uşak (Baş, 1973; Katılmış & Kıyak, 2008; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).

Host: *Quercus infectoria* and *Q. pubescens*.

Andricus curtisii (Müller, 1870)

Material examined: Şarkikaraağaç, Salur village, 09.09.2017, 38°17'18"N, 31°08"53"E, 1069 m; Uluborlu, 10.09.2017, 38°04'19"N, 30°25'19"E, 1083 m, Yalvaç, Sücüllü village, 18.03.2017, 38°21'43"N, 31°08'44"E, 1161 m; Keçiborlu, Aydoğmuş village, 23.05.2017, 37°56'33"N, 30°16'18"E, 1043 m; Uluborlu, 10.09.2017, 38°04'19"N, 30°25'19"E, 1083 m.

Distribution in Turkey: Afyon, Ankara, Antalya, Aydın, Burdur, Bursa, Denizli, Erzincan, Gümüşhane, Isparta, Kütahya, Malatya, Uşak (Katılmış & Kıyak, 2008; Kıyak et. al., 2008; Mutun & Dinç, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017b).

Host: *Quercus pubescens* and *Q. infectoria*.

Andricus curvator Hartig, 1840

Material examined: Eğirdir, Yuvalı village, 06.10.2017, 37°41'37"N, 30°56'48"E, 1234 m; Eğirdir, 09.09.2017, 37°54'15"N, 30°54'23"E, 1053 m.

Distribution in Turkey: Afyon, Ankara, Aydın, Bolu, Burdur, Bursa, Denizli, İstanbul, Kırklareli, Kütahya, Uşak (Acatay, 1943; Baş, 1973; Katılmış & Kıyak, 2008; Azmaz & Katılmış, 2017a,b).

Host: *Quercus pubescens* and *Q. infectoria*.

Andricus cydoniae Giraud, 1859

Material examined: Gelendost, Afşar village, 09.09.2017, 38°06'34"N, 30°57'50"E, 985 m; Gelendost, Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m; Gelendost, Madenli village, 02.06.2017, 38°11'12"N, 31°05'59"E, 1005 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Senirkent, Gençali village, 21.10.2017, 38°14'24"N, 30°45'51"E, 947 m; Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54"N, 30°51'03"E, 1244 m.

Distribution in Turkey: Afyon, Kütahya, Uşak (Katılmış & Kıyak, 2008, 2011).
Host: *Quercus ithaburensis*.

Andricus foecundatrix (Hartig, 1840)

Material examined: Aksu, Yılanlı village, 06.10.2017, 37°47'37"N, 30°59'29"E, 1217 m; Eğirdir, 09.09.2017, 37°54'15"N, 30°54'23"E, 1053 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m.
Distribution in Turkey: Afyon, Ankara, Balıkesir, Erzincan, İstanbul, Kocaeli, Kütahya, Malatya, Manisa (Acatay, 1943; Schimitschek, 1953, Baş, 1973; Katılmış, 2010; Katılmış & Kıyak, 2008, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).
Host: *Quercus infectoria* and *Q. pubescens*.

Andricus gallaeurnaeformis (Fonscolombe, 1832)

Material examined: Gelendost, Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m; Gelendost, Afşar village, 09.09.2017, 38°06'34"N, 30°57'50"E, 985 m; Güneyce village, 21.08.2017, 37°39'35"N, 30°42'54"E, 714 m; Eğirdir, Aşağıgökdere village, 21.08.2017, 37°33'43"N, 30°45'17"E, 366 m.
Distribution in Turkey: Afyon, İstanbul, Kütahya, Uşak (Katılmış & Kıyak 2008, 2011; Azmaz & Katılmış, 2017a,b).
Host: *Quercus ithaburensis* and *Q. cerris*.

Andricus grossulariae Giraud, 1859

Material examined: Eğirdir, Aşağıgökdere village, Gökbüvet location, 17.03.2017, 14.04.2017, 37°33'42"N, 30°52'30"E, 734 m; Gelendost, Madenli village, 02.06.2017, 38°11'12"N, 31°05'59"E, 1005 m; Eğirdir, 09.09.2017, 37°54'15"N, 30°54'23"E, 1053 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Eğirdir, Kovada Lake Nature Park, 30.04.2017, 37°38'16"N, 30°51'51"E, 932 m; Eğirdir, Yuvalı village, 24.02.2017, 37°41'37"N, 30°56'48"E, 1234 m; Eğirdir, Yukarıgökdere village, 30.04.2017, 37°42'19"N, 30°51'01"E, 1003 m; Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 27.09.2017, 37°44'32"N, 30°49'43"E, 1555 m; Aksu, Yılanlı village, 06.09.2017, 37°47'37"N, 30°59'29"E, 1217 m.
Distribution in Turkey: Afyon, Antalya, Aydın, Burdur, Denizli, Erzincan, Gümüşhane, Isparta, İstanbul, Kırklareli, Kütahya, Malatya, Sinop, Uşak (Acatay, 1943; Baş, 1973; Kıyak et. al., 2008; Katılmış & Kıyak, 2008; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).
Host: *Quercus vulcanica* and *Q. infectoria*.

Andricus infectorius (Hartig, 1843)

Material examined: Eğirdir, Kasnak Oak Nature Protection Area, Oniki Kardeşler location, 27.09.2017, 37°44'32"N, 30°49'44"E, 1551 m; Sütçüler, 03.02.2017, 37°29'38"N, 30°53'05"E, 525 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Eğirdir, Yukarıgökdere village, 30.04.2017, 37°42'19"N, 30°51'01"E, 1003 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37"N, 30°59'29"E, 1217 m; Eğirdir, Yuvalı village, 24.02.2017, 37°41'37"N, 30°56'48"E, 1234 m; Sütçüler, Gökbüvet location, 14.04.2017, 37°33'42"N, 30°52'30"E, 734 m; Gelendost, Afşar village, 09.09.2017, 38°08'11"N, 30°58'20"E, 933 m.
Distribution in Turkey: Afyon, Ankara, Aydın, Balıkesir, Batman, Burdur, Çanakkale, Çorum, Denizli, Diyarbakır, Isparta, İstanbul, İzmir, Kütahya, Malatya, Manisa, Marin, Muğla, Niğde, Şırnak, Uşak (Acatay, 1943; Baş, 1973; Özkazanç, 2000; Katılmış & Kıyak, 2008; Kıyak et. al., 2008; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).
Host: *Quercus vulcanica*, *Q. robur* and *Q. infectoria*.

Andricus istvani Melika, 2008

Material examined: Keçiborlu, Aydoğmuş village, 23.05.2017, 37°56'33"N, 30°16'18"E, 1043 m; Gelendost, Madenli village, 02.06.2017, 38°11'12"N, 31°05'59"E, 1005 m; Yalvaç, Eğirler village, 02.06.2017, 38°11'36"N, 31°06'09"E, 1016 m; Gelendost, Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m.
Distribution in Turkey: Afyon, Kütahya, Uşak (Azmaz & Katılmış, 2017b).
Host: *Quercus ithaburensis*.

Andricus kollari (Hartig, 1843)

Material examined: Eğirdir, Aşağıgökdere, Gökbüvet location, 17.03.2017, 37°33'42"N, 30°52'30"E, 734 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Eğirdir, Yukarıgökdere village, 30.04.2017, 37°42'19"N, 30°51'01"E, 1003 m; Eğirdir, Kovada Lake Nature Park, 30.04.2017, 37°38'16''N, 30°51'51''E, 932 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21''N, 30°56'26''E, 994 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37''N, 30°59'29''E, 1217 m.

Distribution in Turkey: Ankara, Aydın, Balıkesir, Bitlis, Burdur, Bursa, Denizli, Eskişehir, Gümüşhane, Isparta, İstanbul, Kütahya, Malatya, Uşak, Van (Acatay, 1943; Çanakçıoğlu, 1956; Baş, 1973; Özkazanç, 2000; Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011a; Mutun & Dinç, 2011; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).

Host: *Quercus pubescens* and *Q. infectoria*.

Andricus lignicolus (Hartig, 1840)

Material examined: Sütçüler, Kuzca village, 24.02.2017, 37°37'09''N, 31°00'53''E, 1318 m; Eğirdir, Sipahiler village, 24.02.2017, 37°39'28''N, 30°58'24''E, 1215 m; Eğirdir, Yuvalı village, 24.02.2017, 37°41'37''N, 30°56'48''E, 1234 m; Isparta, Güneyce village, Küplübelen location, 24.03.2017, 37°39'34''N, 30°42'54''E, 712 m; Eğirdir, Aşağıgökdere village, Araçay location, 21.08.2017, 37°33'53''N, 30°45'10''E, 380 m; Gelendost, Balcı village, 13.09.2017, 38°09'08''N, 31°04'59''E, 1032 m; Sütçüler, Ayvalıpınar village, 06.10.2017, 37°410'43''N, 31°01'44''E, 1123 m.

Distribution in Turkey: Afyon, Antalya, Balıkesir, Burdur, Çanakkale, Denizli, Düzce, Eskişehir, Isparta, İstanbul, Kahramanmaraş, Kayseri, Kırıkkale, Konya, Kütahya, Malatya, Manisa, Uşak, Van (Acatay, 1943; Schimitschek, 1953; Katılmış & Kıyak, 2008, 2011; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017b).

Host: *Quercus cerris* and *Q. ithaburensis*.

Andricus lucidus (Hartig, 1843)

Material examined: Eğirdir, Yuvalı village, 24.02.2017, 37°41'37''N, 30°56'48''E, 1234 m; Yalvaç, Sücüllü village, 18.03.2017, 38°21'43''N, 31°08'44''E, 1161 m; Sütçüler, Karadiken village, 30.04.2017, 37°33'10''N, 30°54'17''E, 1018 m; Eğirdir, Yukarıgökdere village, 30.04.2017, 37°42'19''N, 30°51'01''E, 1003 m; Gelendost, Madenli village, 02.06.2017, 38°11'12''N, 31°05'59''E, 1005 m; Yalvaç, Eğirler village, 02.06.2017, 38°11'36''N, 31°06'09''E, 1016 m; Uluborlu, 10.09.2017, 38°04'19''N, 30°25'19''E, 1083 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21''N, 30°56'26''E, 994 m; Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 27.09.2017, 37°44'32''N, 30°49'43''E, 1555 m; Eğirdir, Yukarıgökdere village; 27.09.2017, 37°42'19''N, 30°51'01''E, 1003 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37''N, 30°59'29''E, 1217 m; Yalvaç, Çamharman village; 21.10.2017, 38°25'44''N, 31°06'43''E, 1292 m.

Distribution in Turkey: Adıyaman, Afyon, Antalya, Bingöl, Bitlis, Burdur, Denizli, Elazığ, Erzincan, Gümüşhane, Isparta, İstanbul, Kayseri, Kahramanmaraş, Kütahya, Malatya, Muş, Uşak, Van (Katılmış & Kıyak, 2008, 2011; Katılmış, 2010; Mutun, 2011; Mutun & Dinç, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015).

Host: *Quercus cerris*, *Q. ithaburensis*, *Q. infectoria* and *Q. vulcanica*.

Andricus megalucidus Melika, Stone, Sadeghi ve Pujade-Villar, 2004

Material examined: Eğirdir, Aşağıgökdere village, Cumali district, 03.02.2017, 37°33'07''N, 30°45'44''E, 345 m; Gelendost, Madenli village, 02.06.2017, 38°11'12''N, 31°05'59''E, 1005 m; Şarkikaraağaç, Salur village, 09.09.2017, 38°17'18''N, 31°08''53''E, 1069 m; Aksu, Yılanlı village, 06.10.2017, 37°47'40''N, 30°59'29''E, 1227 m.

Distribution in Turkey: Afyon, Bitlis, Burdur, Denizli, Erzincan, Isparta, İstanbul, Kütahya, Malatya, Uşak, Van (Melika et. al., 2004; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).

Host: *Quercus infectoria* and *Q. pubescens*.

Andricus miriami Shachar, 2015

Material examined: Eğirdir, Yuvalı village, 24.02.2017, 37°41'37''N, 30°56'48''E, 1234 m; Eğirdir, Yukarıgökdere village, 30.04.2017, 37°42'19''N, 30°51'01''E, 1003 m.

Distribution in Turkey: It is a new record for Turkey.

Host: *Quercus cerris*.

Andricus moreae (Graeffe, 1905)

Material examined: Eğirdir, Yuvalı village, 24.02.2017, 37°41'37''N, 30°56'48''E, 1234 m; Aşağıgökdere village, Gökbüvet district, 17.03.2017, 14.04.2017, 37°33'42''N, 30°52'30''E, 734 m; Kovada Lake Nature Park, 30.04.2017, 37°38'16''N, 30°51'51''E, 932 m.

Distribution in Turkey: Denizli, Erzincan, İstanbul, Malatya, Van (Mete & Demirsoy; 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).

Host: *Quercus infectoria*.

Andricus multiplicatus Giraud, 1859

Material examined: Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54"N, 30°51'03"E, 1244 m.

Distribution in Turkey: Afyon, Denizli, İstanbul, Kütahya, Van (Katılmış & Kıyak, 2008; 2011; Azmaz & Katılmış, 2017a,b).

Host: *Quercus ithaburensis*.

Andricus quercuscalicis (Burgsdorf, 1783)

Material examined: Yalvaç, Sücüllü village, 18.03.2017, 38°21'43"N, 31°08'44"E, 1161 m; Gelendost, Afşar village, 09.09.2017, 38°08'11"N, 30°58'20"E, 933 m.

Distribution in Turkey: Afyon, Denizli, İstanbul, Kütahya, Van (Katılmış & Kıyak, 2008; 2011; Azmaz & Katılmış, 2017a,b).

Host: *Quercus cerris* and *Q. robur*.

Andricus quercustozae (Bosc, 1792)

Material examined: Yalvaç, Sücüllü village, 18.03.2017, 38°21'43"N, 31°08'44"E, 1161 m; Yalvaç, Eğirler village, 02.06.2017, 38°11'36"N, 31°06'09"E, 1016 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Gelendost, Madenli village, 02.06.2017, 38°11'12"N, 31°05'59"E, 1005 m; Gelendost, Afşar village, 09.09.2017, 38°08'11"N, 30°58'20"E, 933 m; Şarkikaraağaç, Salur village, 09.09.2017, 38°17'18"N, 31°08"53"E, 1069 m; Uluborlu, 10.09.2017, 38°04'19"N, 30°25'19"E, 1083 m; Eğirdir, Çayköy; 13.09.2017, 19.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Eğirdir, Kasnak Oak Nature Protection Area, 27.09.2017, 37°42'27"N, 30°50'55"E, 1048 m; Yalvaç, Çamharman village, 21.10.2017, 38°25'44"N, 31°06'43"E, 1292 m.

Distribution in Turkey: Adıyaman, Afyon, Aksaray, Ankara, Antalya, Aydın, Balıkesir, Bayburt, Bitlis, Bolu, Burdur, Bursa, Çanakkale, Çankırı, Denizli, Elazığ, Erzincan, Gümüşhane, Isparta, İstanbul, Kahramanmaraş, Kayseri, Kırklareli, Kütahya, Malatya, Mersin, Muğla, Muş, Sakarya, Sivas, Tekirdağ, Uşak, Van (Acatay, 1943; Schimitschek 1953; Çanakçıoğlu, 1956; Baş, 1973; Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011; Mutun & Dinç, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış 2017a,b).

Host: *Quercus trojana*, *Q. infectoria, Q. vulcanica* and *Q. robur*.

Andricus seckendorffi (Wachtl, 1879)

Material examined: Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 27.09.2017, 37°44'32"N, 30°49'43"E, 1555 m; Eğirdir, Kasnak Oak Nature Protection Area, Armutalan location, 27.09.2017, 37°44'25"N, 30°49'46"E, 1530 m; Aksu, Yılanlı village, 06.10.2017, 37°47'40"N, 30°59'29"E, 1227 m.

Distribution in Turkey: Afyon, Antalya, Aydın, Balıkesir, Burdur, Denizli, Isparta, İstanbul, İzmir, Kırklareli, Kütahya, Malatya, Sinop, Uşak (Acatay, 1943; Schimitschek, 1953; Baş, 1973; Hellrigl & Bodur, 2015; Katılmış & Kıyak, 2008; 2011; Kıyak et. al., 2008).

Host: *Quercus vulcanica* and *Q. infectoria*.

Andricus sternlichti Bellido, Pujade-Villar ve Melika, 2003

Material examined: Yalvaç, Sücüllü village, 18.03.2017, 38°21'43"N, 31°08'44"E, 1161 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Yalvaç, Madenli village, 02.06.2017, 38°11'12"N, 31°05'59"E, 1005 m; Yalvaç, Eğirler village, 02.06.2017, 38°11'36"N, 31°06'09"E, 1016 m; Şarkikaraağaç, Salur village, 09.09.2017, 38°17'18"N, 31°08"53"E, 1069 m; Gelendost, Afşar village, 09.09.2017, 38°08'11"N, 30°58'20"E, 933 m.

Distribution in Turkey: Afyon, Denizli, İstanbul, Erzincan, Kütahya, Manisa, Uşak, Van (Katılmış & Kıyak, 2008, 2011; Mete & Demirsoy, 2012; Azmaz & Katılmış, 2017a, 2017b; Eş et. al, 2017).

Host: *Quercus pubescens* and *Q. infectoria*.

Andricus theophrastea (Trotter, 1866)

Material examined: Şarkikaraağaç, Salur village, 09.09.2017, 38°17'18"N, 31°08"53"E, 1069 m; Yalvaç, Çamharman village, 21.10.2017, 38°25'44"N, 31°06'43"E, 1292 m.

Distribution in Turkey: Afyon, Denizli, Gümüşhane, Konya, Kütahya, Malatya, Uşak (Katılmış & Kıyak, 2008, 2011; Mutun & Dinç, 2011; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017b).

Host: *Quercus pubescens*.

Andricus tomentosus (Trotter, 1901)

Material examined: Süleyman Demirel University, Faculty of Forestry garden, 04.02.2017, 37°49'54"N, 30°32'16"E, 1026 m; Süleyman Demirel University, Botanic Garden, 28.10.2017; 20.09.2017, 37°51'04"N, 30°31'39"E, 1013 m, Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m.
Distribution in Turkey: Afyon, Ankara, Antalya, Balıkesir, Bursa, Denizli, Erzincan, Isparta, İstanbul, Kütahya, Malatya, Manisa, Muğla, Samsun, Uşak (Acatay, 1943; Schimitschek, 1953; Baş, 1973; Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).
Host: *Quercus robur.*

Andricus vindobonensis Müllner, 1901

Material examined: Keçiborlu, Aydoğmuş village, 23.05.2017, 37°56'33"N, 30°16'18"E, 1043 m.
Distribution in Turkey: Afyon, Denizli, Kütahya, Uşak (Katılmış & Kıyak, 2009a; Azmaz & Katılmış, 2017b).
Host: *Quercus ithaburensis.*

Aphelonxy cerricola (Giraud, 1859)

Material examined: Eğirdir, Yuvalı village, 24.02.2017, 37°41'37"N, 30°56'48"E, 1234 m; Sütçüler, Kuzca village, Sağlıkpınarı location, 24.02.2017, 37°37'09"N, 31°00'53"E, 1318 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Sütçüler, Kesme village, 24.03.2017, 37°27'19"N, 31°14'08"E, 927 m; Yalvaç, Madenli village, 18.03.2017, 38°11'12"N, 31°05'59"E, 1005 m; Güneyce village, Küplübelen location, 24.03.2017, 37°39'34"N, 30°42'54"E, 712 m; Sütçüler, Karadiken village, 30.04.2017, 37°33'10"N, 30°54'17"E, 1018 m; Kovada Lake Nature Park, 30.04.2017, 37°38'16"N, 30°51'51"E, 932 m; Eğirdir, Kırıntı village, 30.04.2017, 37°39'03"N, 30°51'36"E, 991 m; Eğirdir, Yukarıgökdere village, 30.04.2017, 37°42'19"N, 30°51'01"E, 1003 m; Gelendost, Madenli village, 02.06.2017, 38°11'12"N, 31°05'59"E, 1005 m; Aşağıgökdere village, Araçay location, 21.08.2017, 37°33'53"N, 30°45'10"E, 380 m; Eğirdir, Aşağıgökdere village, 21.08.2017; 37°32'45"N, 30°46'14"E, 335 m, Gelendost, Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m; Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54"N, 30°51'03"E, 1244 m; Eğirdir, Kasnak Oak Nature Protection Area, Armutalan location, 27.09.2017, 37°44'25"N, 30°49'46"E, 1530 m; Senirkent, Gençali village, 21.10.2017, 38°14'24"N, 30°45'51"E, 94 m; Yalvaç, Çamharman village, 21.10.2017, 38°25'44"N, 31°06'43"E, 1292 m.
Distribution in Turkey: Aydın, Burdur, Denizli, Isparta, Konya (Kıyak et. al., 2008).
Host: *Quercus cerris*, *Q. ithaburensis* and *Q. trojana.*

Aphelonxy persica Melika, Stone, Sadeghi ve Pujade-Villar, 2004

Material examined: Eğirdir, Sipahiler village, 24.02.2017, 37°39'28"N, 30°58'24"E, 1215 m; Sütçüler, Kesme village, 24.02.2017, 37°27'32"N, 31°13'46"E, 998 m; Eğirdir, Yuvalı village, 24.03.2017, 37°41'37"N, 30°56'48"E, 1234 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Yalvaç, Sücüllü village, 18.03.2017, 38°21'43"N, 31°08'44"E, 1161 m; Sütçüler, Karadiken village, 30.04.2017, 37°33'10"N, 30°54'17"E, 1018 m; Eğirdir, Kırıntı village, 30.04.2017, 37°39'03"N, 30°51'36"E, 991 m; Eğirdir, Kovada Lake Nature Park, 30.04.2017, 37°38'16"N, 30°51'51"E, 932 m; Kasnak Oak Nature Protection Area, 30.04.2017, 37°44'25"N, 30°49'46"E, 1530 m; Aşağıgökdere village, Araçay location, 21.08.2017, 37°33'53"N, 30°45'10"E, 380 m; Eğirdir, Aşağıgökdere village, 21.08.2017, 37°32'45"N, 30°46'14"E, 335 m; Güneyce village, 21.08.2017, 27°39'43"N, 30°43'23"E, 699 m; Gelendost, Afşar village, 09.09.2017, 38°07'05"N, 30°58'00"E, 953 m; Gelendost, Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59"N, 30°50'56"E, 959 m; Eğirdir, Kasnak Oak Nature Protection Area, Oniki Kardeşler location, 27.09.2017, 37°44'32"N, 30°49'44"E, 1551 m; Senirkent, Gençali village, 21.10.2017, 38°14'24"N, 30°45'51"E, 947 m; Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54"N, 30°51'03"E, 1244 m; Yalvaç, Çamharman village, 21.10.2017, 38°25'44"N, 31°06'43"E, 1292 m.
Distribution in Turkey: Afyon, Denizli, İstanbul, Malatya, Manisa, Uşak, Van (Hellrigl & Bodur, 2015; Katılmış & Kıyak, 2009b; Azmaz & Katılmış, 2017a, 2017b; Eş et. al., 2017).
Host: *Quercus cerris*, *Q. ithaburensis* and *Q. trojana.*

Biorhiza pallida (Oliver, 1791)

Material examined: Eğirdir, Kasnak Oak Nature Protection Area, 30.04.2017, 37°42'27"N, 30°50'55"E, 1048 m; Eğirdir, 09.09.2017, 37°54'15"N, 30°54'23"E, 1053 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37"N, 30°59'29"E, 1217 m.
Distribution in Turkey: Afyon, Ankara, Burdur, Denizli, Gümüşhane, Isparta, İstanbul, Kütahya, Malatya, Trabzon, Uşak, Van (Acatay, 1943; Schimitschek 1953; Baş 1973; Bayram et. al., 1999; Kıyak et. al., 2008; Katılmış & Kıyak, 2008; 2011; Mutun & Dinç, 2011; Hellrigl & Bodur, 2015; Özkazanç, 2000; Azmaz & Katılmış, 2017a,b).
Host: *Quercus infectoria*.

Callirhytis rufescens (Mayr, 1882)

Material examined: Yalvaç, Eğirler village, 02.06.2017, 38°11'36"N, 31°06'09"E, 1016 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m.
Distribution in Turkey: İstanbul, Kütahya (Azmaz & Katılmış, 2008, 2011, 2017a,b).
Host: *Quercus pubescens* and *Q. infectoria*.

Cerroneuroterus lanuginosus (Giraud, 1859)

Material examined: Eğirdir, Sipahiler village, 24.02.2017, 37°40'46"N, 30°57'35"E, 1286 m; Sütçüler, Kesme village, 24.02.2017, 37°27'32"N, 31°13'46"E, 998 m; Sücüllü village, 18.03.2017, 38°21'43"N, 31°08'44"E, 1161 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Gelendost, Afşar village, 09.09.2017, 38°08'11"N, 30°58'20"E, 933 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Gelendost, Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59"N, 30°50'56"E, 959 m; Eğirdir, Kasnak Oak Nature Protection Area, 27.09.2017; Senirkent, Gençali village, 21.10.2017, 38°14'24"N, 30°45'51"E, 947 m; Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54"N, 30°51'03"E, 1244 m.
Distribution in Turkey: Afyon, Aydın, Burdur, Denizli, Erzincan, Isparta, İstanbul, Kütahya, Uşak (Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011; Mete & Demirsoy, 2012; Azmaz & Katılmış, 2017b).
Host: *Quercus cerris, Q. ithaburensis* and *Q. trojana*.

Cerroneuroterus minutulus (Giraud, 1859)

Material examined: Gelendost, Bağıllı village, 18.03.2017, 38°09'06"N, 31°04'10"E, 1007 m; Gelendost, Afşar village, 09.09.2017, 38°06'34"N, 30°57'50"E, 985 m; Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m; Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54"N, 30°51'03"E, 1244 m; Yalvaç, Aşağıkaşıkara village, 21.10.2017, 38°15'42"N, 30°48'05"E, 959 m.
Distribution in Turkey: Afyon, Uşak (Katılmış, 2010; Azmaz & Katılmış, 2017b).
Host: *Quercus ithaburensis*.

Cerroneuroterus obtectus (Wachtl, 1880)

Material examined: Gelendost, Balcı village, 13.09.2017, 38°09'08"N, 31°04'59"E, 1032 m.
Distribution in Turkey: Afyon, Denizli, İstanbul, Kütahya (Katılmış & Kıyak, 2011; Azmaz & Katılmış, 2017a,b).
Host: *Quercus ithaburensis*.

Chilaspis israeli (Sternlicht, 1968)

Material examined: Eğirdir, Yukarıgökdere village, 30.04.2017, 37°42'19"N, 30°51'01"E, 1003 m.
Distribution in Turkey: It is a new record for Turkey.
Host: *Quercus cerris*.

Cynips agama Hartig, 1840

Material examined: Eğirdir, 09.09.2017, 37°55'10"N, 30°55'09"E, 966 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m.
Distribution in Turkey: Afyon, Burdur, Denizli, İstanbul, Kütahya (Schimitschek, 1953; Kıyak et. al., 2008; Katılmış & Kıyak, 2008; 2011; Azmaz & Katılmış, 2017b).
Host: *Quercus infectoria*.

Cynips cornifex Hartig, 1843

Material examined: Isparta, Güneyce village, 21.08.2017, 37°39'35"N, 30°42'54"E, 699 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59"N, 30°50'56"E, 959 m.

Distribution in Turkey: Afyon, Antalya, Denizli, Erzincan, İstanbul, Kütahya, Malatya, Sinop (Baş, 1973; Katılmış & Kıyak, 2008, 2011; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).
Host: *Quercus infectoria.*

Cynips disticha Hartig, 1840

Material examined: Eğirdir, Yukarıgökdere village, Kasnak Oak Nature Protection Area, 27.09.2017, 37°44'32"K, 30°49'44"D, 1551 m.
Distribution in Turkey: Afyon, İstanbul (Azmaz & Katılmış, 2017a, 2017b; Katılmış & Kıyak, 2011).
Host: *Quercus pubescens* and *Q. vulcanica.*

Cynips divisa Hartig, 1840

Material examined: Yalvaç, Eğirler village, 02.06.2017, 38°11'36"N, 31°06'09"E, 1016 m; Eğirdir, 09.09.2017, 37°55'10"N, 30°55'09"E, 966 m; Şarkikaraağaç, 09.09.2017, 38°05'07"N, 31°21'48"E, 1170 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Eğirdir, Kasnak Oak Nature Protection Area, 27.09.2017, 37°44'32"N, 30°49'43"E, 1555 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59"N, 30°50'56"E, 959 m; Yalvaç, Çamharman village, 21.10.2017, 38°25'44"N, 31°06'43"E, 1292 m; Yalvaç, Sücüllü village, 21.10.2017, 38°21'43"N, 31°08'44"E, 1161 m.
Distribution in Turkey: Afyon, Ankara, Artvin, Bolu, Denizli, İstanbul, Kütahya, Malatya, Niğde, Sakarya, Uşak (Acatay, 1943; Baş 1973; Hellrigl & Bodur, 2015; Katılmış & Kıyak 2008, 2011).
Host: *Quercus infectoria*, *Q. pubescens*, *Q. vulcanica* and *Q. petraea.*

Cynips korsakovi Belizin, 1961

Material examined: Eğirdir, Yukarıgökdere village, 27.09.2017 37°41'59"N, 30°50'56"E, 959 m; Eğirdir, Yuvalı village, 06.10.2017, 37°41'37"N, 30°56'48"E, 1234 m.
Distribution in Turkey: Gümüşhane (Mutun & Dinç, 2011).
Host: *Quercus pubescens.*

Cynips longiventris Hartig, 1840

Material examined: Eğirdir, 09.09.2017, 37°54'15"N, 30°54'23"E, 1053 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37"N, 30°59'29"E, 1217 m.
Distribution in Turkey: Bolu, Edirne, İstanbul, Sakarya, Tekirdağ, Zonguldak (Azmaz & Katılmış, 2015; Mutun & Dinç, 2015).
Host: *Quercus infectoria.*

Cynips quercusfolii (Linnaeus, 1758)

Material examined: Yalvaç, Sücüllü village, 18.03.2017, 38°21'43"N, 31°08'44"E, 1161 m; Eğirdir, 09.09.2017, 37°54'15"N, 30°54'23"E, 1053 m; Gelendost, Afşar village, 09.09.2017, 38°08'11"N, 30°58'20"E, 933 m; Uluborlu, 10.09.2017, 38°04'19"N, 30°25'19"E, 1083 m; Eğirdir, Kasnak Oak Nature Protection Area, Oniki Kardeşler location, 27.09.2017, 37°44'32"N, 30°49'44"E, 1551 m; Eğirdir, Kasnak Oak Nature Protection Area, Armutalan location, 27.09.2017, 37°44'25"N, 30°49'46"E, 1530 m; Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 27.09.2017, 37°44'32"N, 30°49'43"E, 1555 m.
Distribution in Turkey: Afyon, Ankara, Antalya, Artvin, Aydın, Balıkesir, Bolu, Burdur, Denizli, Erzincan, Gümüşhane, Isparta, İstanbul, Kırklareli, Kütahya, Malatya, Manisa, Muğla, Tunceli, Uşak, Van (Acatay 1943; Schimitschek, 1953; Baş, 1973; Bayram et. al., 1999; Özkazanç, 2000; Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011; Mutun & Dinç, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Eş et. al., 2017; Azmaz & Katılmış, 2017a,b).
Host: *Quercus infectoria*, *Q. robur* and *Q. vulcanica.*

Neuroterus anthracinus (Curtis, 1838)

Material examined: Eğirdir, 09.09.2017, 37°54'15"N, 30°54'23"E, 1053 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21"N, 30°56'26"E, 994 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59"N, 30°50'56"E, 959 m; Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 27.09.2017, 37°44'32"N, 30°49'43"E, 1555 m; Yalvaç, Yukarıkaşıkara village, 21.10.2017, 38°20'54"N, 30°51'03"E, 1244 m.
Distribution in Turkey: İstanbul, Kütahya, Malatya, Van (Acatay, 1943; Hellrigl & Bodur, 2015; Katılmış & Kıyak, 2008, 2011; Azmaz & Katılmış, 2017a,b).
Host: *Quercus infectoria* and *Q. vulcanica.*

Neuroterus numismalis (Geoffroy, 1785)

Material examined: Eğirdir, Kasnak Oak Nature Protection Area, Armutalan location, 27.09.2017, 37°44'25''N, 30°49'46''E, 1530 m; Eğirdir, Kasnak Oak Nature Protection Area, Oniki Kardeşler location, 27.09.2017, 37°44'32''N, 30°49'44''E, 1551 m.
Distribution in Turkey: Afyon, Ankara, Antalya, Aydın, Burdur, Denizli, Erzincan, Isparta, İstanbul, Kütahya, Sakarya, Samsun, Uşak (Acatay, 1943; Baş, 1973; Katılmış & Kıyak, 2008; Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a,b).
Host: *Quercus vulcanica.*

Neuroterus quercusbaccarum (Linnaeus, 1758)

Material examined: Sütçüler, Kesme village, 24.03.2017, 37°27'19''N, 31°14'08''E, 927 m; Şarkikaraağaç, Salur village, 09.09.2017, 38°17'18''N, 31°08''53''E, 1069 m; Eğirdir, 09.09.2017, 37°54'15''N, 30°54'23''E, 1053 m; Gelendost, Afşar village, 09.09.2017, 38°08'11''N, 30°58'20''E, 933 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21''N, 30°56'26''E, 994 m; Gelendost, Balcı village, 13.09.2017, 38°09'08''N, 31°04'59''E, 1032 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59''N, 30°50'56''E, 959 m; Aksu, Yılanlı village, 06.10.2017, 37°47'37''N, 30°59'29''E, 1217 m; Yalvaç, Sücüllü village, 21.10.2017, 38°21'43''N, 31°08'44''E, 1161 m.
Distribution in Turkey: Afyon, Ankara, Aydın, Burdur, Denizli, Erzincan, Gümüşhane, Isparta, İstanbul, Kırklareli, Kütahya, Malatya, Manisa, Sakarya, Van (Acatay, 1943; Baş, 1973; Bayram et. al., 1999; Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011; Mutun & Dinç, 2011; Mete & Demirsoy, 2012; Hellrigl & Bodur, 2015; Azmaz & Katılmış, 2017a, 2017b; Eş et. al., 2017).
Host: *Quercus infectoria*, *Q. petraea* and *Q. robur.*

Plagiotrochus quercusilicis (Fabricius, 1789)

Material examined: Isparta, Mount Davraz road, 29.04.2017, 37°41'19''N, 30°37'02''E, 1520 m; Isparta, Direkli village, 14.06.2017, 37°43'12''N, 30°37'02''E, 1087 m; Eğirdir, 09.09.2017, 37°54'15''N, 30°54'23''E, 1053 m; Eğirdir, Yukarıgökdere village, 27.09.201737°41'59''N, 30°50'56''E, 959 m.
Distribution in Turkey: Afyon, Denizli, İstanbul, Uşak (Katılmış & Kıyak, 2008, 2011; Kıyak et. al., 2008; Azmaz & Katılmış, 2017a,b).
Host: *Quercus coccifera.*

Pseudoneuroterus macropterus (Hartig, 1843)

Material examined: Eğirdir, Yuvalı village, 24.02.2017, 37°41'37''N, 30°56'48''E, 1234 m; Gelendost, Bağıllı village, 18.03.2017, 38°09'06''N, 31°04'10''E, 1007 m; Aşağıgökdere village, Araçay location, 21.08.2017, 37°33'53''N, 30°45'10''E, 380 m; Eğirdir, Çayköy, 13.09.2017, 37°48'21''N, 30°56'26''E, 994 m; Eğirdir, Ağılköy, 06.10.2017, 37°48'26''N, 30°55'15''E, 1130 m.
Distribution in Turkey: Afyon, Aydın, Balıkesir, Bolu, Denizli, İstanbul, Kırklareli, Kütahya, Sivas, Tokat, Uşak (Baş, 1973; Kıyak et. al., 2008; Katılmış & Kıyak, 2008, 2011; Azmaz & Katılmış, 2017a,b).
Host: *Quercus cerris.*

Pseudoneuroterus saliens (Kollar, 1857)

Material examined: Eğirdir, Yuvalı village, 06.10.2017, 37°41'37''N, 30°56'48''E, 1234 m; Senirkent, Gençali village, 21.10.2017, 38°14'24''N, 30°45'51''E, 947 m.
Distribution in Turkey: Afyon, Denizli, Kütahya, Uşak (Katılmış & Kıyak, 2011; Azmaz & Katılmış, 2017b).
Host: *Quercus cerris* and *Q. ithaburensis.*

Trigonaspis synaspis (Hartig, 1841)

Material examined: Eğirdir, Kasnak Oak Nature Protection Area, Oniki Kardeşler location, 27.09.2017, 37°44'32''N, 30°49'44''E, 1551 m; Eğirdir, Kasnak Oak Nature Protection Area, Beşbahçe location, 37°44'32''N, 30°49'43''E, 1555 m; Eğirdir, Kasnak Oak Nature Protection Area, Armutalan location, 37°44'25''N, 30°49'46''E, 1530 m; Eğirdir, Yukarıgökdere village, 27.09.2017, 37°41'59''N, 30°50'56''E, 959 m.
Distribution in Turkey: Adıyaman, Afyon, Amasya, Bingöl, Bitlis, Bolu, Çankırı, Çorum, Denizli, Edirne, Elazığ, Erzincan, Giresun, İstanbul, Karaman, Kastamonu, Kayseri, Kırşehir, Konya, Kütahya, Muş, Nevşehir, Sivas, Tokat, Tunceli, Yozgat (Katılmış & Kıyak, 2008, 2011; Mete & Demirsoy, 2012; Azmaz & Katılmış, 2017a,b).

Host: *Quercus infectoria* and *Q. vulcanica.*

DISCUSSIONS

In this study the species from Cynipini tribe were investigated in Isparta *Quercus* forests. We identified 51 oak gall wasps species belonging to 11 genera from Cynipini tribe. *Andricus miriami* and *Cynips israeli* were recorded from Turkey for the first time. *A. miriami* was previously known as *A. morula* (Shachar, Inbar & Dorchin) (Sharchar et. al., 2018). *A. morula* is now considered synonymous and it was reported from Israel and Jordan. *C. israeli* was reported from Israel, Lebanon, Jordan and Iran until now.

Andricus amenti, *A. burgundus*, *A. curvator, A. cydoniae*, *A. foecundatrix*, *A. gallaeurnaeformis*, *A. istvani*, *A. moreae*, *A. multiplicatus*, *A. quercuscalicis*, *A. sternlichti, A. theophrastea*, *A. vindobonensis*, *Aphelonxy persica*, *Callirhytis rufescens*, *Cerroneuroterus obtectus*, *Cynips agama*, *C. cornifex*, *C. disticha*, *C. divisa*, *C. korsakovi*, *Neuroterus anthracinus*, *Cerroneuroterus minutulus*, *Plagiotrochus quercusilicis*, *Pseudoneuroterus macropterus*, *Pseudoneuroterus saliens* and *Trigonaspis synaspis* were recorded for the first time from Isparta oak forests.

We examined eight oak species (*Quercus cerris, Q. ithaburensis, Q. vulcanica, Q. robur, Q. petraea, Q. trojana, Q. infectoria* ve *Q. coccifera)* in the study area (Table 1). The highest number of gall wasp species was found on *Q. infectoria* (24 species). Number of gall wasp species found on *Q. cerris, Q. vulcanica* and *Q. pubescens* was 12, on *Q. ithaburensis* 12, on *Q. robur* 5, on *Q. trojana* 4 and on *Q. petraea* 3.

27 of listed species were recorded for the first time for cynipid fauna of Isparta, of which two species were also new records for cynipid fauna of Turkey. After updating according to our results, Cynipidae fauna of Isparta currently consists of 57 species. This work made significant contributions to the fauna of Isparta and Turkey. Discovering two new species for Turkish Cynipidae fauna in Isparta province suggests that more species from this tribe could be found in Turkey in the future.

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Table 1. Oak gall wasps species and their hosts in Isparta.

Number	Species names	Host
1	*Andricus amenti* Giraud, 1859	*Quercus vulcanica*
2	*Andricus aries* (Giraud, 1859)	*Q. vulcanica*
3	*Andricus burgundus* Giraud, 1859	*Q. cerris*
4	*Andricus caputmedusae* (Hartig, 1843)	*Q. cerris, Q. petraea, Q. infectoria, Q. pubescens, Q. vulcanica*
5	*Andricus cecconii* Kieffer, 1901	*Q. cerris, Q. ithaburensis*
6	*Andricus coriarius* (Hartig, 1843)	*Q. infectoria, Q. pubescens, Q. vulcanica*
7	*Andricus coronatus* (Giraud, 1859)	*Q. infectoria, Q. pubescens*
8	*Andricus curtisii* (Müller, 1870)	*Q. pubescens, Q. infectoria*
9	*Andricus curvator* Hartig, 1840	*Q. pubescens, Q. infectoria*
10	*Andricus cydoniae* Giraud, 1859	*Q. ithaburensis*
11	*Andricus foecundatrix* (Hartig, 1840)	*Q. infectoria, Q. pubescens*
12	*Andricus gallaeurnaeformis* (Fonscolombe, 1832)	*Q. ithaburensis, Q. cerris*
13	*Andricus grossulariae* Giraud, 1859	*Q. vulcanica, Q. infectoria*
14	*Andricus infectorius* (Hartig, 1843)	*Q. vulcanica, Q. robur, Q. infectoria*
15	*Andricus istvani* Melika, 2008	*Q. ithaburensis*
16	*Andricus kollari* (Hartig, 1843)	*Q. pubescens, Q. infectoria*
17	*Andricus lignicolus* (Hartig, 1840)	*Q. cerris, Q. ithaburensis*
18	*Andricus lucidus* (Hartig, 1843)	*Q. cerris, Q. ithaburensis, Q. infectoria, Q.*

		vulcanica
19	*Andricus megalucidus* Melika, Stone, Sadeghi, Pujade-Villar, 2004	*Q. infectoria*, *Q. pubescens*
20	*Andricus moreae* (Graeffe, 1905)	*Q. infectoria*
21	*Andricus miriami* Shachar, 2015	*Q. cerris*
22	*Andricus multiplicatus* Giraud, 1859	*Q. ithaburensis*
23	*Andricus quercuscalicis* (Burgsdorf, 1783)	*Q. robur*, *Q. cerris*
24	*Andricus quercustozae* (Bosc, 1792)	*Q. trojana*, *Q. infectoria*, *Q. vulcanica*, *Q. robur*
25	*Andricus seckendorffi* (Wachtl, 1879)	*Q. vulcanica*, *Q. infectoria*
26	*Andricus sternlichti* Bellido, Pujade-Villar, Melika, 2003	*Q. infectoria*, *Q. pubescens*
27	*Andricus theophrastea* (Trotter, 1866)	*Q. pubescens*
28	*Andricus tomentosus* (Trotter, 1901)	*Q. robur*
29	*Andricus vindobonensis* Müllner, 1901	*Q. ithaburensis*
30	*Aphelonxy cerricola* (Giraud, 1859)	*Q. cerris*, *Q. ithaburensis*, *Q. trojana*
31	*Aphelonxy persica* Melika, Stone, Sadeghi, Pujade-Villar, 2004	*Q. cerris*, *Q. ithaburensis*, *Q. trojana*
32	*Biorhiza pallida* (Oliver, 1791)	*Q. infectoria*
33	*Callirhytis rufescens* (Mayr, 1882)	*Q. pubescens*, *Q. infectoria*
34	*Cerroneuroterus lanuginosus* (Giraud, 1859)	*Q. cerris*, *Q. ithaburensis*, *Q. trojana*
35	*Cerroneuroterus minutulus* (Giraud, 1859)	*Q. ithaburensis*
36	*Cerroneuroterus obtectus* (Wachtl, 1880)	*Q. ithaburensis*
37	*Chilaspis israeli* Sternlicht, 1968	*Q. cerris*
38	*Cynips agama* Hartig, 1840	*Q. infectoria*
39	*Cynips cornifex* Hartig, 1843	*Q. infectoria*
40	*Cynips disticha* Hartig, 1840	*Q. vulcanica*, *Q. pubescens*
41	*Cynips divisa* Hartig, 1840	*Q. infectoria*, *Q. pubescens*, *Q. vulcanica*, *Q. petraea*
42	*Cynips korsakovi* Belizin, 1961	*Q. pubescens*
43	*Cynips longiventris* Hartig, 1840	*Q. infectoria*
44	*Cynips quercusfolii* (Linnaeus, 1758)	*Q. infectoria*, *Q. robur*, *Q. vulcanica*
45	*Neuroterus anthracinus* (Curtis, 1838)	*Q. vulcanica*, *Q. infectoria*
46	*Neuroterus numismalis* (Geoffroy, 1785)	*Q. vulcanica*
47	*Neuroterus quercusbaccarum* (Linnaeus, 1758)	*Q. infectoria*, *Q. petraea*, *Q. robur*
48	*Plagiotrochus quercusilicis* (Fabricius, 1789)	*Q. coccifera*
49	*Pseudoneuroterus macropterus* (Hartig, 1843)	*Q. cerris*
50	*Pseudoneuroterus saliens* (Kollar, 1857)	*Q. cerris*
51	*Trigonaspis synaspis* (Hartig, 1841)	*Q. infectoria*, *Q. vulcanica*

A LIST OF HETEROPTERA SPECIES REPORTED FROM *ASTRAGALUS* SPP. IN TURKEY

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ABSTRACT: In this study, 61 species inhabiting on *Astragalus* as a hostplant, of 14 families in Heteroptera from Turkey are recorded.

KEY WORDS: Heteroptera, hostplant, *Astragalus*, Turkey

The aim of this study is presented a list of previously reported Turkish terrestrial Heteroptera species inhabiting on *Astragalus* spp. in Turkey according to the previous literatures as Hoberlandt (1955), Seidenstücker (1958, 1960), Wagner (1973), Aysev (1974), Lodos & Önder (1980), Çakır & Önder (1990), Pehlivan (1981), Çakır (1988), Kıyak (1990, 1993), Abbas (1990), Yardım (1990), Çağlar (1992), Boz (1992). Thus, 61 heteropteran species inhabiting on *Astragalus* as a hostplant, of 14 families from Turkey are determined with this work. 7 species of Miridae, 1 species of Anthocoridae, 3 species of Reduviidae, 1 species of Nabidae, 1 species of Tingidae, 1 species of Aradidae, 2 spcies of Coreidae, 1 species of Stenocephalidae, 1 species of Alydidae, 3 species of Rhopalidae, 16 species of Lygaeidae, 21 species of Pentatomidae, 3 species of Cydnidae, 1 species of Plataspididae are recorded.

All species are given into a list in the following table.

<u>List of Heteroptera species inhabiting on *Astragalus* in Turkey</u>

Familia/ Species	Host plant (s)	Cited Literature (s)
MIRIDAE		
Aelphocoria lineolatus (Gz., 1778)	*A. microcephalus*	Çağlar, 1992
Capsodes cingulatus (F., 1787)	*A. microcephalus*	Çağlar, 1992
Dimorphocoris distylus Sdst, 1964	*A. microcephalus*	Çağlar, 1992
Globiceps astragali Sdst, 1964	*Astragalus* sp.	Wagner, 1973
Globiceps genistae Sdst, 1971	*Astragalus* sp.	Wagner, 1973
Notostira erratica (L., 1758)	*Astragalus* sp.	Yardım, 1990
Systellonotus putoni Reuter, 1890	*Astragalus* sp.	Hoberlandt, 1955
ANTHOCORIDAE		
Anthocoris nemoralis (F., 1794)	*Astragalus* sp.	Hoberlandt, 1955
REDUVIIDAE		
Coranus tuberculifer Rt., 1881	*Astragalus* sp.	Boz, 1992
Phymata crassipes (F., 1775)	*A. microcephalus*	Çağlar, 1992
NABIDAE		
Nabis pseudoferus Rm., 1949	*A. microcephalus*	Çağlar, 1992
TINGIDAE		
Galeatus scrophicus Sd., 1876	*Astragalus* sp.	Hoberlandt, 1955
ARADIDAE		
Aradusmuricatus Hm., 1827	*Astragalus* sp.	Seidenstücker, 1958
COREIDAE		
Coriomeris planicornis Lnd., 1923	*Astragalus* sp.	Kıyak, 1990
Coriomeris spinolai (C., 1847)	*Astragalus* sp.	Kıyak, 1990

ALYDIDAE		
Camptopus tragacanthae (Klt., 1845)	*A. microcephalus*, *Astragalus* sp.	Kıyak, 1993; Çağlar, 1992; Pehlivan, 1981
STENOCEPHALIDAE		
Dicranocephalus agilis ssp. *agilis* (Scop., 1763)	*A. microcephalus*	Çağlar, 1992
RHOPALIDAE		
Chrorosoma schillingi (Schl., 1829)	*Astragalus* sp.	Pehlivan, 1981
Rhopalus parumpunctatus Schl., 1829	*Astragalus* sp., *A. microcephalus*	Kıyak, 1990; Çağlar, 1992
Rhopalus rufus Schl., 1829	*A. microcephalus*	Çağlar, 1992
LYGAEIDAE		
Emblethis brachipterus Lnn., 1953	*Astragalus* sp.	Kıyak, 1990
Emblethis brachynotus Hv., 1897	*Astragalus* sp.	Hoberlandt, 1955
Geocoris grylloides (L., 1758)	*Astragalus* sp., *A. microcephalus*	Çakır & Önder, 1990; Çağlar, 1992
Geocoris.lineola (Rb., 1842)	*A. microcephalus*, *Astragalus* sp.	Çağlar, 1992; Çakır, 1988
Geocoris megacephalus (R., 1790)	*Astragalus* sp.	Çakır, 1988
Henestaris laticeps (Ct., 1836)	*A. microcephalus*	Çağlar, 1992
Lygaeus equestris ssp. *equestris* (L., 1758)	*Astragalus* sp.	Kıyak, 1990
Lygaeus saxatilis (Scop., 1763)	*A. microcephalus*	Çağlar, 1992
Macroplax fasciata ssp. *fasciata* (H.-S., 1835)	*Astragalus* sp., *A. microcephalus*	Aysev, 1974; Hoberlandt, 1955; Çağlar, 1992
Microplax interrupta (Fb., 1836)	*Astragalus* sp., *A. microcephalus*	Hoberlandt, 1955; Çağlar, 1992
Megalonotus prpraetextatus (H.-S., 1835)	*Astragalus* sp.	Hoberlandt, 1955
Nysius graminicola ssp. *graminicola* Klt., 1845	*A. microcephalus*	Çağlar, 1992
Rhyparochromus phoeniceus (R., 1794)	*Astragalus* sp., *A. microcephalus*	Kıyak, 1990; Çağlar, 1992
Rhyparochromus immaculatus (Ry., 1920)	*A. microcephalus*	Çağlar, 1992
Syngnocorisella mayeti (Pt., 1879)	*Astragalus* sp.	Seidenstücker, 1958
Piocoris erythrocephalus (P.& S., 1825)	*Astragalus* sp.	Çakır, 1988
PENTATOMIDAE		
Agatharchus linea (K., 1845)	*Astragalus* sp.	Seidenstücker, 1960
Aelia henschi (Mtd., 1886)	*Astragalus* sp.	Kıyak, 1990
Aelia rostrata Boh., 1852	*A. microcephalus*	Çağlar, 1992
Codophila absinthii (Wgn., 1952)	*Astragalus callichorus*	Hoberlandt, 1955
Cnephosa flavomarginata Jak., 1880	*Astragalus* sp.	Kıyak, 1990
Carpocoris fuscispinus (Bh., 1851)	*Astragalus* sp.	Hoberlandt, 1955
Eurygaster ntegriceps Pt. 1881	*Astragalus* sp.	Abbas, 1990
Eurygaster maura (L., 1758)	*A. microcephalus*, *Astragalus* sp.	Çağlar, 1992; Abbas, 1990
Graphosoma lineatum ssp. *italicum* (Ml., 1766)	*A. microcephalus*	Çağlar, 1992
Jalla dumosa (L., 1758)	*A. microcephalus*	Çağlar, 1992
Mustha spinosula (Lef., 1831)	*A. microcephalus*	Çağlar, 1992
Odontoscelis fuliginosus (L., 1761)	*Astragalus* sp.	Kıyak, 1990
Odontotarsus karatasensis Hob., 1956	*Astragalus* sp.	Kıyak, 1990
Odontotarsus purpureo-linneatus (R., 1790)	*A. microcephalus*	Çağlar, 1992
Odontoscelis.seminitens Wgn., 1953	*Astragalus* sp.	Hoberlandt, 1955
Piezodorus lituratus (F., 1794)	*Astragalus* sp.	Kıyak, 1990
Rhombocoris regularis (H.- S., 1851)	*Astragalus* sp.	Seidenstücker, 1960

Sciocoris cursitans ssp. *cursitans* (F., 1794)	*Astragalus* sp.	Kıyak, 1990; Hoberlandt, 1955
Sciocoris ressli Wgn., 1966	*A. microcephalus*	Çağlar, 1992
Sciocoris umbrinus (W., 1804)	*Astragalus* sp.	Hoberlandt, 1955
Sciocoris luteolus Fb., 1861	*A. microcephalus*	Çağlar, 1992
CYDNIDAE		
Sehirus melanopterus (H.-S., 1885)	*A. microcephalus*	Çağlar, 1992
Sehirus dubius (Scop., 1763)	*Astragalus* sp.	Hoberlandt, 1955
Ochetostethus nanus (H.-S., 1834)	*Astragalus* sp.	Hoberlandt, 1955; Lodos & Önder, 1980
PLATASPIDIDAE		
Coptosoma maurum Vid., 1939	*Astragalus* sp.	Seidenstücker, 1960

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REPELLING PERFORMANCE OF DIFFERENT UMBELLIFER CROP IN REDUCING BRINJAL SHOOT AND FRUIT BORER INFESTATION ON BRINJAL

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ABSTRACT: Repelling performance of some selected umbellifer crop in reducing BSFB infestation on brinjal was studied during 2004-2005 at the experimental farm of Bangabandhu Shiekh Mujibur Rahman Agricultural University, Gazipur. It was observed that all the repellent crop reduce shoot fruit infestation. Significantly lowest number of shoot and fruit infestation (2.56%,34.65%)) was found when brinjal grown with soluk (*Peucedanum graveolens*). Generally a higher number of spider (1.59) and lady bird beetle (4.55) were found in crop association with umbellifer in comparison to brinjal monoculture.

KEY WORDS: Repelling performance, umbellifer crop, brinjal, India

Among the Solanaceous vegetables brinjal is one of the most popular and principal vegetables crops in Bangladesh. It is also a popular in other countries of the world. The brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) is one of the most destructive pest of brinjal in Bangladesh (Alam, 1969) and India (Tewari & Sandana, 1990) and also a major pest in the other countries of the world (Dhankar, 1988). It is very active during the rainy and summer seasons and often causes more than 90% damage (Ali et al., 1980; Kalloo, 1988). The yield loss has been estimated up to 86% (Ali et al., 1980) and 67% (Islam & Karim, 1991) in Bangladesh and up to 95% (Naresh et al., 1986) and 63% (Dhankar et al., 1977) in Haryana, India. For the management of this pest brinjal grower of Bangladesh mostly depends on chemical insecticides. Traditionally insect pest are controlled by insecticide but the indiscriminate use of insecticide creates several adverse effects such as development of resistance, outbreak of secondary pests (Hagen & Franz, 1973), health hazards (Bhadhury et al., 1989) and environmental pollution (Kavadia et al., 1984). Moreover it leads a negative effects on natural enemies and other beneficial and disrupting biodiversity. Among the non chemical control measures although references on abiotic factors, such as relative humidity, rainfall, temperature, fertilizer etc. and biotic factor such as parasitoid and pathogen (Alam et al., 1969) were available only. Some progress in the host plant resistance research against this pest has been achieved (Dhanker, 1988). But it has not yet been to formulate any effective management strategy for the pest. As such chemical control measure has remained as the key control tectice BSFB. Simmonds et al. (1992) reported plants with anti-feedant activities. Among them, *Allium* spp. are reportedly very effective. Kirtikar & Basu (1975) reported that onion, garlic, coriander (*Coriandrum sativum* L.) have also strong pungent repellent action.

Intercropping of tomato (Annon., 1985; Roltsh & Gage, 1990), garlic (Annon., 1985; Halepyatic et al., 1987), onion and ginger (Chowdhury 1988) with different crops have been reported to reduce the population of different target pests. Hussain & Samad (1993) reported that intercropping chili with brinjal reduces the population of *Aphis gossypii* in brinjal. Umbellifer crop has strong pungent repellant action. Presence of umbellifer crop within the row of target crop produces masking effect. So the BSFB become confused for selecting its host. Repelling performance of umbellifer except coriander for reducing of BSFB has never been evaluated. So the present study was under taken with the following objectives:

1. to observe the performance of different umbellifer crop in reducing BSFB infestation and
2. to identify best umbellifer crop against BSFB management.

MATERIALS AND METHODS

The study was conducted at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur from September 2004 to March 2005. Umbellifer were used in this experiment are Coriander (*Coriandrum sativum*), Radhuni (*Carum roxburghianum*), Soluk (*Peucedanum graveolens*), Mouri (*Foeniculum vulgarae*) and brinjal variety BARI brinjal -1 was used for the study. Intercrop combination of Brinjal+Coriander, Brinjal+Radhuni, Brinjal +Soluk, Brinjal +Mouri and sole brinjal were considered as treatments. The design was RCBD with 3 replications. The unit plot size was 3m X 3m. The distance between plots and block was .5 m and 1 m, respectively. After establishment of brinjal (25 DAT) all the umbellifer seeds were shown in a line between brinjal row continuously. All intercultural operation and crop management were done following standard horticultural practices.

Data Collection

After the incidence of brinjal shoot and fruit borer 5 plants were randomly selected in each plot for observing the number of infested shoot healthy shoot at every 7 days interval and data on the number of infested fruit and healthy fruit were recorded per plot per treatment. At harvested data on the number of healthy and infested fruits ansd their weight were recorded separately per plot. The cumulative healthy, infested and total fruit yield per plot was calculated. Natural enemies roaming in the plot were counted at the same time.

Data were analyzed by MSTAT-C softwere and discussed the results through interpretation. The data recorded on different parameters were subjected to ANOVA and the means were comparedusing LSD test at 5% level of significance.

RESULTS AND DISCUSSION

The results on the effect of repellent crop with Radhuni , Soluk, Mouri and Coriander with brinjal compared to its monoculture sole brinjal on insect pest particularly brinjal shoot and fruit borer and its natural enemies complex are presented and discussed under the following sub-headings:

Infestation of brinjal shoot by BSFB

The comparative effectiveness of various repellant crop on percent shoot infestation by BSFB has been evaluated in terms of their efficiency in reducing the shoot infestation over control is presented in Table (1.1). Significantly, the lowest number of shoot infestation (2.56) by BSFB in brinjal plant was recorded in brinjal+Soluk plot (Table 1.1) which is statistically similar to all other repellant crop. On the other hand, the highest number of shoot infestation (6.59) by BSFB was recorded where brinjal grown alone. In terms of percent shoot infestation reduction over control , brinjal+soluk had 61.15% reduction in shoot infestation followed by 58.11 % and 40.44% in brinjal+Coriander and brinjal+ radhuni, respectively.

Infestation of brinjal fruit by BSFB

The comparative effectiveness of various repellant crop on percent fruit infestation by BSFB has been calculated in terms of percent fruit infestation by number and weight as well as the percent reduction infestation over control (Table 1.1). The lowest fruit infestation by number (34.65%) and weight 30.01% recorded from the plots of brinjal+soluk they were significantly different from that of brinjal monoculture plot. However the highest fruit infestation by number (62.32%) and by weight 57.59% was observed in brinjal when grown as sole crop. In terms of reduction in fruit infestation over control, brinjal+soluk planted plots provided the highest reduction in fruit infestation (44.39%) by number and 47.89% by weight over the untreated control. This was followed by those of brinjal + coriander (32.62%), brinjal+mouri (32.04%) and brinjal +radhuni (30.76%) planted plot in respect of reduction in fruit infestation by weight.

Umbellifer repellant crop grow with brinjal and its effect on the yield performance of brinjal

Effect of different treatment consisting of brinjal grown with various umbellifer on total fruit yield , healthy fruit yield and BSFB infested fruit yield on the basis of number and weight of fruit per plant was evaluated and presented in Table 1.2 and 1.3. The highest number of infested fruit per plant was recorded in brinjal sole (44.00) followed by brinjal + Radhuni (32.44) (Table1.2). Result showed that significantly the lowest (20.00) fruit infestation was observed when brinjal grown with soluk. Fruit infestation by weight ranged from 1.30 kg to 0.59 kg (Table 1.3) and followed a similar trend with that of infestation by number (Table 1.2). The percent reduction of infestation by weight over sole brinjal was the highest in brinjal + soluk (54.61%) planted plots followed brinjal + coriander (43.85%) and the lowest was recorded from brinjal + radhuni (26.15%) planted plots (Table 1.3).

The incidence of brinjal shoot and fruit borer in presence of repellant crop with brinjal plot in the present study is in conformity with the findings of several studies conducted elsewhere. Kartikar & Bashu (1975) reported that onion garlic, coriander have strong pungent repellant action on different insect pest. Lal (1991) revealed that the larval infestation of *Phthorimea operculella* on potatoes were consistently reduced when potatoes were grown with chillies, onion and peas compared to potato alone.The present study the brinjal shoot and fruit damage due to BSFB infestation was less in brinjal when grown with repellant crop such as soluk, radhuni, mouri and coriander compared to that of brinjal grown alone. Rabindra & Prashad (2001) observed significant reduction of the incidence of shoot and fruit borer when brinjal was grown in association with Marigold. Percent shoot damage was 15.60 in brinjal +Marigold planted plots compared with 22.86% in the brinjal monoculture. In all the repellant crop of the present study, the abundance of BSFB was lower as compared to brinjal monoculture which might be due to physical barriers to insect movement, plant quality affected by repellant crop, adverse environmental factors or less abundance of food sources etc.

Effect of different umbellifer crop on the abundance of natural enemies

Effect of different umbellifer crop on the abundance of natural enemies in brinjal crop has been observed per plant in each crop combination during the entire crop period and are presented in Table 1.4. The mean number of spider per plant differed significantly among the treatments. The highest incidence of spider was observed in brinjal when grown with soluk (1.59) followed by brinjal+Radhuni (1.54) (Table 1.4). Significantly lower number of spider were observed in brinjal sole.The mean number of lady bird beetle per plant recorded from different crop combinations are also shown in Table 1.4. The highest number of lady bird beetle recorded in brinjal +Soluk (4.55) followed by brinjal + coriander (4.33) and lowest in brinjal alone (1.54) other crop association also found statistically similar number of LBB.

It is evident from Table 1.4 that generally a higher number of spider and LBB were found in multicrop situation in comparison to that of monocrop. This might be due to the fact that diversity of plant species provided important resources for natural enemies such as alternate prey, necter and pollen or breeding site as pointed by Russel (1989). Dampster and Choker (1974) found that the predatory activities of ground beetles were enhanced when cabbage was under shown with white and red clover resulting in regulation of population of *Erioschia brassicae* and *Pieries rapae*.

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Table 1.1.Different umbellifer crops grown with brinjal and its effect on shoot and fruit infestation of brinjal by brinjal shoot and fruit borer during December (2004) through February (2005).

Treatments	Shoot infestation (%)	Shoot infestation reduction over control (%)	Fruit infestation (%)		Reducing fruit infestation over control (%)	
			By number	By weight	By number	By weight
Brinjal (control)	6.59a (2.55)		62.32a (7.88)	57.59a (7.57)		
Brinjal + Radhuni	3.91ab (1.97)	40.44	45.44b (6.74)	39.87b (6.31)	27.08	30.76
Brinjal + Soluk	2.56b (1.59)	61.15	34.65b (5.88)	30.01b (5.48)	44.39	47.89
Brinjal + Mouri	4.88ab (2.18)	25.94	42.35b (6.49)	35.35b (5.93)	32.04	38.61
Brinjal + Coriander	2.76b (1.66)	58.11	41.99b (6.48)	38.10b (6.17)	32.62	33.84

Figures in the column bearing the same letter (s) are not significantly different at 5% level using Least Significant Difference test (LSD)
Values are means of three replications.
Values within parentheses are the transformed values based on Square root transformation {$\sqrt{(x + 0.5)}$}.

Table 1.2.Different umbellifer crops grown with brinjal and its effect on the yield. Performance of brinjal suppressingBSFB infestation by number during winter 2004.

Treatments	Number of fruit per plant			Healthy fruit (%)	Reduction of fruit infestation over control
	Healthy	Infested	Total		
Brinjal (control)	26.00b	44.00a	70.00	37.14	
Brinjal + Radhun	35.27ab	32.44ab	67.71	52.09	26.27
Brinjal + Soluk	43.00a	20.00b	63.00	68.25	54.54
Brinjal + Mouri	36.24ab	28.89b	65.13	55.64	34.34
Brinjal + Coriander	33.16ab	24.64b	57.80	57.37	44.41

Figures in the same column bearing the same letter(s) are not significantly different at 5% level using Least Significant Difference test (LSD)
Values are means of three replications.

Table 1.3. Different umbellifer crops grown with brinjal and it effect on yield performance of brinjal by weight during winter 2004.

Treatment	Weight of fruit per plant(kg)			Yield increase over control	Reduction of fruit infestation over control
	Healthy	Infested	Total		
Brinjal (control)	0.77b	1.30a	2.06		
Brinjal + Radhuni	1.04ab	0.96ab	1.99	35.06	26.15
Brinjal + Soluk	1.27a	0.59b	1.86	64.93	54.61
Brinjal + Mouri	1.07ab	0.85b	1.92	38.96	34.62
Brinjal + Coriander	0.98ab	0.73b	1.71	27.27	43.85

Figures in the same column having the same letter(s) are not significantly different at 5% level using Least Significant Difference test (LSD)
Values are means of three replications.

Table 1.4. Umbellifer crops grown with brinjal and its influence on the incidence of natural enemies of brinjal shoot and fruit borer during winter 2004.

Treatment	Number of natural enemies recorded per plant	
	Spider	Lady bird beetle
Brinjal sole (control)	0.53b	1.54b
Brinjal + Radhuni	1.54a	3.29ab
Brinjal + Soluk	1.59a	4.55a
Brinjal + Mouri	0.88ab	4.04ab
Brinjal + Coriander	1.04ab	4.33a

Figures in the same column accompanied by the same letter(s) are not significantly different at 5% level usingLeast Significant Difference test (LSD)
Values are means of three replications.

OCCURRENCE AND PREVALENCE OF SIX HONEY BEE VIRUSES IN HAKKARI (TURKEY) AND THEIR GENOMIC DIVERGENCE

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ABSTRACT: A survey study was conducted to establish the occurrence and prevalence of *Black queen cell virus* (BQCV), *Deformed wing virus* (DWV), *Sacbrood virus* (SBV), *Chronic bee paralysis virus* (CBPV), *Kashmir bee virus* (KBV) and *Israeli acute paralysis virus* (IAPV) in traditionally beekeeping sites of Hakkari province (Turkey). Including the central Hakkari, the districts of Cukurca, Semdinli and Yuksekova were surveyed to assess the types of symptoms and the severity of the diseases of honey bees in a total of 90 apiaries. The presence of BQCV, DWV, SBV and CBPV infections were ascertained for the first time by RT-PCR. BQCV was found in three sampled districts and was the most frequently detected virus, found in 32% of bee samples. Less than 24% of asymptomatic bee samples were positive for DWV, SBV and CBPV with the infection ratio of 23, 12 and 9%, respectively. The samples showing deformed wing symptoms were always reacted positive for DWV. During this survey, KBV and IAPV were not detected in any of tested bee samples. Some double and triple infections were encountered: BQCV+DWV 7 (7.7%), BQCV+SBV 4 (4.4%), BQCV+CBPV 2 (2.2%), DWV+CBPV 2 (2.2%), DWV+SBV 1 (1.1%) and DWV+BQCV+SBV 1 (1.1%). The overall incidences of detected viruses (BQCV, DWV, SBV and CBPV) were lower than the other records of various sites of the world. Based on blast analysis at NCBI database, the cloned nucleotide sequences of Hakkari's isolates of BQCV, DWV, SBV, and CBPV have been showed varied nucleic acid similarities between 77-99%.

KEY WORDS: *Apis mellifera,* Hakkari province, molecular characterization, RNA viruses, RT-PCR

Single-stranded RNA viruses, infecting honeybee, have been considered one of the most important factors that may play a role in honeybee mortality as well as the presence of bacteria, fungi, protozoa, parasitic mites or exposure to pesticides used in agriculture (Bailey & Ball, 1991; Suchail et al., 2004; Ellis & Munn, 2005). Twenty-four viruses have been described that affect honeybee (*Apis mellifera* L.) including *Black queen cell virus* (BQCV), *Deformed wing virus* (DWV), *Sacbrood virus* (SBV), *Chronic bee paralysis virus* (CBPV), *Kashmir bee virus* (KBV) and *Israeli acute paralysis virus* (IAPV) (de Miranda et al., 2013)). Among them, the only three (DWV, SBV, and CBPV) would produce clinical symptoms that can be easily recognizable. Honeybee RNA viruses have been detected on a global scale and are common in many countries and continents including Europe (Tentcheva et al., 2004), South America (Antunez et al., 2005), Australia (Anderson and Gibbs, 1988), USA (Chen et al., 2004a), South Africa (Benjeddou et al., 2002) and Asia (Christian et al., 2005). In general, they cause inapparent, symptomless infections in honeybee and therefore, often go undetected (Bailey, 1967).

In Turkey, traditional beekeeping is one of the oldest practices carried out by beekeepers in Hakkari province and some other localities. Cylindric long hives are typically used to produce bee products (e.g. honey) in the region. Recently, mortality of honeybees has been considered one of the most serious problems that Hakkari's beekeepers face periodically. There are very limited number of reports about viral honeybee diseases in Turkey. Up to date, the presence of *Acute bee paralysis virus* (Rüstemoğlu & Sipahioğlu, 2016), *Deformed wing virus* (Gülmez et al, 2009), *Chronic bee paralysis virus*, *Black queen cell virus* (Gümüşova et al., 2010) and *Israeli acute paralysis virus* (Özkırım & Schiesser, 2013) were reported to infect honeybees.

With this study, we screened the apiaries in Hakkari for the presence of DWV, KBV, IAPV, CBPV, BQCV and SBV by reverse transcription-PCR (RT-PCR). For each detected virus species, one isolate was selected for cloning and sequencing to investigate the virus genetic diversity.

MATERIALS AND METHODS

Survey and sample collection

From surveyed 90 apiaries, a total of two hundred seventy honeybee samples from different districts of Hakkari province (central Hakkari, Yuksekova, Semdinli and Cukurca) of Turkey were randomly collected during May to August 2014. The honeybee samples exhibiting deformed wing, shortened abdomen, discoloration, flightless, blackening, paralysis etc. were also collected for virus detection. The honeybee samples were transported on ice, then frozen at -86 °C until processed. Honeybees known to be infected with BQCV, DWV, SBV and CBPV from preliminary tests were used as positive controls for diagnosis of viruses. Genomic RNA from a healthy honeybee sample was served as negative control.

RNA isolation

A modified silica-capture procedure was adapted for the isolation of honeybee total RNA (Foissac et al., 2001). Honeybee samples were homogenized in a pre-cooled sterile mortar in the presence of 1 ml of grinding buffer (4.0 M guanidine thiocyanate, 0.2 M NaOAc, 25 mM EDTA, 1.0 M KOAc, 2.5% PVP-40, 1% 2-mercaptoethanol). Aliquots of 500 µl of the extract were mixed with 100 µl of 10% sodium lauryl sarcosyl solution in a new set of sterile microfuge tubes and centrifuged at 14,000 rpm with a refrigerated centrifuge for 10 min. Then, 300 µl of the supernatant were transferred to a new sterile tube containing 150 µl of ethanol, 100 µl of resuspended silica and 300 µl of 6 M sodium iodide. After centrifugation at 6,000 rpm for 1 min, the supernatant was discarded and the pellet washed twice with washing buffer. The pellet was resuspended with 150 µl of RNase-free water and incubated for 4 min at 70 °C, followed by a centrifugation at 14,000 rpm for 3 min. The supernatant was transferred to a new sterile tube and stored at –20 °C until use.

Construction of gene specific primers and RT-PCR

Coat protein (CP), RNA dependent RNA polymerase (RdRp) or non-structural protein gene specific primers for DWV, BQCV, CBPV, SBV, IAPV, and KBV were designed based on the published nucleotide sequences in GenBank (GenBank Accession No. NC_004830.2, NC_003784, NC_010711, AY626247, KC690270, NC_004807, respectively). A web based program (Primer 3: http://www-genome.wi.mit.edu/cgi-bin/primer/primer3_www.cgi) or Vector NTI software (Invitrogen) were implemented to select the best primer pair for each target honeybee virus. The designed primers used in the study are shown in Table 1. Reverse transcription of purified RNA was performed using a commercial cDNA kit (Fermentas) according to the manufacturer's recommendations. PCR was performed in a final volume of 25 µl containing 2.5 µl of 10x buffer (100 mM Tris-

HCl (pH 8.8.), 500 mM KCl, 0.8% Nonidet (octyl phenoxypolyethoxylethanol) P40), 1.5 µl 2.5 mM of $MgCl_2$, 0.5 µl 20 mM of each primer, 0.5 µl of 10 mM dNTP mix (containing 10 mM of each), 0.2 µl of enzyme, 1 µl of cDNA, 18.3 µl of sterile RNAse free water. The RT-PCR cycling program of each virus are shown in Table 1. The all reactions were performed using an Eppendorf Mastercycler and products were visualized by electrophoresis in 1% (w/v) agarose gels stained with ethidium bromide (Sambrook et al., 1989).

Molecular cloning and sequencing of partial CP, non-structural protein and RdRp genes

For each detected virus species, an isolate was randomly selected for molecular cloning and sequencing. PCR amplified fragments were separated on 1% agarose gel and recovered using a GeneJET Gel Extraction Kit (Thermo Scientific) according to the manufacturer's recommendations. The purified DNA fragments were ligated into the pGEM®-T Easy vector (Promega). The constructed plasmid was used to transform *Escherichia coli* JM 109 competent cells to ampicillin resistance by electroporation (BioRad, USA). The transformants harboring the DNA of the isolates were selected by blue-white selection on X-gal medium plate and screened as positive clones by colony PCR. The clones containing the four viruses related genes were selected for propagation. For each virus one clone was chosen for DNA sequencing. The cDNA clones were sequenced bidirectionally by automated DNA sequencer at Refgen Research and Biotechnology Company (Turkey).

Phylogenetic analysis of honeybee viruses

To create phylogenetic trees, sequences corresponding to amino acids of the RdRp, non-structural protein and CP domain were used to establish phylogenetic relationships of honeybee viruses. Based on non-structural protein, RdRp and CP gene sequences, the phylogenetic relationships among strains of the honeybee viruses and other close groups available in NCBI (http://www.ncbi.nlm.nih.gov/gquery/gquery.fcgi) were initially assessed using BLAST. The sequences of viruses were aligned by using MEGA7 and CLC Main workbench 6.6.1 software and the cladistic analyses were performed by using MEGA7. The relationships were assessed using 1000 bootstrap replicates. The phylogenetic tree was created using Neighbor-Joining method from sequences of honeybee viruses and sequences of other 4 distinct honeybee viruses studied in this work.

RESULTS

Out of 90 apiaries examined, symptomatic individuals were encountered showing deformed wing induced by DWV and shortened abdomens, discoloration, flightless, blackening, paralysis induced by other bee viruses (Figs. 1a,b). The presence of DWV was easily distinguished by clinical symptoms. Almost all symptomatic individuals were reacted positive for DWV or co-infected with more than one virus in RT-PCR tests. However, DWV was also detected in individuals without symptoms.

Singular viral infections

Here, we demonstrate the successful use of RT-PCR to detect honeybee viruses in the apiaries of Hakkari. The method used in this study for detection of honeybee viruses was rapid, reliable and useful for large scale epidemiological studies. In total, 90 apiaries were examined for the presence of six viruses (DWV, BQCV, CBPV, IAPV, KBV and SBV). Gene specific primers of DWV (non-structural protein), BQCV (CP gene), IAPV (CP gene), SBV (CP gene), CBPV (RdRp gene) and KBV (CP gene) were used in uniplex-RT-PCR tests targeting to generate 488, 567, 402, 429, 434 and 339 bp respectively. Based on uniplex-RT-PCR results, singular and mixed virus infections were encountered in collected bee samples. The viruses detected were DWV, BQCV, CBPV, and SBV. However, KBV and IAPV were not detected in any of the samples tested. The frequencies of the detected viruses were varied. During our survey, the most prevalent virus in tested bee populations was BQCV. The virus occurred in only three surveyed areas including central Hakkari, Semdinli and Yuksekova and in 32% of all samples (Fig. 2). This was followed by DWV (23%), SBV (12%), and CBPV (9%) (Table 2).

Multiple virus infections

Based on RT-PCR test results, multiple infections were commonly detected in a single bee sample. In Table 2, the number and combinations of multiple infections are shown. Almost 18% of the samples were infected by dual infections. Nearly 8% of the samples were infected by BQCV and DWV, 4% were BQCV and SBV, 2% were BQCV and CBPV, 1% were DWV and SBV and 2% were DWV and CPBV. One triple infection (DWV+BQCV+SBV) was also recorded. Among dual infections, the combination of BQCV and DWV infections was observed with the highest frequency (8%).

Genetic variation

The nucleotide sequences of virus-encoded RdRp, CP and non-structural protein gene were used to create multiple alignments. As shown in phylogenetic trees the compared individual virus species were exhibited high levels of sequence similarity for compared genes (Figs. 3A,B,C,D). For RdRp and CP genes, DWV formed a group with *Varroa destructor virus* 1 (VDV-1) and SBV with bootstrap values of 73% and 81%, respectively. The all compared viral sequences exhibited high levels of sequence similarity for all genes. SBV and DWV formed a separate group along with VDV-1, IAPV, KBV and ABPV.

In comparing CP gene, DWV, SBV, Slow bee paralysis virus (SBPV) and VDV-1 formed a separate group in the phylogenetic tree. In the group, DWV and VDV-1were more related one another than to SBV and SBPV (Fig. 3A). The major functional domains associated with the CP, RdRp and non-structural protein gene can be readily identified.

DISCUSSION

In this study, we have screened the honeybee apiaries in traditional beekeeping areas of Hakkari, South East corner of Turkey, using reverse transcription-PCR (RT-PCR) method, for the presence of 6 honeybee viruses and analyzed selected isolates for viral genetic diversity. We have demonstrated that virus infections in honey bees are widespread among honeybees in nature of Hakkari, as we detected BQCV, DWV, SBV and CBPV in Hakkari's apiaries. This is the first report of these four viruses in Hakkari province. Almost all symptomatic samples from surveyed localities were infected with at least one virus or co-infected with more than one. In many cases, these viruses were also detected in bee samples without symptoms. In total, 35.5% of apiaries were positive for a single infection, approx. 18% a double infection, approx. 1% a triple infection and 54% at least with one infection.

BQCV was the most prevalent virus, with 32.2% of colonies screened being positive for the presence of this virus. It was present in every district of Hakkari, except in Cukurca. Total frequency of BQCV has been less then France 86% (Tentcheva et al., 2004), Uruguay 91% (Antunez et al., 2006), Brazil 37% (Weinstein-Teixeira et al., 2008) but, more than Austria 30% (Berenyi et al., 2006), the Eastern Black Sea Region of Turkey 21.4% (Gümüşova et al., 2010), Spain 10.4% (Antunez et al., 2012), England 1.4% (Baker & Schroeder, 2008) and Denmark 1% (Nielsen et al., 2008). Although DWV was the most abundant virus in the other places of the world, it was the second abundant virus in Hakkari, being found in 23.3% of the apiaries. It was detected in every surveyed district of Hakkari. The virus was highly prevalent particularly in samples from central Hakkari. In the world, DWV was recorded in varying incidences i.e. 33% in Thailand (Sanpa and Chantawannakul, 2009), 20.3% in Brazil (Weinstein-Teixeira et al., 2008), 18.6% in Spain (Antunez et al., 2012), 100% in Uruguay (Antunez et al., 2006), 97% in France (Tentcheva et al., 2004) and England (Baker and Schroeder, 2008), 92% in Jordan (Haddad et al., 2008), 91% in Austria (Berenyi et al., 2006) and 55% in Denmark (Nielsen et al., 2008). SBV was detected in 12.2% of apiaries which is less than Uruguay 100% (Antunez et al., 2006), France 86% (Tentcheva et al., 2004), Denmark 78% (Nielsen et al., 2008), Austria 49% (Berenyi et al., 2006). CBPV was found in 8.8% apiaries of Hakkari. This result is less than Uruguay 47% (Antunez et al., 2006), France 28% (Tentcheva et al., 2004) and the Eastern Black Sea Region of Turkey 25% (Gümüşova et al., 2010). In general, the frequencies obtained from this study are less than the frequencies found for the same viruses from other parts of the world. The real reason of differences in prevalence of bee viruses worldwide are not fully known. It may probably be related to bee management practices, topographic isolation and sample selection.

For each identified virus species, a virus isolate was randomly selected, and their partial genomes were characterized. For BQCV and SBV partial coat protein (CP) genes and for DWV and CBPV partial RdRp genes were characterized, cloned and sequenced. Virus sequence data generated were deposited in GenBank, (Accession No. KP835212 for SBV, KP835213 for BQCV, KP835214 for DWV, KP835215 and KP835216 for CBPV). Based on blast analysis at NCBI database, the sequences of Hakkari's isolates of BQCV, DWV and SBV have been showed varied nucleic acid similarities as 89-90%, 96-99%, and 77-90%, respectively. However, the nucleotide sequences of the PCR product of CBPV-Hakkari isolate was only 85-86% identical to the world CBPV isolates. Even though mono infections were more common than dual and triple infections in our study, a high level of dual infections was observed in sampled apiaries. Dual, triple and even quadruple infections of BQCV, DWV, SBV, and CBPV have been recorded by others (Anderson & Gibbs, 1988; Evans, 2001; Chen et al., 2004b).

The phylogenetic trees were created mainly from sequences obtained from recent isolates of bee viruses from different countries (Fig. 3). DWV was clustered with the members of the Iflavirus genus (Dicistroviridae). The basic genome organization of DWV, SBV, SBPV, and VDV-1 is typical for the Iflavirus genus. The particles of the members contain a single molecule of linear, positive sense, ssRNA and the 3'-end of the viral RNA is polyadenylated. All the obtained BQCV, SBV and CBPV sequences were exhibited high levels of variation, but each clustered into one cluster, involving the genus members which they belong to (Figs. 2B,C,D).

In the present work, we have provided evidence for four out of six different honeybee viruses as singular or multiple-infections in Hakkari, Turkey. The low incidence of infection levels of bees in Hakkari probably resulted from high *mountains* constitute the *several* ecozones for bees in the surveyed areas, restricting the flying of bees. Based on genomic sequences, the diversity of viruses in Hakkari was found high, in particular, CBPV. For better understanding of viral introduction, transmission, and viral fluctuations in bee populations, further studies need to be made, covering different types of insects around the apiaries and virus-vector mites in Hakkari. To control bee viruses, monitoring their prevalence and spread is vital.

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Table 1. Primers used in this study and the amplification target.

Primers (5'–3')	Product size (bp)/ Position at genome/
Deformed wing virus DWV-F (5'-TTGGTATGCTCCGTTGACTG-3') DWV-R (5'-ATTCCTCAGAAGTTGGTTTCG-3')	488/ Non-structural protein
Black queen cell virus BQCV-F (5'-GACAGCGTGCCAAAGAGAG-3') BQCV-R (5'-GCGAACCCGTCCAATACTTA-3')	567/ CP gene
Israeli acute paralysis virus IAPV-F (5'-TTGGCGTGCAACTATGTGTT-3') IAPV-R (5'-TCTTCTGCCCACTTCCAAAC-3')	402/ CP gene
Sacbrood virus SBV-F (5'-TATTCAGGGGGACGCTACAC-3') SBV-R (5'-AGTGCTGCTTGAAACCCTGT-3')	429/ CP gene
Chronic bee paralysis virus CBPV-F (5'-GCAAACTGCCCACCAATAGT-3') CBPV-R (5'-TGGTACGGAAGGTGTGTCAA-3')	434/ RdRp gene
Kashmir bee virus KBV-F (5'-CACATTCCGAACAATAA-3') KBV-R- (5'-GCGATAGGAATTTTGCGGTA-3')	339/ CP gene

Table 2. Virus infections encountered in honeybee samples of Hakkari.

Type of infection	**Detected virus(es)**	**Number of infected sample (Incidence of viral infection %)**
Mono infection	BQCV, DWV, SBV and CBPV	32 (35.5%)
	BQCV	15 (16.6%)
	DWV	10(11.11%)
	SBV	5 (5.5%)
	CBPV	4 (4.4%)
Dual infection	BQCV+DWV, BQCV+SBV, BQCV+CBPV, DWV+CBPV, DWV+SBV	16(17.7 %)
	BQCV + DWV	7 (7.7%)
	BQCV + SBV	4 (4.4 %)
	BQCV + CBPV	2 (2.2%)
	DWV + CBPV	2 (2.2%)
	DWV + SBV	1 (1.1%)
Triple infection	DWV + BQCV + SBV	1 (1.1%)

a) b) c)

Figure 1. Deformed wing symptom encountered in the field surveys a) under microscope and b) in the field, c) swollen abdomen induced by BQCV.

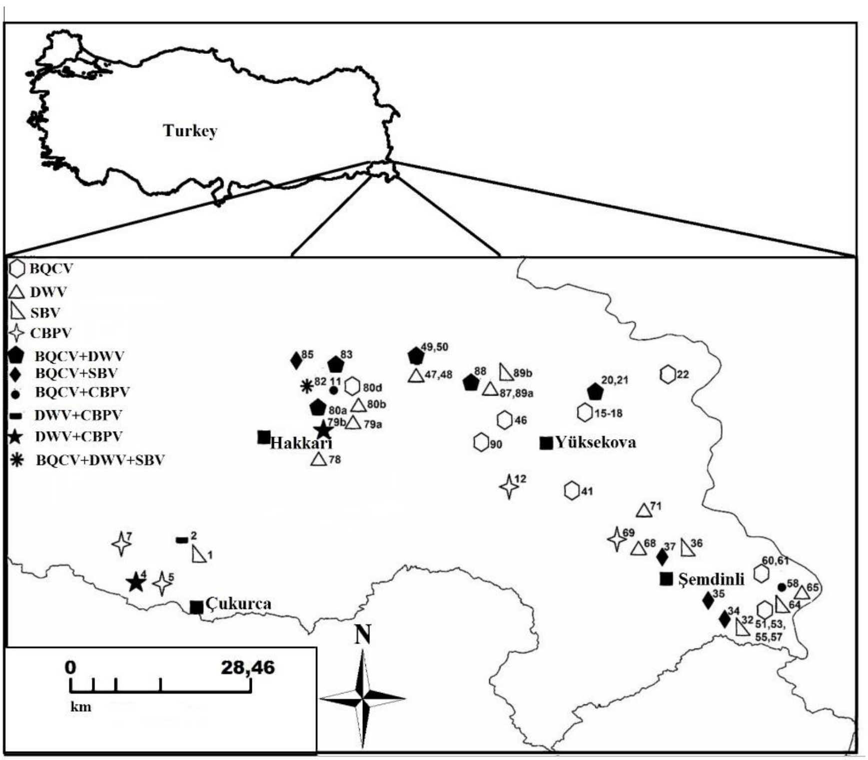
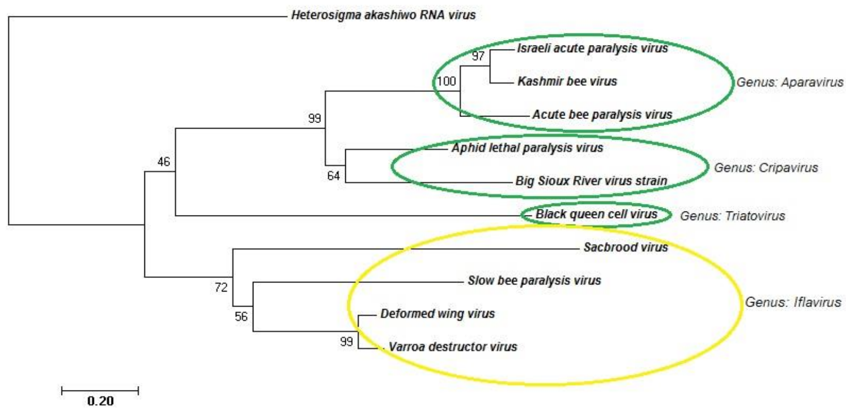
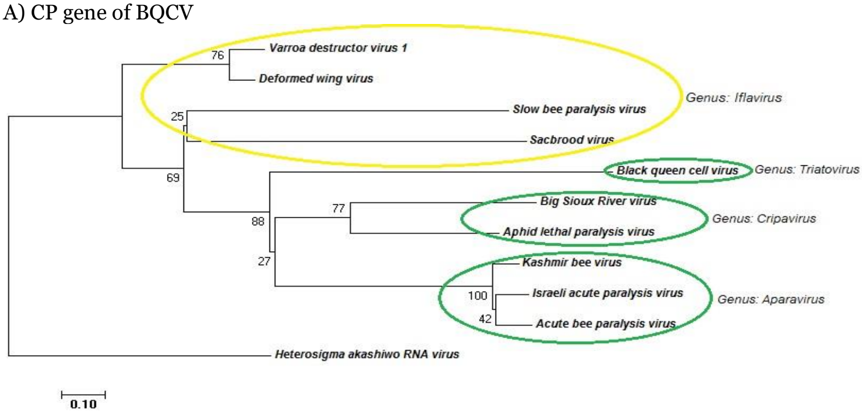


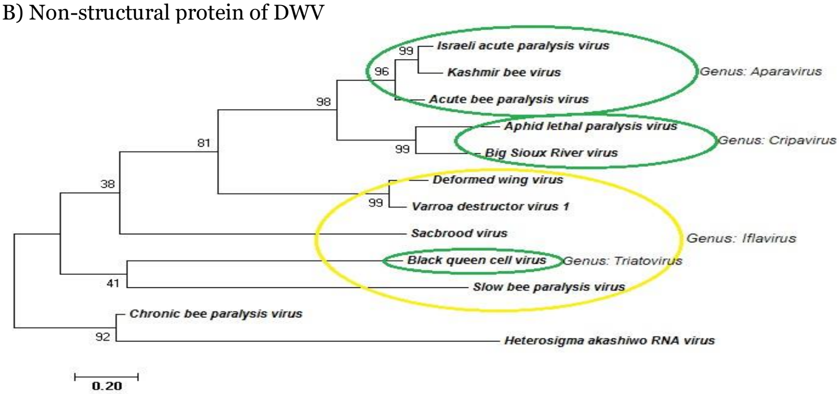
Figure 2. Hakkari province, located at the eastern Anatolia (Turkey), surveyed for the presence of bee-infecting viruses. Each symbol shows single and multiple virus infections and their combinations.



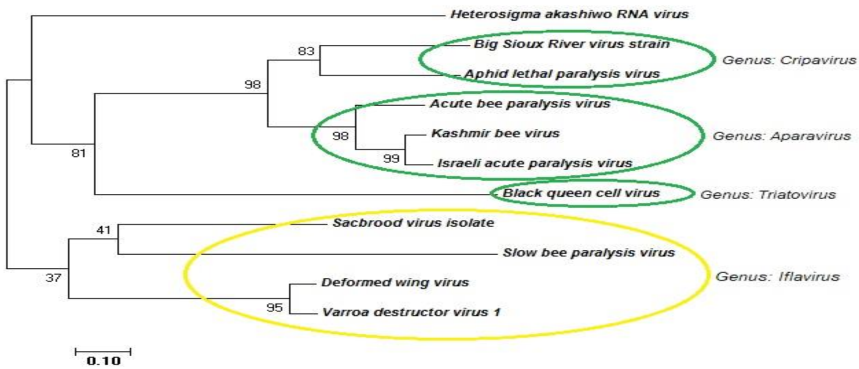
A) CP gene of BQCV



B) Non-structural protein of DWV



C) RdRp gene of CBPV



D) CP gene of SBV

Figure 3. Phylogenetic trees derived from the CP (A) BQCV, non-structural protein (B) DWV, RdRP (C) CBPV and CP (D) SBV sequences of the viruses. The sequences were aligned using the MEGA 7 software program. Neighbor-Joining method was used to create the phylogenetic relationship of viruses. *Heterosigma akashiwo RNA virus* was used as an outgroup to root the trees. Green and yellow hoops show Dicistroviridae and Iflaviridae respectively. Numbers at each node represent bootstrap values as percentages of 1000.

A CONTRIBUTION TO THE ICHNEUMONINAE (HYMENOPTERA: ICHNEUMONIDAE) OF TRABZON, TURKEY

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ABSTRACT: Thirty Ichneumoninae samples were collected from Black Sea Region (Trabzon, Ortahisar) during the summer period of 2017. A total of 11 species are recorded. Among them *Barichneumon fumipennis* (Gravenhorst, 1820) and *Centeterus rubiginosus* (Gmelin, 1790) are recorded for the first time from Turkey. For each species, individual diversity, geographical distribution, zoogeographical notes, hosts and associate plants data are summarized.

KEY WORDS: Hymenoptera, Ichneumonidae, Ichneumoninae, new records, Turkey, Trabzon

Turkey boasts a rich variety of landscapes, from its three coasts (bordering the Mediterranean, Aegean, and Black Seas) up to the mountains that reach 5137 meters in height. There are forests, shrub lands, large rivers, wetlands, and several mountain ranges. Turkey's unique position at the crossroads between Europe, Asia and Africa has provided an interesting mixture of species to populate these habitats (Gross, 2012).

Hymenoptera started to diversify around 281 million years ago (mya) (Peter et al., 2017). Today the order Hymenoptera (Fig. 1) (sawflies, wasps, ants, and bees) are one of four mega-diverse insect orders, comprising more than 153,000 described and possibly up to one million undescribed extant species (Grimaldi & Engel, 2005; Aguiar et al., 2013).

The taxonomy of the family Ichneumonidae is still poorly known. The family is highly diverse, containing 24,281 described species (Yu et al., 2016). Approximately 60,000 species are estimated to exist worldwide (Townes, 1969), though some estimates place this number at over 100,000. They are severely under sampled, and studies of their diversity typically produce very high numbers of species which are represented by only a single individual (Saunders & Ward, 2018; Fraser et al., 2008). Parasitoid wasps of the family Ichneumonidae are one of the most diverse and species-rich groups of organisms with a worldwide distribution (Spasojevic et al., 2018).

This is the second largest subfamily Ichneumoninae with about 437 genera and 4355 species in the world (Yu et al., 2016). Up to 1995, 65 Ichneumoninae species have been recorded (Kolarov, 1995).

Although the Ichneumoninae fauna of Turkey has been studied (Özdemir, 1996; Yurtcan et al., 1999; Çoruh et al., 2002; Özbek et al., 2003; Çoruh et al., 2005; Kolarov, 2007; Riedel, 2008; Çoruh & Kesdek, 2008; Çoruh & Özbek, 2008; Gürbüz et al., 2008; Riedel et al., 2010; Çoruh et al., 2011; Eroğlu et al., 2011; Riedel et al., 2011; Çoruh & Özbek, 2013; Özdan, 2014, Çoruh et al., 2014; Kolarov et al. 2014, Çoruh et al., 2016; Kolarov et al., 2016; Çoruh, 2017; Sarı & Çoruh, 2018; Riedel et al., 2018) these studies still has not enough. The number of Ichneumoninae species has reached 241 with the above valuable studies and this study.

This paper aim to contribute to the knowledge of Ichneumoninae species distribution in Turkey with new records.

MATERAL AND METHODS

Ichneumonids samples were collected by hand net in the period between June-August 2017 in the Black Sea Region (Ortahisar, Trabzon, Turkey) (Fig. 2).

Trabzon, historically known as Trebizond, is a city on the Black Sea coast of northeastern Turkey and the capital of Trabzon Province. Trabzon, located on the historical Silk Road, became a melting pot of religions, languages and culture for centuries and a trade gateway to Persia in the southeast and the Caucasus to the northeast.

Due to its spectacular nature and regular and plentiful rainfall Trabzon posesses a thick and abundant vegetation corner. Ortahisar, which is the largest district of the city, also has evidence that it is the oldest settlement with its historical and cultural heritage.

Our samples were collected from three different altitudes (150 m, 350 m, 700 m) by Ömer Selim Ercelep. Hazelnut gardens were preferred as the study area. Collected samples were transferred in to an aspirator and were killed ethyl acetate. Conventional standard methods (Çoruh & Özbek, 2008) were used for preparation of the samples. Material is preserved in Museum of Ataturk University, Erzurum (EMET). New records of species are marked by an asterisk (*). General distributions, hosts and associate plants of species were taken from Yu et al (2016).

Data on individual numbers, geographical and zoogeographical distributions of species are provided in tables (Tab. 1).

RESULTS

Family ICHNEUMONIDAE Latreille, 1802
Subfamily ICHNEUMONINAE Latreille, 1802

Anisobas hostilis (Gravenhorst, 1820)

Material examined: Trabzon: Ortahisar, Dolaylı, 150 m, 01.VIII.2017, 1 ♂.
Hosts: *Lacanobia suasa*, *Lycaena dispar*, *Lycaena dispar rutile*, *Lycaena virgaureae*, *Neozephyrus quercus*.
Associate plants: *Acer campestre*, *A. pseudoplatanus*, *Adonis vernalis*, *Anthriscus cerefolium*, *Chaerophyllum aromaticum*, *Chaerophyllum bulbosum*, *Ferulago sylvatica*, *Heracleum sphondylium*, *Rubus fruticosus*, *Salix fragilis*, *Thapsia villosa*.
Distribution of Turkey: Erzurum, Kars, Tekirdağ (Yurtcan et al., 1999; Özbek et al., 2003; Riedel et al., 2010, Çoruh et al., 2014; Çoruh, 2017, Sarı & Çoruh, 2018).
General Distribution: Europe, Algeria, Morocco, Turkey, Iran, Kazakhstan, Kyrgyzstan and Western China.

**Barichneumon fumipennis* (Gravenhorst, 1820)

Material examined: Trabzon: Ortahisar, Bostancı, 350 m, 04.VI.2017, 1 ♀.
New record for the Turkish fauna.
General Distribution: Europe.

******Centeterus rubiginosus* **(Gmelin, 1790)**

Material examined: Trabzon: Ortahisar, Bostancı, 350 m, 29.VI.2017, 1 ♀.
Hosts: *Argyresthia bergiella, Cydia pomonella, Diplolepis rosae, Glyphipterix thrasonella, Pyropteron muscaeformis.*
Associate plant: *Myrmica ruginodis.*
New record for the Turkish fauna.
General Distribution: Europe, Azerbaijan, Iran, Kazakhstan and Mongolia.

Cratichneumon viator **(Scopoli, 1763)**

Material examined: Trabzon: Ortahisar, Bulak, 700 m, 05.VI.2017, 1 ♂.
Hosts: *Abraxas grossulariata, Abraxas sylvata, Angerona prunaria, Atolmis rubricollis, Autographa gamma, Banchus hastator, Biston betularia, Brachionycha sphinx, Bupalus piniarius, Diprion pini, Ectropis crepuscularia, Ematurga atomaria, Eriogaster lanestris, Hylaea fasciaria, Hyphantria cunea, Hypomecis punctinalis, Leucoma salicis, Lymantria monacha, Macaria liturata, Macaria sexmaculata, Macaria signaria, Macaria truncataria, Melanchra persicariae, Orthosia miniosa, Panolis flammea, Pieris brassicae, Plusia festucae, Protoboarmia porcelaria.*
Associate plants: *Chaerophyllum aromaticum, Corylus avellana, Daucus carota, Ferulago sylvatica, Heracleum sphondylium, Inula helenium, Laserpitium latifolium, Listera ovata, Peucedanum oreoselinum, Pinus sylvestris, Rubus fruticosus, Vaccinium vitis-idaea.*
Distribution of Turkey: Bursa, Istanbul, Ordu, Rize (Fahringer, 1922; Kolarov, 1995, Kolarov et al., 2014; Kolarov et al., 2016; Çoruh, 2017).
General Distribution: Holarctic region.

Diadromus collaris **Gravenhorst, 1829**

Material examined: Trabzon: Ortahisar, Dolaylı, 150 m, 24.VIII.2017, 1 ♀.
Hosts: *Acrolepiopsis assectella, Lobesia botrana, Plutella xylostella, Brassica napus, Brassica oleracea, Brassica oleracea capitata.*
Associate plants: *Anthriscus sylvestris, Chaerophyllum aromaticum, Chaerophyllum bulbosum, Daucus carota, Heracleum sphondylium, Oryza sativa, Peucedanum oreoselinum.*
Distribution of Turkey: Ankara, Aydın, Erzurum, Kırşehir, Konya, Muğla, Rize, Yozgat (Avcı & Özbek, 1990; Özdemir, 1996; Çoruh et al., 2002; Kolarov et al., 2002; Özbek et al., 2003; Çoruh et al., 2013, Çoruh et al., 2014; Çoruh et al., 2016; Çoruh, 2017).
General Distribution: Afrotropical, Australasian, Palaearctic, Neotropical, Oceanic and Oriental Region.

Heterischnus anomalus **(Wesmael, 1857)**

Material examined: Trabzon: Ortahisar, Bulak, 700 m, 27.VI.2017, 1 ♂.
Host: *Plutella xylostella.*
Associate plant: *Heracleum sphondylium.*
Distribution of Turkey: Artvin, Erzurum (Özbek et al., 2003; Çoruh et al., 2014; Çoruh, 2017).
General Distribution: Europe and Turkey.

Heterischnus truncator **(Fabricius, 1798)**

Material examined: Trabzon: Ortahisar, Bostancı, 350 m, 02.06.2017, 1 ♂ 1 ♀; Bulak, 700 m, 12.VII.2017, 1 ♂ 2 ♀♀; Dolaylı, 14.VIII.2017, 4 ♀♀.
Hosts: *Alucita grammodactyla, Cnaemidophorus rhododactylus, Dalaca quadricornis, Emmelina monodactyla, Eriogaster lanestris, Heliothis viriplaca, Hyphantria cunea, Leucoma salicis, Marasmarcha lunaedactyla, Panolis flammea, Pterophorus pentadactyla.*
Associate plants: *Anethum graveolens, Daucus carota, D. carota sativus, Mentha* spp., *Oryza sativa, Rubus fruticosus, R. idaeus, Setaria glauca.*
Distribution of Turkey: Çanakkale, Isparta, Istanbul, Erzurum, Giresun, Trabzon, Rize (Kolarov, 1989; Kolarov, 1995; Kolarov et al., 1997; Yurtcan et al., 1999; Özbek et al., 2003; Çoruh et al., 2014; Kolarov et al., 2014; Özdan, 2014; Çoruh et al., 2016; Çoruh, 2017).
General Distribution: Europe, Azerbaijan, Turkey and Iran.

Oronotus binotatus (Gravenhorst, 1829)

Material examined: Trabzon: Ortahisar, Bostancı, 350 m, 02.VI.2017, 4 ♂♂ 1 ♀, 20.VII.2017, 1 ♂ 1♀; Dolaylı, 150 m, 04.VI.2017, 1♀, 07.VII.2017, 1♀. 01.VIII.2017. 1 ♂.
Distribution of Turkey: Ordu, Giresun, Trabzon (Çoruh et al., 2016).
General Distribution: Europe and Georgia.

Stenichneumon culpator (Schrank, 1802)

Material examined: Trabzon: Ortahisar, Bostancı, 350 m, 09.VII.2017, 1 ♂; Bulak, 700 m, 19.VI.2017, 1 ♂; Dolaylı, 150 m, 18.VI.2017, 1 ♂; 24.VIII.2017, 1 ♀.
Hosts: *Aporia crataegi*, *Autographa gamma*, *Euphydryas maturna*, *Euthrix potatoria*, *Mellicta athalia*, *Plusia festucae*, *Setina aurita*, *Trichiura crataegi*, *Trichoplusia ni.*
Associate plants: *Angelica sylvestris*, *Anthriscus sylvestris*, *Carum carvi*, *Chaerophyllum bulbosum*, *Corylus avellana*, *Daucus carota*, *Heracleum sphondylium*, *Laserpitium latifolium*, *Pastinaca; Pastinaca graveolens*, *Peucedanum oreoselinum*, *Poa pratensis*, *Quercus sessiliflora*.
Distribution of Turkey: Erzurum, Giresun (Riedel et al., 2010; Kolarov et al., 2014; Çoruh, 2017).
General Distribution: Holarctic region.

Tycherus fuscicornis (Wesmeal, 1845)

Material examined: Trabzon: Ortahisar, Dolaylı, 01.VIII.2017, 1 ♂.
Hosts: *Epiblema cirsiana*, *Olethreutes hercyniana.*
Associate plants: *Daucus carota*, *Heracleum sphondylium.*
Distribution of Turkey: Anatolia (Diller & Mark, 2014).
General Distribution: Europe, Turkey and Armenia.

Vulgichneumon deceptor (Scopoli, 1763)

Material examined: Trabzon: Ortahisar, Dolaylı, 24.VIII.2017, 1 ♂.
Host: *Callophrys rubi.*
Associate plants: *Acer pseudoplatanus*, *Adonis vernalis*, *Angelica* sp., *Anthriscus trichosperma*, *Chaerophyllum aromaticum*, *Daucus carota*, *Ferulago sylvatica*, *Foeniculum vulgare*, *Heracleum sphondylium*, *Medicago sativa*, *Melilotus indica*, *Pastinaca graveolens*, *Peucedanum oreoselinum*, *Scutellaria* sp.
Distribution of Turkey: Erzurum, Nevşehir, Trabzon (Özdemir,1996; Kolarov et al., 2014); Çoruh et al., 2014; Çoruh et al., 2011; Riedel et al., 2010; Çoruh, 2017).
General Distribution: Europe, Georgia, Turkey and Iran.

Zoogeographical notes

The zoogeographical characterization mainly follows the chorotype classification of the Near East fauna proposed by Taglianti et al. (1999). After investigation of the recent geographic distribution of the species listed above, they can be divided into the following groups:

1. Cosmopolitan range has *Diadromus collaris*.
2. Two species have Holarctic ranges – *Cratichneumon viator* and *Stenichneumon culpator*.
3. With Centralasian-Europeo-Mediterranean range is the species *Anisobas hostilis*.
4. Centralasian-European range has the species *Centeterus rubiginosus*.
5. With Turano-European ranges are two species – *Heterischnus truncator* and *Vulgichneumon deeptor*.

Most numerous are the species with European ranges. Here belong the species *Barichneumon fumipennis*, *Heterischnus anomalus*, *Oronotus binotatus* and *Tycherus fuscicornis*.

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Figure 1. Hymenoptera species.

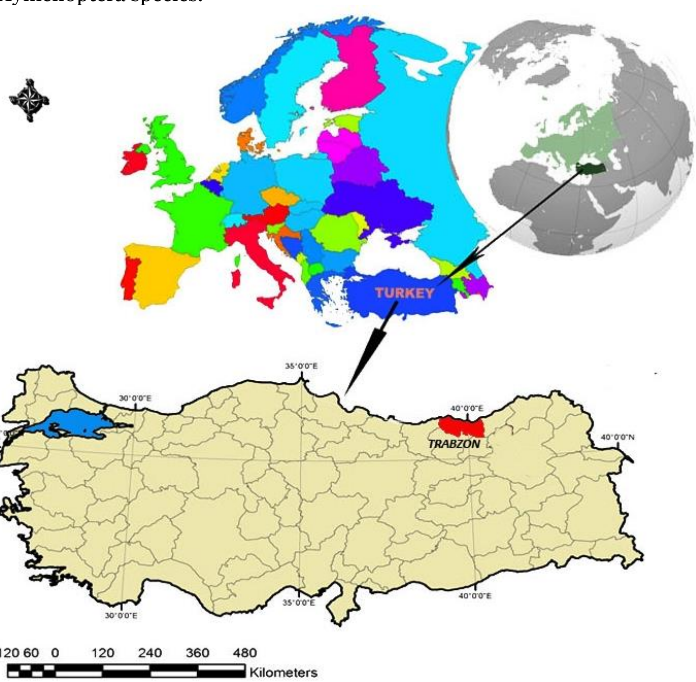

Figure 2. Study area.

Table 1. Faunistic evaluations of Ichneumonidae species.

Collected species from Trabzon, Ortahisar Village						
Name of species	IN ♂	IN ♀	Collected from locality	Distribution in Turkey	General Distribution	NR
SUBFAMILY: ICHNEUMONINAE LATREILLE, 1802						
Anisobas hostilis (Gravenhorst, 1820)	1		Dolaylı	Erzurum, Kars, Tekirdağ	Europe, Algeria, Morocco, Turkey, Iran, Kazakhstan, Kyrgyzstan and Western China	
**Barichneumon fumipennis* (Gravenhorst, 1820)		1	Bostancı	**New record for the Turkish fauna.**	Europe	X
**Centeterus rubiginosus* (Gmelin, 1790)		1	Bostancı	**New record for the Turkish fauna.**	Europe, Azerbaijan, Iran, Kazakhstan and Mongolia	X
Craticheumon viator (Scopoli, 1763)	1		Bulak	Bursa, Istanbul, Ordu, Rize	Holarctic region	
Diadromus collaris Gravenhorst, 1829		1	Dolaylı	Ankara, Aydın, Erzurum, Kırşehir, Konya, Muğla, Rize, Yozgat	Cosmopolitan	
Heterischnus anomalus (Wesmael, 1857)	1		Bulak	Artvin, Erzurum	Europe and Turkey	
Heterischnus truncator (Fabricius, 1798)	2	7	Bostancı, Bulak, Dolaylı	Çanakkale, Isparta, Istanbul, Erzurum, Giresun, Trabzon, Rize	Europe, Azerbaijan, Turkey and Iran.	
Oronotus binotatus (Gravenhorst, 1829)	6	4	Bostancı, Dolaylı	Ordu, Trabzon, Giresun	Europe and Georgia.	
Stenichneumon culpator (Schrank, 1802)	3	1	Bostancı, Bulak, Dolaylı	Erzurum, Giresun	Holarctic region	
Tycherus fuscicornis (Wesmeal, 1845)	1		Dolaylı	Anatolia	Western Palaearctic	
Vulgichneumon deceptor (Scopoli, 1763)	1		Dolaylı	Erzurum, Nevşehir, Trabzon	Europe, Georgia, Turkey and Iran	

(IN): Individual numbers; (NR): New record

EVALUATION OF INTEGRATED APPROACHES FOR THE MANAGEMENT OF BRINJAL SHOOT AND FRUIT BORER UTILIZING ANTIXENOTIC VARIETY OF BRINJAL

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ABSTRACT: An experiment was conducted to evaluate the effectiveness of 10 integrated approaches comprising Antixenotic variety, mechanical control, repellent crop, sex pheromone and chemical insecticides for the management of BSFB in brinjal grown in the experimental farm of Bangabandhu Shiekh Mujibur Rahman Agricultural University, Gazipur in Winter 2005. The highest shoot infestation reduction over control (84.71%) was recorded in IPM package plots consisting of antixenotic variety +Mechanical control + Marshal 20 EC @ 1ml/L applied at 15 days interval. Among the IPM packages, the package consisting of antixenotic variety +Mechanical control + Marshal 20 EC @ 1ml/L applied at 15 days interval was found as the most effective package and provided the highest shoot (60.97%) and fruit (75.94%) infestation reduction over control. This package resulted significantly the highest healthy brinjsl fruit yield of 39.69 t/ha.IPM package of AV+MC+CS ensured the maximum yield increase (66.88%) of healthy fruit over control. This was followed by 49.94% in (AV+SP) 42.03% in AV+MC+SP, 32.59% in AV+CS, 24.40% in AV+MC+ Soluk, and, 23.79% in AV+MC+NS IPM packages. Similarly the maximum reduction of 88.04% infested fruit yield was observed in IPM package, AV+MC+CS. The adjusted net return was the highest (Tk 2,33920.0) in IPM package consisting of AV+ MC+ Spray of Marshal 20EC @ 1mi/L of water and was followed by Tk. 158820.0 in AV+MC+SP Tk 127040.0 in AV+CS Tk 93560in AV+MC+ Soluk Tk 91020.0 in AV+MC+NS treatment. Similarly it is revealed that the BCR was the highest (72.35) in case of AV+NS due to low cost of seed price of neem. It is evident from the analysis that the use of pesticide gave higher return than the non chemical packages (AV+MC+Soluk, AV+MC+SP, AV+MC+NS). The total number of lady bird beetle and spider was highest (24.32%) in the plot of IPM package consisting of AV+soluk followed by untreated control (18.39%)having only antixenotic variety and in plots of AV+MC+Soluk (22.32). It was lowest (12.46%) in AV+MC+CS and 12.61% in IPM package with AV+SP. In case of spider, the total number of spider is lower than the untreated control except IPM package containing brinjal planted with umbellifer. Highest percent parasitazation was recorded in the untreated control (9.67%) plots followed by IPM package having AV+MC (8.57%), package with AV+SP (8.33%), AV+ MC +sex pheromone (9.33%) . But lowest percent parasitization was recorded from IPM package plots of AV+ MC+ Chemical spray (6.25%).

KEY WORDS: Management of BSFB, brinjal, India

Brinjal shoot and fruit borer *Lucinodes orbonalis* Guen. is the major insect pest of brinjal in Bangladesh and also in many other countries. The caterpillar bore into the shoot which ultimately withers as a result of reduced sap movement in the affected plant parts. During the fruiting stage the larvae infest both the shoot and fruit but prefer fruits to shoot. Secondary infection caused by certain bacteria further deteriorates by rotting the fruits. In Bangladesh the percentage of BSFB infestation to fruit and shoot may be 20-63% and 12-16% (Alam, 1969).

Currently insecticides are the only means to control the pest with varying degree of success. The vegetable growers of Jessore region spray insecticide almost everyday or every alternate day in the brinjal field with as many as 84 time in a season (Anon., 1994). This is also a common practices in other Asian countries where at least 50% of the farmer spray 2-3 time per week against dimond back moth . In many parts of Asia farmer feel that without massive use of pesticides or pesticide mixture vegetable cultivation is impossible (Guan Soon, 1990).

The indiscriminate and over use of pesticides has created many problem like excessive residue on market vegetables that concern general consumer health and the environment, pesticide resistance, trade implication, poisoning, hazard to non target organism especially parasitoid and predators, rise in production cost etc. (GuanSoon, 1990; Tabashnik et al., 1987; Phillip et al., 1990). The growing awareness of shortcoming of chemical insecticide has necessitated the exploration of alternate method of pest control which is relatively free from adverse side effects.

To overcome these problems the Ecologist, Entomologist and Zoologist gave great importance on IPM programme. Scientist are relentlessly working for finding a suitable and safe means against this pest among which use of resistant variety, use of natural enemies, grafting with wild solanum, mechanical control including removal of infested shoot and fruit, using net barrier, cultivation of repellant crop, use of neem product, trapping male with female sex pheromone are important. But the dependency on insecticide can not be ignored for the management of BSFB. Integration of different method with susceptible varieties has been practiced but with tolerant or resistant variety had not been tested. For minimizing dependency on insecticide use the brinjal variety with favourable antixenotic properties may be explored and use it as a possible option for managing BSFB.With this end in view the present styudy was undertaken with the following objectives:

1. to determine the effective IPM package for the management of BSFB,
2. to measure the species diversity and equitability of brinjal under different IPM packages,
3. to study the economics of various treatment in combination with other components and
4. to investigate the impact of different treatment on the field biology of the brinjal shoot and fruit borer along with their natural enemies.

MATERIALS AND METHODS

The experiment was conducted at the experimental farm of the department of Entomology Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, during the period from September 2005 to April 2006. The materials and method used in the study are described below:

Experimental site and duration

The location of the experimental site was 24.09^{o}N latitude and 90.26^{o} E longitude with an elevation of 8.5 m from the sae level. Previously the land was under shal forest and was developed later for research purpose. The site was situated in the sub tropical climate zone, characterize by heavy rainfall during the month of May to September and scanty rainfall during the rest of the year. The soil of the experimental field was clay loam in texture and acidic in nature with a pH of around 5.8 with poor fertility status. It belongs to the shallow red brown terrace soil of Salna series under Madhupur tract (Brammer, 1971).The experiment was conducted during the winter (2005) season under prevailing weather condition.

Design of experiment

The experiment was laid out in Randomized Complete Block Design with three replication in the field.

Land preparation

The land was first opened by a tractor with disc harrow 20 days before transplanting then the land was prepared thoroughly by ploughing and cross ploughing followed by laddering to have a good tilth. All weeds debris of previous crops were removed and the land was finally prepared with the addition of basal dose of cow dung (15 t/ha). Raised plots of 3m X 3m were prepared accomoding 15 number of seedling per plot.

Manuring and fertilization

The following doses of manure and fertilizer was applied as per recommendation Rashid (1993): Cowdung @15t/ha, Urea 250 kg/ha, TSP 50 kg/ha and MP 125 kg/ha.

The full amount of cowdung and TSP, half of MP were applied basally in the plot on week before transplanting and mixed with soil. The remaining half of MP and urea were applied in three equal installments as top dressing at 20 DAT, 2nd at flowering initiation and 3rd at fruit initiation stages.

Collection of seed, raising seedling and transplanting

Seeds of BARI-brinjal-6 were collected from the Horticulture Research centre BARI, Gazipur. A seed bed measuring 3mX1m was prepared and seeds were shown on 28th Septrmber 2005. The seed bed were regularly monitored for proper growth and development of the seedlings. Thirty three days old healthy seedlings were transplanted on 31st October in the main field. A total of 450 seedling was transplanted in 30 plots at the rate of 15 seedling per plot.

Cultural operation

Pit with transplanted seedling were immediately irrigated lightly. Refilling was done with healthy seedlings in place of any damaged seedlings. Supplementary irrigation was applied at an interval of 2-3 days. Weeding in the plot was done 4 times. The MP and urea fertilizer were top dressed at 3 splits as described earlier.

Details of treatment

The brinjal variety was selected based on the earlier findings. BARI brinjal -6 was selected as a variety with favourable antixenotic properties.The following IPM packages including the control was considerd and evaluated to select the best one for economic management of BSFB:

Treatment T_1 = Variety with favourable antixenotic properties (A.V.) as control
Treatment T_2 = T_1 + Mechanical control comprising clean cultivation, weekly removal of infested shoots and fruits
Treatment T_3 = T_1 +Repellant crop (Soluk)
Treatment T_4 = T_1 + Sex pheromone setting in BARI water trap @ 100/h
Treatment T_5= T_1 +Spray neem seed karnel extract @ 10 gm powder/litre of water at 15 days interval
Treatment T_6= T_1 +Application of Marshal 20 EC @1 ml/L of water at 15 days interval
Treatment T_7= T_2 + Repellant crop (Soluk)
Treatment T_8= T_2 + Sex pheromone setting in BARI water trap @ 100/h
Treatment T_9= T_2 + Spray neem seed karnel extract @ 10 gm powder/litre of water at 15 days interval
Treatment T_{10}= T_2 + Application of Marshal 20 EC @1 ml/L of water at 15 days Interval

Mechanical control

Infested shoots were cut with sharp knife after collecting data each week starting from first notice of shoot infestation.Then all the infested shoot and fruit were buried under the soil.

Sowing of Umbellifer (Soluk seed)

Soluk was selected as best umbellifer from the result of the previous study. The seeds were collected from Thakurgaon and were sown @ 0.7 t /ha at the center line between two rows of brinjal after the establishment of brinjal seedling.

Insecticide application

Marshal 20 EC is a brand product of carbo sulphun group was selected on the basis of findings of previous worker and applied 5 timea at 15 days interval starting after first appearance of shoot infestation.

Neem seed karnel extract application

Mature seeds of neem were collected from Porabari bazar, Gazipur and then dried in sunshine. After drying the seeds were crushed in the laboratory and the crushed neem seed were soaked overnight @ 10 gm/l of water. It was then filtered with nylon net and the solution was sprayed with a spray machine. This treatment was selected from the results of the works of the previous workers.

Female sex pheromone trap setting

When the shoot infestation was first observed in the field then thesex pheromone collected from BARI Entomology division and was hanged inside BARI water trap was placed in the field @100 trap /ha with the help of two bamboo stick. The bottom of the BARI trap (plastic pot) was filled with detergent mixed water for trapping the insect. The water was changed at 3 days interval. The trap was fixed at plant canopy level and raised with the growth of brinjal plant.

Data recording

The efficiency of each treatment in suppressing infestation caused by brinjal shoot and fruit borer and was determined by recording the following parameters:

Percent shoot infestation

The total number of shoots and the number of infested shoot were recorded from 5 plants from each plot at 7 days intervals during the period from 11th January 2006 to 15th February 2006. Shoot infestation was expressed in percent using the following formula:

$$\%\text{ shoot infestation} = \frac{\text{Number of infested shoot}}{\text{Number of total shoots}} \times 100$$

Percent Fruit infestation and yield

At each harvest data on the number of healthy and infested fruits and their weight per plot per treatment were recorded seperately from 15 plants. Eight harvests were done throughout the fruiting season i. e. during 6th February to 10th April 2006. Fruit were harvested at 7 days interval. Fruit infestation was calculated using the following formula.

$$\%\text{ fruit infestation (by number)} = \frac{\text{Number of infested fruit}}{\text{Number of total fruit}} \times 100$$

$$\%\text{ fruit infestation (by weight)} = \frac{\text{Weight of infested fruit}}{\text{Weight of total fruit}} \times 100$$

The cumulative plot yield of healthy and infested fruit of 8 harvests were added and determined the transferred into healthy yield and total yield per ha in tons.

Incidence of natural enemies in the field

a) Predator

The total number of lady bird beetle and spider from 5 plants of each plots were recorded by visual observation during the cropping period at 7 days interval.

b) Natural parasitization of BSFB:

After recording the fruit infestation data at each harvest all the infested fruits from all the treated plots were collected and brought to the laboratory and spread over a wooden tray having a layer of 5cm sand. Pupae were collected everyday and put in a cage for subsequent adult/parasitoid emerge. The number of adults/ parasitoid emerged were recorded. The percent parasitization was calculated by using the formula:

$$\text{Parasitization (\%)} = \frac{\text{Number of parasitoid adults}}{\text{Number of BSFB and Parasitoid adults}} \times 100$$

Data analysis:

All the data collected & processed as stated above and analyzed statistically after necessary appropriate transformation. The analysis of variance (ANOVA) of different parameters was done and the means were separated by using the Duncan's Multiple Range Test (DMRT).

Linear regression analysis was also performed to explore the relationships between the number of taxonomic categories of different arthropod species and diversity index and equitability.

RESULTS AND DISCUSSION

The results on the comparative effectiveness of different IPM packages for the management of BSFB infestation along with their benefit cost ratio analysis have been presented. Diversity of arthropod community in different IPM package were measured and presented in this section. The impact of different IPM packages on the natural enemies of BSFB has also been reported.

Effect of different IPM packages on brinjal shoot infestation

The comparative effectiveness of different IPM packages on percent shoot infestation by BSFB has been evaluated in term of their efficiency in reducing the shoot infestation over control are presented in Table 1.1.

The result showed that significantly the highest percent of shoot infestation was obtained in the untreated control treatment (3.27) and the treatment, Antixenitic Variety (AV)+ Mechanical control (MC), Antixenitic Variety (AV) + Repellant crop (Soluk), Antixenitic Variety (AV) + Spray neem seed karnel extract @ 10 gm powder/litre of water at 15 days interval, Antixenitic Variety (AV) + Application of Marshal 20 EC @1 ml/L of water at 15 days Interval (CS), Antixenitic Variety (AV)+ Mechanical control (MC) + Repellant crop (Soluk) and Antixenitic Variety (AV)+ Mechanical control (MC) + Spray neem seed karnel extract @ 10 gm powder/litre of water at 15 days interval had no significance difference with that of control. Significantly the lowest percent (0.50%) shoot infestation was observed in the IPM package , plot consisting of AV+MC+CS. The second lowest percent shoot infestation (0.69%) was observed in the IPM package plot having AV+MC+Sex Pheromone (SP) which was statistically similar to that of

IPM package utilizing AV+SP (0.72%) (Table 6.1). Accordingly the percent shoot infestation reduction over control was the highest (84.71%) in the IPM package of AV+MC+CS and lowest reduction over control was obtained (24.42%) from IPM package using AV+Soluk (Umbellifer).In the present study most of the tested IPM packages reduced percent shoot infestation over control (Table 1.1).

The performance of trappingmale moth with female sex pheromone observed in this experiment was in conformity with the finding of Alam et al. (2003). They also found that the pheromone bated trap significantly reduced BSFB damage to brinjal shoot and fruit.

Effect of different IPM packages on fruit infestation

The comparative effectiveness of various IPM packages on fruit infestation calculated in term of percent fruit infestation by number and weight as well as in percent reduction in infestation over control are presented in Table 1.2.

The results revealed that the lowest fruit infestation of 20.18% by number and 10.21% by weight was observed in the plots of IPM package consisting of AV+MC+CS followed by 25.45% and 27.36% fruit infestation by number and 15.70% and 17.67% by weight in the plots of IPM package using AV+MC+SPand in the plots of AV+CS (number 27.36 ; weight 17.67). Performance of IPM package of AV+MC+Soluk, AV+MC+SP, AV+MC+NS and AV+MC+CS were significantly different from that of untreated plot using only the Antixenotic variety of brinjal (51.71%, 42.43%).

In terms of reduction in fruit infestation over control the IPM package consisting of AV+MC+CS provided the highest reduction in fruit infestation by number (60.97%) and weight (75.94%). This was followed by A.V.+M.C.+S.P (50.78%), A.V.+CS (47.08%), A.V.+M.C.+N.S. (42.74%) A.V.+M.C.+Soluk (33.18%) by number and A.V.+M.C.+S.P (63%), A.V.+CS (58.35%), A.V.+M.C.+ N.S. (53.57%) A.V.+M.C.+Soluk (41.75%) in respect of reduction in fruit infestation by weight.

The efficiency of Marshal 20 EC, sex pheromone, neem seed karnel extract and repellent crop with mechanical control used against the BSFB as observed in the present study is in partial agreement with those reported by other workers. Sandeep et al. (2004) conducted an experiment in India to reduce the insecticidal use against BSFB with less susceptible variety of brinjal. Five alternate spray of recommended insecticide were given at fortnightly intervals on pest appearance. Clean cultivation and shoot clipping of infested shoots having larvae was done at weekly interval and infested fruits were collect and destroyed at each picking. Significantly lowest number of fruit infestation were recorded from the treated plot than that of untreated control.

Rath et al. (2005) reported that IPM component viz. application of neem oil cake @247kg/ha at transplanting, installation of sex pheromone trap @ 61.75kg/ha at 45 days crop age, clipping of infested shoot at weekly interval and spraying of neem oil (Multineem) at 10-12 days interval significantly reduced the shoot and fruit infestation on brinjal when compared with non IPM plots. Rabindra & Proshad (2001) observed significant suppression of the incidence of BSFB when brinjal was grown in association with either marigold or okra. The effect of crop association on the incidence of the shoot and fruit borer revealed that marigold was found to be comparable in terms of reduction in pest incidence.

Effect of different IPM packages on the yield of brinjal

The effect of different IPM package on yield of brinjal has been evaluated in terms of total fruit yield , healthy fruit yield and infested fruit yield obtained during the entire harvesting period of the crop are presented in Table 1.3.Healthy fruit yield was lowest (24.67 t/ha) in the control plots where only antixenotic variety was used and it was significantly different from all other packages except IPM package provided with AV+Umbellifer crop (25.04 t/ha). The infested fruit yield was significantly minimum in IPM package consisting of AV+MC+CS (2.97t/ha) and IPM package using AV+CS (2.88t/ha). This was followed by AV+MC+SP (6.69t/ha), AV+MC (7.29t/ha), AV+SP (7.93 t/ha) and AV+MC+NS (9.45 t/ha).

Further analysis of yield was done to asses the impact of each package on yield increase or decrease over control and presented in Table (1.4). The result suggested that IPM package of AV+MC+CS ensured the maximum yield increase (66.88%) of healthy fruit over control. This was followed by 49.94% in (AV+SP) 42.03% in AV+MC+SP, 32.59% in AV+CS, 24.40% in AV+MC+Soluk,and, 23.79% in AV+MC+NS IPM packages. Similarly the maximum reduction of 88.04% infested fruit yield was observed in IPM package, AV+MC+CS.

Direct comparison of the present finding could not be done with those of other workers due to lack of references. However, several worker have reported similar impact of insecticide (carbofuran), sex pheromone, neem seed karnel, repellant crop with mechanical control against BSFB. Rath et al. (2005) reported that the ecofriendly approaches for the management of BSFB increased the yield of healthy marketable fruit of brinjal.

Benefit/cost analysis:

The benefit/cost ratio (BCR) was worked out based on the expenses incurred and value of crop obtained against the IPM packages used in the present study for the control of brinjal shoot and fruit borer and presented in Table 1.5. It is to be noted here that the expense incurred referred to those only on pest control. It is revealed from the Table 6.5 that the adjusted net return was the highest (Tk 2,33920.0) in IPM package consisting of AV+ MC+ Spray of Marshal 20EC @ 1mi/L of water and was followed by Tk. 158820.0 in AV+MC+SP Tk 127040.0 in AV+CS Tk 93560in AV+MC+Soluk Tk 91020.0 in AV+MC+NS treatment. Similarly it is revealed that the BCR was the highest (72.35) in case of AV+NS due to low cost of seed price of neem. It is evident from the analysis that the use of pesticide gave higher return than the non chemical packages (AV+MC+Soluk, AV+MC+SP, AV+MC+NS).But since the hazards of pesticides are well known, the higher cost of management with non chemical method may be justified and compensated by low risk to health and environment. A compromise between the higher economic gain and reduced risk to health and environment may be contempted for the sake of the safety of human and environment. Thus based on BCR the IPM packages AV+MC+Soluk, AV+MC+SP, AV+MC+NS could be preferred because these give the more or less similar BCR. The BCR thus obtained in AV+MC+SP, AV+MC+NS in the present study is more or less in conformity with the finding of an experiment conducted in India by Rath *et al.* (2005). They observed highest cost benefit ratio in IPM plot containing sex pheromone, neem oil and mechanical control.

Effect of different IPM package on the incidence of natural enemies of BSFB

Predator

The effect of different IPM packages on natural enemies has been evaluated in term of population of two most common predators, the lady bird beetle and spider, during the cropping season and are presented in Table 1.6. The total number of lady bird beetle and spider was highest (24.32%) in the plot of IPM packageconsisting of AV+soluk followed by untreated control (18.39%)having only antixenotic variety and in plots of AV+MC+Soluk (22.32). It was lowest(12.46%) in AV+MC+CS and 12.61% in IPM package with AV+SP. However the number of lady beetle in AV+MC+NS, AV+MC+SP, AV+CS and AV+NS was statistically similar to that untreated control meaning minimum effect (19.31%). In case of spider, the total number of spider is lower than the untreated control except IPM package containing brinjal planted with umbellifer. It is evident from the Table 6.6 that a number of spider and lady bird beetles were found in brinjal with umbellifer plots in comparison to that of sole crop. This is might be due to the fact that diversity of plant species provided important resources such as alternate prey, nectar and pollen or breeding sitefor natural eemies. It was also pointed by Russel (1989). Because of poor availability of research finding it is difficult to explain the present results. However, Islam et al. (1999) reported that natural enemies of brinjal shoot and fruit borer were less affected in the IPM intervention plots than in the scheduled spray plots.

Parasitization

Effect of different IPM packages on the larval parasitization of BSFB by *Trathala flavoorbitalis* was also observed and presented. The number of BSFB adults and their ichneumonid parasitoid wasps emerged in the laboratory from the larvae collected from all the IPM package plots and are presented in Table 1.7. The total number of BSFB pupae obtained from the infested fruits ranged from 26-240 and total number of BSFB emerged ranged 15-196 from all the IPM package plots including untreated control. The number of parasitoid adults emerged were 1.21. Highest percent parasitazation was recorded in the untreated control (9.67%) plots followed by IPM package having AV+MC (8.57%), package with AV+SP (8.33%), AV+ MC +sex pheromone (9.33%) . But lowest percent parasitization was recorded from IPM package plots of AV+ MC+ Chemical spray (6.25%). Results of Table 6.7 indicated that the insecticide application had adverse effect on the parasitoid population. The highest percent parasitization reduction over control plot were recorded in the chemical spray field (35.37%). Mallik et al. (1989) reported 3.57 and 9.06% parasitization of BSFB larvae by *T.flavoorbitalis* with an increased pupal period. Sandanyake & Edirisiyhe (1992) reported that *T. flavoorbitalis* was found as larval parasitoid of BSFB causing an average parasitism of 36.2% in India and Srilanka. The result of this study indicated that when insecticide sprayed plot decreased the natural parasitazation substantially. But the plots with IPM package are suitable for the incidence of natural enemies of BSFB.

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Table 1.1. Comperative effectiveness of different IPM packages in suppressing shoot infestation of Brinjal caused by brinjal shoot and fruit borer during winter 2005.

IPM packages	Shoot infestation %	Shoot infestation reduction over control %
Antixenotic variety(A.V.) (Control)	3.27a (1.94)	
A.V. +Mechanical control(M.C.)	1.76abc (1.49)	46.17
A.V. +Umbellifer (Soluk)	2.47ab (1.69)	24.46
A.V. +Sex pheromone(S. P.)	0.72bc (1.09)	77.98
A.V. +Neem seed spray(N. S.)	2.23abc (1.62)	31.80
A.V. +Chemical spray(C. S.)	1.58abc (1.43)	51.68
A.V. +M.C.+ Soluk	2.14abc (1.60)	34.56
A.V. +M.C.+ S. P	0.69bc (1.08)	78.90
A.V. +M.C.+ N. S.	1.89abc (1.53)	42.20
A.V. +M.C.+C.S.	0.50c (0.99)	84.71

Figures in the same column carrying the same letter(s) are not significantly different at 5% level by DMRT. Values are means of three replications. Values within parentheses are the transformed values based on Square root transformation {√(x +0.5)}.

Table 1.2. Effect of different IPM packages for suppressing fruit infestation by brinjal shoot and fruit borer during winter 2005.

IPM packages	Fruit infestation (%)		Reducing fruit infestation over control%	
	by number	by weight	by number	by weight
Antixenotic variety(A.V.) (Control)	51.71a (7.22)	42.43a (6.53)		
A.V. +Mechanical control(M.C.)	39.46abc (6.31)	29.70abc (5.49)	23.69	30.00
A.V. +Umbellifer (Soluk	44.82ab (6.73)	35.46ab (5.94)	13.32	16.43
A.V. +Sex pheromone(S. P.)	36.82abcd (6.09)	26.85abcd (5.22)	28.80	36.72
A.V. +Neem seed spray(N. S.)	40.33abc (6.37)	30.30abc (5.50)	22.00	28.59
A.V. +Chemical spray(C. S.)	27.36cde (5.26)	17.67cde (4.25)	47.08	58.35
A.V. +M.C.+ Soluk	34.55bcd (5.90)	24.70bcd (5.00)	33.18	41.75
A.V. +M.C.+ S. P	25.45de (5.06)	15.70de (3.98)	50.78	63.00
A.V. +M.C.+ N. S.	29.61cde (5.45)	19.70cde (4.45)	42.74	53.57
A.V. +M.C.+C.S.	20.18e (4.54)	10.21e (3.26)	60.97	75.94

Figures in the same column accompanied by the same letter(s) are not significantly different at 5% level by DMRT. Values are means of three replications. Values within parentheses are the transformed values based on Square root transformation {√(x +0.5)}

Table 1.3. Effect of different IPM packages on yield of brinjal during winter 2005.

IPM packages	Yield (t/ha)		
	Healthy	Infested	Total
Antixenotic variety(A.V.) (Control)	24.67f	16.47a (4.12)	41.14d
A.V. +Mechanical control(M.C.)	27.77e	7.29d (2.79)	35.06f
A.V. +Umbellifer (Soluk)	25.04f	14.43ab (3.86)	39.47e
A.V. +Sex pheromone(S. P.)	31.99c	7.93cd (2.89)	39.92e
A.V. +Neem seed spray(N. S.)	30.43d	12.41b (3.59)	42.84bc
A.V. +Chemical spray(C. S.)	32.71c	2.88e (1.83)	35.59f
A.V. +M.C.+ Soluk	30.69cd	12.67b (3.63)	43.36ab
A.V. +M.C.+ S. P	35.04b	6.69d (2.68)	41.73c
A.V. +M.C.+ N. S.	30.54d	9.45c (3.15)	39.99e
A.V. +M.C.+C.S.	39.69a	1.97e (1.57)	41.66e

Figures in the same column accompanied by the same letter(s) are not significantly different at 5% level by DMRT. Values are means of three replications. Values within parentheses are the transformed values based on Square root transformation {√(x +0.5)}.

Table 1.4. Effect of different IPM packages on the increase/decrease in yield of brinjal over control during winter 2005.

IPM packages	Healthy yield		Infested yield		Total yield	
	t/ha	Increase (+) /decrease (-) over control (%)	t/ha	Increase (+) /decrease (-) over control (%)	t/ha	Increase (+) /decrease (-) over control (%)
Antixenotic variety(A.V.) (Control)	24.67f		16.47a (4.12)		41.14d	
A.V. +Mechanical control(M.C.)	27.77e	+12.57	7.29d (2.79)	-55.73	35.06f	-14.77
A.V. +Umbellifer (Soluk)	25.04f	+1.50	14.43ab (3.86)	-12.39	39.47e	-4.06
A.V. +Sex pheromone(S. P.)	36.99b	+49.94	7.93cd (2.89)	-51.85	44.92a	+9.18
A.V. +Neem seed spray(N. S.)	30.43d	+23.35	12.41b (3.59)	-24.65	42.84bc	+4.13
A.V. +Chemical spray(C. S.)	32.71c	+32.59	2.88e (1.83)	-82.51	35.59f	-13.49
A.V. +M.C.+ Soluk	30.69cd	+24.40	12.67b (3.63)	-23.07	43.36ab	+5.40
A.V. +M.C.+ S. P	35.04b	+42.03	6.69d (2.68)	-59.38	41.73c	+1.43
A.V. +M.C.+ N. S.	30.54d	+23.79	9.45c (3.15)	-42.62	39.99e	-2.80
A.V. +M.C.+C.S.	39.69a	+60.88	1.97e (1.57)	-88.04	41.66e	+1.26

Figures in the same column accompanied by the same letter(s) are not significantly different at 5% level by DMRT. Values are means of three replications. Values within parentheses are the transformed values based on Square root transformation {√(x +0.5)}

Table 1.5. Economic analysis of different IPM packages for the control of brinjal shoot and fruit borer during winter 2005.

IPM packages	Cost of pest management	Yield t/ha	Gross return (tk/ha)	Net return (tk/ha)	Adjusted net return (tk)	BCR
Antixenotic variety(A.V.) (Control)	-	24.67	391520.0	391520.0		
A.V. +Mechanical control(M.C.)	4800.0	27.77	444320.0	439520.0	48000.0	10.0
A.V. +Umbellifer (Soluk)	1160.0	25.04	400640.0	399480.0	7960.0	6.86
A.V. +Sex pheromone(S. P.)	5500.00	31.99	511840.0	506340.0	114820.0	20.87
A.V. +Neem seed spray(N. S.)	1300.0	30.43	486880.0	485580.0	94060.0	72.35
A.V. +Chemical spray(C. S.)	4800.0	32.71	523360.0	518560.0	127040.0	26.46
A.V. +M.C.+ Soluk	5960.0	30.69	491040.0	485080.0	93560.0	15.46
A.V. +M.C.+ S. P	10300.0	35.04	560640.0	550340.0	158820.0	15.42
A.V. +M.C.+ N. S.	6100.0	30.54	488640.0	482540.0	91020.0	14.92
A.V. +M.C.+C.S.	9600.0	39.69	635040.0	625440.0	233920.0	24.36

Note: Market price of brinjal @Tk 16.00/kg
Labour @ Tk 80/day 12 labour/ha/per operation for mechanical control
2 labour/ha/per operation for chemical and neem extract spray
Marshal 100 EC@ Tk. 80/100ml
Cost of Neem seed @Tk 50/kg
Cost of Soluk seed @ Tk 25/kg
Cost of lure with plastic Boyam @ Tk 55/set

Table 1.6 .Effect of different IPM packages on population density of Lady bird beetle and spider in brinjal during winter 2005.

IPM packages	Lady bird beetle		Spider	
	No. per 15 plant	% reduction over control	No. per 15 plant	% reduction over control
Antixenotic variety(A.V.) (Control)	19.31abc		14.22abc	
A.V. +Mechanical control(M.C.)	15.36bc	20.46	11.49bc	19.19
A.V. +Umbellifer (Soluk)	24.32a	+25.89	16.34ab	+14.90
A.V. +Sex pheromone(S. P.)	12.61c	34.70	10.35c	27.22
A.V. +Neem seed spray(N. S.)	13.38c	30.71	13.41abc	5.70
A.V. +Chemical spray(C. S.)	13.22c	31.54	12.45abc	12.44
A.V. +M.C.+ Soluk	22.32ab	+15.58	18.39a	+29.32
A.V. +M.C.+ S. P	12.46c	35.47	12.85abc	9.63
A.V. +M.C.+ N. S.	16.31abc	15.53	12.32bc	13.36
A.V. +M.C.+C.S.	14.38bc	25.53	13.34abc	6.19

Figures in the same column accompanied by the same letter(s) are not significantly different at 5% level by DMRT. Values are means of three replications.

Table 1.7. Effect of different IPM packages on the biology of brinjal shoot and fruit borer and their larval parasitization during winter 2005.

IPM packages	Total no. of BSFB pupae collected	Total no. of adult emerged		Parasitization (%)	Parasitization reduction over control (%)
		BSFB	Parasitoid		
Antixenotic variety(A.V.) (Control)	240	196	21	9.67	
A.V. +Mechanical control(M.C.	122	96	9	8.57	11.38
A.V. +Umbellifer (Soluk)	198	163	16	8.94	7.55
A.V. +Sex pheromone(S. P.)	103	88	8	8.33	13.85
A.V. +Neem seed spray(N. S.)	150	122	11	8.27	14.48
A.V. +Chemical spray(C. S.)	32	24	2	7.69	20.48
A.V. +M.C.+ Soluk	180	146	16	10.95	+13.23
A.V. +M.C.+ S. P	88	68	7	9.33	3.52
A.V. +M.C.+ N. S.	110	84	9	9.67	0.00
A.V. +M.C.+C.S.	26	15	1	6.25	35.37

ON THE DISTRIBUTION OF A NEW INVASIVE WEEVIL BEETLE *PSEUDOCNEORHINUS OBESUS* (ROELOFS, 1873) (COLEOPTERA: CURCULIONIDAE: ENTIMINAE) IN THE NEARCTIC REGION

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ABSTRACT: In this paper, new data on the distribution of a new invasive weevil beetle *P. obesus* (Coleoptera, Curculionidae, Entiminae) in the Nearctic Region and the first documented record of this species in the State of New York are reported. Combined with the new data presented here, *P. obesus* is currently known in the United States from the states of New York, New Jersey, Pennsylvania, Kentucky, Georgia, Virginia, and the District of Columbia. *P. obesus* is the second reported species of the genus *Pseudocneorhinus* introduced into the Nearctic Region. The first one, *P. bifasciatus*, has widely spread across the United States and is currently designated as a species of high economic concern. *P. obesus* can also be a potentially dangerous pest of deciduous plants in the United States.

KEY WORDS: Coleoptera, Entiminae, Nearctic Region, *Pseudocneorhinus obesus*, the United States

The genus *Pseudocneorhinus* Roelofs, 1873 belongs to the tribe Trachyphloeini Gistel, 1848 in the subfamily Entiminae Schoenherr, 1823 and to date comprises 14 species distributed in the eastern part of the Palaearctic Region (Alonso-Zarazaga et al., 2017). The natural range of the genus covers the Russian Far East, China, Mongolia, Japan and the Korean Peninsula (Borovec, 2009; Alonso-Zarazaga et al., 2017). *Pseudocneorhinus obesus* Roelofs, 1873 has recently been reported to have been introduced into the United States (Yunakov, 2015). In the present paper, I report new data on the distribution of this new invasive species in the Nearctic Region and the first documented record of this species in the State of New York.

MATERIALS AND METHODS

The study material is deposited in the I. V. Kizub`s private collection (Kyiv, Ukraine and Ossining, New York, the United States). The photographs were taken using CoolingTech USB Digital Microscope S02 500X. The nomenclature of the taxa and synonymy for the species names are given according to The Cooperative Catalogue of Palaearctic Coleoptera Curculionoidea (Alonso-Zarazaga et al., 2017).

RESULTS AND DISCUSSION

***Pseudocneorhinus obesus* Roelofs, 1873** (Figs. 1-5, 11-17)

= *trifasciatus* Voss, 1958

Material examined: 6 females, the United States, New York, Westchester County, Ossining, 41°09'54"N 73°51'52"W, 01.07. – 31.09.2014, Kizub I. V. leg.; 1 female, idem, 29.05.2018, Kizub I. V. leg.

***Pseudocneorhinus bifasciatus* Roelofs, 1880** (Figs. 6-10, 17)

Material examined: 6 females, the United States, New York, Westchester County, Ossining, 41°09'54"N 73°51'52"W, 01.07. – 31.09.2014, Kizub I. V. leg.; 14 females, the United States, New York, Westchester County, Valhalla, 41°04'56.2"N 73°48'35.9"W, 01 – 31.08.2018, Kizub I. V. leg.; 1 females, idem, 01.09. – 04.10.2018, Kizub I. V. leg.; 2 females, the United States, New York, Westchester County, Millwood, 41°11'44.9"N 73°47'37.7"W, 02.09.2018, Kizub I. V. leg.

Geographical distribution

The natural range of *P. obesus* covers the Russian Far East, Northern and Central-Eastern China, Japan and the Korean Peninsula (Zherikhin, 1972; Takenouchi, 1976, 1982; Egorov, 1977; Ler, 1996; Han et al., 2000; Kojima & Morimoto, 2004; Borovec, 2009; Legalov, 2009, 2010; Kojima, 2012; Alonso-Zarazaga et al., 2017). Several races or subspecies of *P. obesus* likely exist, with distinct geographical distributions within the natural range, in particular among populations from Northern Japan and the South of the Kuril Islands (Kunashir Island) (Takenouchi, 1976, 1982; Ler, 1996).

In 1914 J. G. Sanders, an agent and expert of the United States Department of Agriculture Bureau of Entomology, in his letter to Dr. L. O. Howard, Head of the Bureau, reported that "*An undetermined weevil similar in appearance to Pseudocneorhinus obesus (auct. H. Barber) was found*" feeding on flowering cherry trees from Japan in Washington, the District of Columbia. This letter was only published in 1977 (Jefferson & Fusonie, 1977). The presence of *P. obesus* in the United States was only confirmed 100 years later, in 2015, when 1 female specimen was found in Georgia (Yunakov, 2015). Since the report by Yunakov of 2015, the species has never been reported from the United States. Meanwhile, the first photographs of *P. obesus* were taken in Virginia in 2006 and published under the name *P. bifasciatus* (BugGuide..., 2007). Then photographs of a clearly recognizable *P. obesus* were taken by different naturalists in Georgia in 2012 (Newton, 2012) (Fig. 11), New Jersey in 2012 (Stuart, 2012) (Fig. 12) and 2015 (Christensen, 2015), Kentucky in 2013 (Hoyer, 2013) (Figs. 13, 14), New York in 2013 (Dankowicz, 2015) (Fig. 15) and 2018 (Klein, 2018), and Pennsylvania in 2016 (Ausubel, 2016) (Fig. 16) and 2018 (Coulter, 2018), and published under the name *P. bifasciatus*, following misidentification. Based on my data and the above-mentioned observations, a map of the current *P. obesus* distribution in the Nearctic Region is presented in Fig. 17. To date, the species is known in the United States from the states of New York, New Jersey, Virginia, Pennsylvania, Kentucky, Georgia, and the District of Columbia.

P. obesus is the second reported species of the genus *Pseudocneorhinus* introduced in the Nearctic Region. The first one, *P. bifasciatus* (common economic name in the United States is a Twobanded Japanese Weevil), has already widely spread over the territory of the United States. For the first time *P. bifasciatus* was collected in Pennsylvania in1914, however it was officially reported only 10 years later, in 1924, from Connecticut as *Pseudocneorhinus setosus* Roelofs, 1879 (Buchanan, 1946). For more than 20 years the species was treated as *P. setosus* and was recognized in the United States as *P. bifasciatus* only in 1946 (Buchanan, 1946). The present range of *P. bifasciatus* in the United States includes 29 states and one district: Alabama, Arkansas, Connecticut, District of Columbia, Delaware, Florida, Georgia, Iowa, Illinois, Indiana, Kentucky, Massachusetts, Maryland, Maine, Michigan, North Carolina, Nebraska, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Virginia, Vermont, Wisconsin, and West Virginia (Buchanan, 1946; Werner et al., 1954; Hamilton 1957; Allen, 1959; O'Brien & Wibmer, 1982; Maier, 1986; Sikes, 2003; Thomas, 2005; Wheeler & Boyd, 2005; Grantham & Rebek, 2008; Cottrell & Horton, 2013; Texas Invasive Species, 2014; Gyeltshen & Hodges, 2015; Liesch, 2016; Boone, 2018; Dmitriev, 2019) (Fig. 17). The natural range of *P. bifasciatus* slightly narrower, but mostly overlaps that of *P. obesus* and covers the Russian Far East, Northern and Central-Eastern China, Japan, as well as North and South Korea (Marshall, 1934; Zherikhin, 1972; Takenouchi, 1976; Egorov, 1977; Morimoto, 1994; Ler, 1996; Han et al., 2000; Kojima & Morimoto, 2004; Borovec, 2009; Legalov, 2009, 2010; Kojima, 2012; Alonso-Zarazaga et al., 2017; Yu & Wang, 2017).

Presently it`s unclear whether the United States population of *P. obesus* began in Washington, D. C., 100 years ago brought with cherry trees from Japan (Jefferson & Fusonie, 1977). In such case, *P. obesus* should have spread out far throughout the eastern United States and would have been known from there for a long time – a scenario that happened to *P. bifasciatus*, which was first found in the United States in the same 1914 (Buchanan, 1946). By contrast, *P. obesus* could have been reintroduced (if the Sanders` report of 1914 related to *P. obesus*) into the United States in more recent times.

Morphological notes

P. obesus is very similar in appearance to *P. bifasciatus* but can be easily distinguished from the latter by the characters listed in Table 1. Additionally, *P. obesus* is also characterized by a slightly smaller size of rounded scales covering the body than in *P. bifasciatus*, longer and slender tibia and the funicle of the antennae, and relatively smaller eyes and broader frons between them (Figs. 1-10). Noteworthy that Roelofs, when describing *P. obesus*, decided that specimens of *P. bifasciatus* are males of *P. obesus* (Roelofs, 1873). Only six years later (reported at a meeting in April 1879) he came to a conclusion that there were two distinct species (Roelofs, 1880).

Biological notes

Both species, *P. obesus* and *P. bifasciatus*, are wingless and reproduce parthenogenetically (Takenouchi, 1976, 1981, 1982; Takenouchi et al., 1983; Maier, 1983; Morimoto & Lee, 1992; Morimoto, 1994; Wheeler & Boyd, 2005). This high reproductive capacity allows them to spread widely into new territories. Within the natural range of *P. obesus*, several polyploid forms (3x, 4x, and 6x) are known that reproduce by thelytoky, a form of parthenogenesis whereby females are produced from unfertilized egg (Takenouchi, 1976, 1982; Gregory, 2005). 3x, 4x and 5x polyploid forms are also known for *P. bifasciatus* (Takenouchi, 1981, 1982; Takenouchi et al., 1983; Gregory, 2005). Males of *P. obesus* and *P. bifasciatus* are also known from their natural ranges (Takenouchi, 1982; Borovec, 2009). Males of *P. bifasciatus* are not encountered in the United States (Wheeler & Boyd, 2005). The duration of life cycle and seasonal activity of *P. obesus* is probably similar to that of *P. bifasciatus*. In the northeastern United States, *P. bifasciatus* hibernate as adults, eggs or young larvae, and are a univoltine (single brood per season) species (Allen, 1959; Thomas, 2005). In the spring, adults begin feeding and laying eggs, while other stages continue their development. The overwintering weevils resume feeding on the first hot days of spring, and continue to feed and oviposit throughout the summer. Eggs of *P. bifasciatus* are laid from the middle of May through October, the peak period for oviposition begin from

September throug early October. Oviposition stops by November (Zepp, 1978; Marrone & Zepp, 1979; Thomas, 2005). The newly hatched larvae burrow into the soil to feed on roots and pupation begins in early June (Allen, 1959; Marrone & Zepp, 1979). In the northeastern United States, adults of *P. bifasciatus* emerge from late June through early July and eventually outnumber the overwintering population and cause extensive damage to foliage (Allen, 1959).

Pest alert

Similarly to *P. bifasciatus, P. obesus* can be a potentially dangerous pest of deciduous plants in the United States. Imagoes of both species are leaf feeders and when abundant can cause significant damage. *P. bifasciatus* is highly polyphagous and is known as a pest of various cultivated and ornamental plants including citrus trees. Both adults and larvae cause plant damage. Adults cause defoliation, whereas the larvae destroy the roots. In Japan and the United States this species has been reported to feed on more than 100 species of plants from more than 25 families (Hamilton 1957; Allen, 1959; Marrone & Zepp, 1979; Maier, 1983, 1986; Staines & Staines, 1988; Boyd & Wheeler, 2004; Thomas, 2005; Japanese Society..., 2006; Zoology, 2006; Cottrell & Horton, 2013; Day, 2014; Gyeltshen & Hodges, 2015). Hosts of *P. obesus* in the United States have not been studied so far. The species has been found by Yunakov on *Quercus* sp. (Yunakov, 2015) and by the author on *Acer* sp. leaves. Currently *P. bifasciatus* is treated in the United States and Japan as a species of high economic concern (Bouchard et al., 2017), which could be anticipated for *P. obesus* in the United States as well. Because *P. obesus* is flightless, just like *P. bifasciatus*, its range expansion can probably be through human-mediated jump dispersal such as spread via domestic shipments of infested plant material (Boyd & Wheeler, 2004).

In conclusion, the author hopes that the present paper will inspire scientists and naturalists in the United States to review collections and records in order to reconstruct the history of invasion and determine the present range of the new invasive weevil beetle *P. obesus* in the Nearctic Region.

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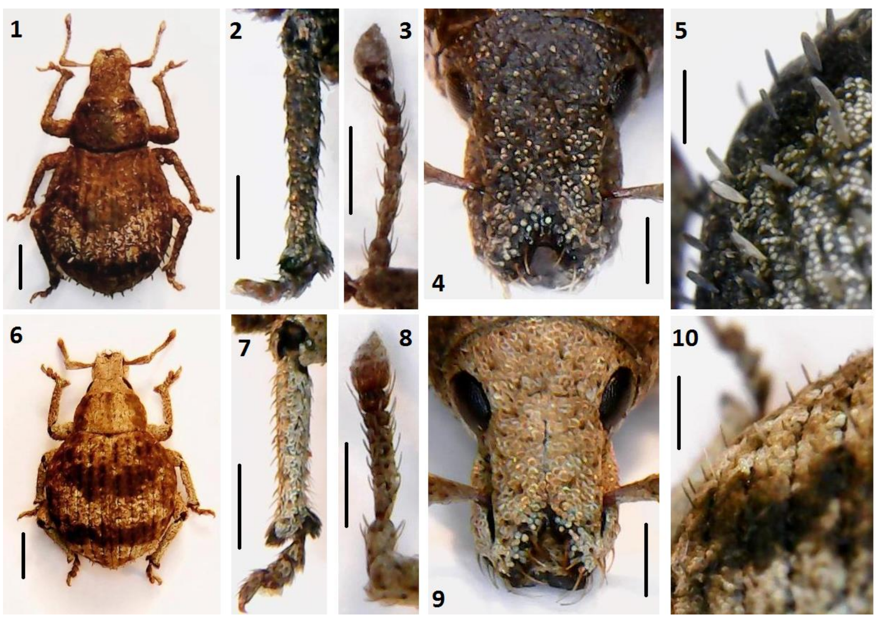
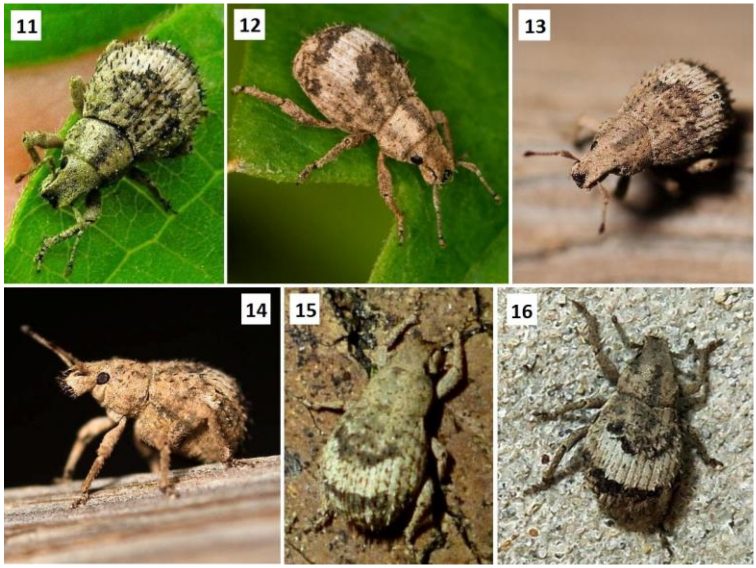
Table 1. Morphological characters discriminating *P. obesus* from *P. bifasciatus*.

	P. obesus	***P. bifasciatus***
Shape of elytra	Elytra pear-shaped, widest at the middle (Fig. 1)	Elytra almost globe-shaped, angularly widened behind the shoulders and widest anteriorly of the middle (Fig. 6)
Metatibia	Inner edge of metatibia without or with 2 small and 1-2 tiny teeth (Fig. 2)	Inner edge of metatibia with 4-5 big and 2-4 small teeth (Fig. 7)
Antennal funicle	Segments 3–6 of antennal funicle longer than width (Fig. 3)	Segments 3–6 of antennal funicle transverse (Fig. 8)
Postepistomal area	Postepistomal area short, far from reaching the level of antennae attachment (Fig. 4)	Postepistomal area of rostrum long, almost reaching the level of antennae attachment (Fig. 9)
Elytral scales	Piliform scales on intervals of elytra long, broad, and leaf-shaped (Fig. 5)	Elytral piliform scales short, slender, needle- or stick-shaped, scarcely dilated distally (Fig. 10)



Figures 1-10. Weevils of the genus *Pseudocneorhinus* from the Nearctic Region, females. *P. obesus:* 1) general view dorsally; 2) metatibia; 3) elytral surface in front-dorsal view; 4) antennal funicle; 5) rostrum dorsally. *P. bifasciatus*: 6) general view dorsally; 7) metatibia; 8) elytral surface in front-dorsal view; 9) antennal funicle; 10) rostrum dorsally. Scale bars in 1 and 6: 1 mm; scale bars in 2-5 and 7-10: 0.5 mm.



Figures 11-16. Specimens of *Pseudocneorhinus obesus* from the United States depicted in the natural environment: 11) Chamblee, DeKalb County, Georgia, March 31 2012, photo by W. D. Newton with permission; 12) Pennington, Mercer County, New Jersey, June 10 2012, photo by T. Stuart with permission; 13, 14) Louisville, Jefferson County, Kentucky, May 18 2013, photos by R. Hoyer with permission; 15) Irvington, Westchester County, New York, June 25 2013, photo by Even Dankowicz with permission; 16) New Hope/Bowman's Hill Wildflower Preserve, Bucks County, Pennsylvania, July 16 2016, photo by S. Ausubel with permission.

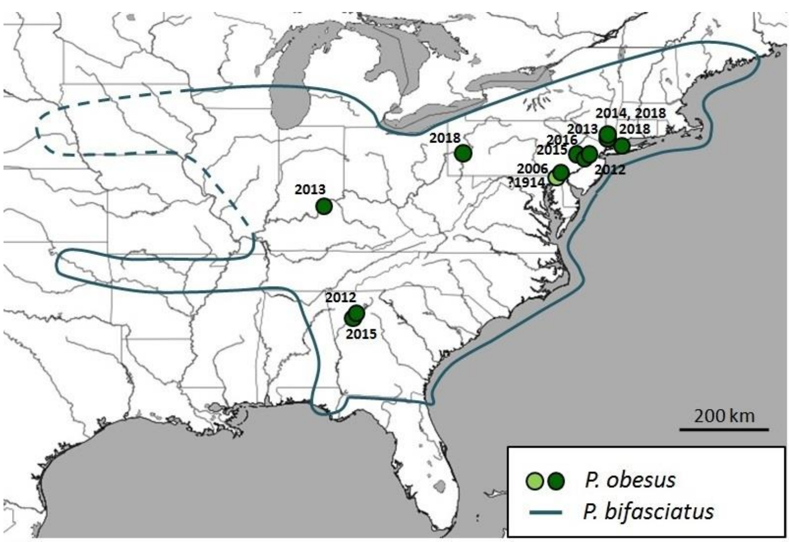


Figure 17. Map of *P. obesus* records in the Nearctic Region as compared to the present range of *P. bifasciatus*. Records of *P. obesus* are given as dotes with the year of record. Known borders of *P. bifasciatus* range in the Nearctic Region are shown as a line.

ROPALOPUS CAROLINI SP. NOV. - DESCRIPTION OF A NEW SPECIES FROM GREECE-PELOPONNESE PENINSULA (COLEOPTERA: CERAMBYCIDAE)

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[**Vartanis, J. & Borek, R.** 2019. *Ropalopus carolini* sp. nov. - description of a new species from Greece-Peloponnese Peninsula (Coleoptera: Cerambycidae). Munis Entomology & Zoology, 14 (2): 610-614]

ABSTRACT: The new species *Ropalopus carolini* sp. nov., comes from Greece, and for the time being, it is endemic to Greece- Peloponnese Peninsula. *Ropalopus carolini* sp. nov., was compared with the species *Ropalopus boreki* Rapuzzi, 2017 / *Ropalopus clavipes* Fabricius, 1775 / *Ropalopus siculus* Stierlin, 1864 / *Ropalopus insubricus insubricus* Germar, 1824.

KEY WORDS: Coleoptera, Cerambycidae, Cerambycinae, Ropalopus, new species, Greece-Peloponnese Peninsula

Ropalopus carolini sp. nov.

Ropalopus carolini, a new species of the genus *Ropalopus* Mulsant, 1839 from southeast Europe (Greece) was found on a thistle (Carduus L.), plant in a southern part of the Peloponnesus Peninsula, Mani area, at an altitude above the sea level of 700 m, in an oak forest. Until now, it is an endemic species within the framework of the whole genus, in which the body size of males and females ranges between 28 and 30 mm.

The new species was compared with all the species of the genus known from Greece and/or the whole Balkan or from Italy, from which it can be differentiated by its morphological characters as described below.

HOLOTYPE: male – Greece, Peloponnese / Mani Peninsula-Nimfio 700 m, VI. 2018 lgt. R.Borek (coll. Janis Vartanis).
PARATYPE: 1 x female – Greece, Peloponnese / Mani Peninsula- Nimfio 700 m, V. 2017 (lgt.,coll. R.Borek). 1 x male, 1 x female – Greece, Peloponnese / Mani Peninsula- Nimfio 700 m, VI. 2018 lgt. R.Borek.

Length: males – 28 mm, females – 29 - 30 mm.

Body: entirely black, with moderate shine, including pronotum, legs and elytra, without metallic lustre and colour, very elongate in general, without considerable dilation in both males and females.
Head: coersely and densely wrinkled- punctate, with considerable midline furrow on its vertex.
Antennae: black, inner side of antennomeres 3 - 5 with short, erect setae. Antennomeres not serrate contrastingly to other species, without remarkably extended teeth on inner and outer sides (see the photo). Antennae as long as body in males, reaching to half body length in females.

Pronotum: coarsely and densely wrinkled- punctate, with a smooth elevated area on its summit. Considerably wider than head, hexagonal, considerably angularly widened laterally. Only laterally very sparsely setaceous. Its top surface without any erect setae.
Scutellum: coersely punctate, with broadly rounded apex.
Elytra: black throughout their surface, without any metallic lustre. Very long, at least 2.4 times as long as wide at base (at humeri). Anterior half of elytra wrinkled, coarsely punctate and very sparsely setaceous. Posterior half finely and densely punctate, with denser, decumbent setation. Elytra moderately widened toward apex, but not as distinctly as in other species. Elytral apex rounded.
Abdominal sternites: with fine and decumbent setae in both males and females, setae pointing in one direction.
Legs: black, with very sparse and decumbent setation, particularly on tibiae.

Extension of *Ropalopus* species:
1- *R. carolini* sp.n.,- Greece / Peloponnese Peninsula.
2- *R. boreki* Rapuzzi, 2017 – Greece.
3- *R. clavipes* Fabricius, 1775 – Balkan, central Europe.
4- *R. siculus* Stierlin, 1864 – Italy / Sicilia Isl.
5- *R. insubricus insubricus* Germar, 1824 – Croatia, Romania.
6- *R. mali* Holzschuh, 1993 – Kyrgyzstan, Uzbekistan.

Differential diagnosis:

The new species *Ropalopus carolini* sp.n., was found in the southern part of the Greek Peninsula Peloponnesus, in its southernmost area Mani. Imagines were found in oak forests, sitting on plants *Carduus* L. The host plant is very likely to be *Quercus*, and if so, then the insects do not fall into the genus *Ropalopus* Mulsant, 1839 whose representatives have the host plant *Acer* sp., and do not visit *Carduus* type plants.

Ropalopus carolini sp.n., belongs to largest representatives of the genus and its morphological characters differentiate it considerably from other species known from Italy, Greece and the whole Balkan Peninsula. From Greece and particularly from Peloponnesus, three large species of the genus are known *Ropalopus boreki* Rapuzzi, 2017 / *Ropalopus clavipes* Fabricius, 1775 / *Ropalopus siculus* Stierlin, 1864, which were studied for comparison and subsequent description of the new species. Obvious differences observable in the new species are shown in the colour of elytra, shape and length of the whole body, antennae, and further differences observable under a magnifying glass or stereoscopic microscope, pubescence of abdominal sternites, pronotum, elytra, etc. Other species and their characters exerting differences from the new species will be detailed below.

Ropalopus boreki Rapuzzi, 2017: I have a number of specimens including a paratype and in addition, according to the original description by Rapuzzi, in this species, the anterior half of the elytra has metallic lustre and obviously golden-green colour. The elytra are more compressed and more widened toward the elytral apex compared to the new species. They are relatively shorter compared to their width at humeri. The general variability within the holotype and all the paratypes of the species *Ropalopus boreki* Rapuzzi, 2017 is constant in colours. The holotype: antennae have short, dense, erect setae on the inner side, antennomeres 3-8 have a considerable longitudinal tooth on the inner side, antennomeres 9-10 have a short tooth.

Ropalopus siculus Stierlin, 1864: this species is very similar to the preceding species *Ropalopus boreki* Rapuzzi, 2017. It also has metallic lustre in the anterior half of the elytra with reddish-green colour. The type specimens come from the isle Sicily (Italy), but it was also discovered in Greece (in the Thessaly Region). This is a smaller species, the body length of males and females ranges between 16 and 20 mm.

Ropalopus clavipes Fabricius, 1775: a black, matte species with the body length of only 2.1 times the elytra width at humeri. The scutellum is glabrous. Antennae of males are distinctly longer than the body, those of females either are as long as the body or slightly exceed beyond the body length. Antennomeres 3-10 are obviously extended apically on outer side, to produce large thorns. The abdomen of males as well as females with finely scattered pubescence, the ventral surface with rather long, semierect setae.

Ropalopus insubricus insubricus Germar, 1824: the occurrence of the species is rather typical for the northern Balkan and has its elytra with considerable metallic lustre throughout, with green-blue to reddish colour. The pronotum has a large, nearly impunctate area on its summit. The antennae unambiguously exceed beyond the body length.

Ropalopus carolini sp.n., - the new species exerts very different morphological characters compared to the species listed above. It is completely black, without metallic lustre and any colours. Its antennomeres are not as distinctly extended in thorns and are also not as serrate as in the remaining species (see the photo). It has a considerably longer body and the elytra are more elongate in relation to their width at humeri. The second half of the elytra is not as widened as in the species *Ropalopus boreki* Rapuzzi, 2017. In males as well as females, the antennae are considerably shorter than in the species *Ropalopus clavipes* Fabricius, 1775 having the antennae considerably longer than the body. It is a very large species within the whole genus, and all the other species are considerably smaller with exceptions of *Ropalopus boreki* Rapuzzi, 2017 and *Ropalopus insubricus insubricus* Germar, 1824. All the above mentioned species of the genus are represented by several specimens in my collection including several paratypes.

Etymology: The new species from Greece / Peloponnesus Peninsula, *Ropalopus carolini* sp.n., was given its specific name after Carolina Borek, a daughter of my colleague Robert Borek dwelling on Peloponnesus, in the area Mani.

ACKNOWLEDGEMENTS

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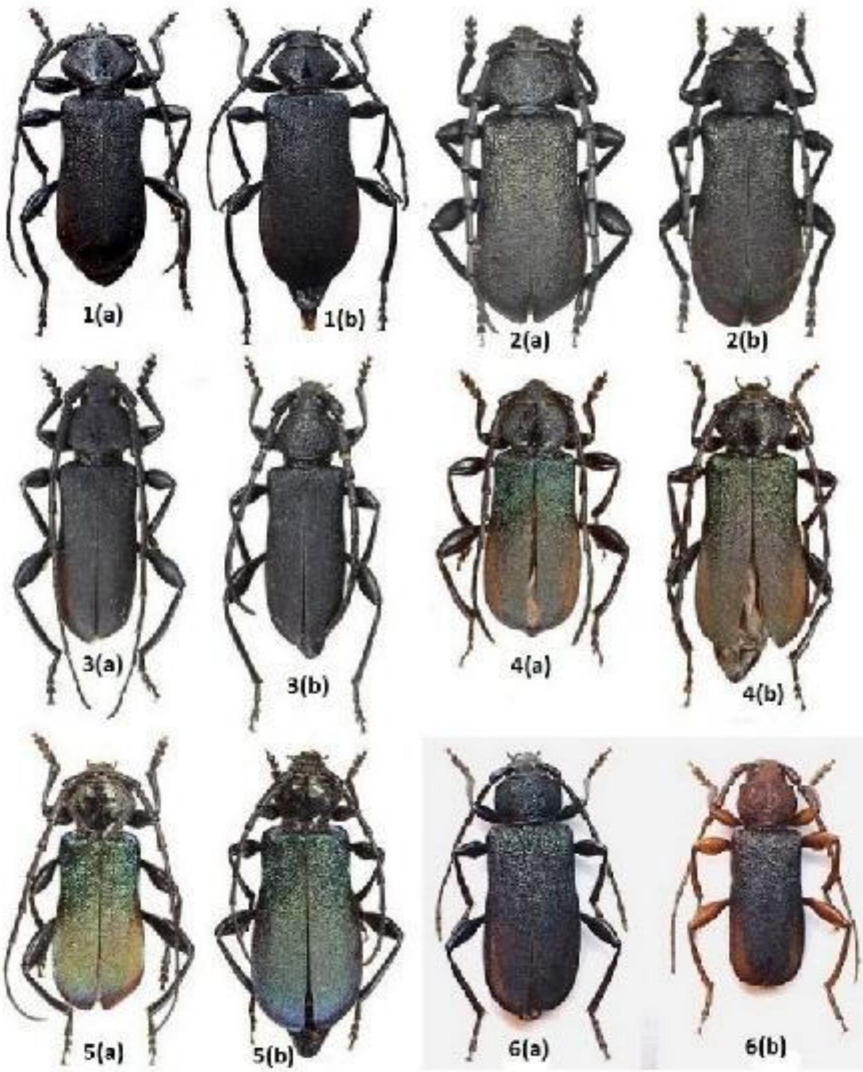
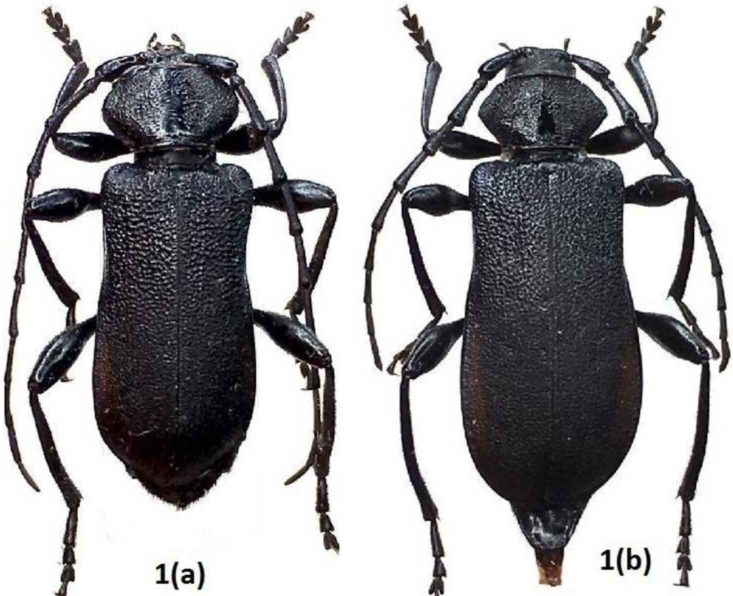
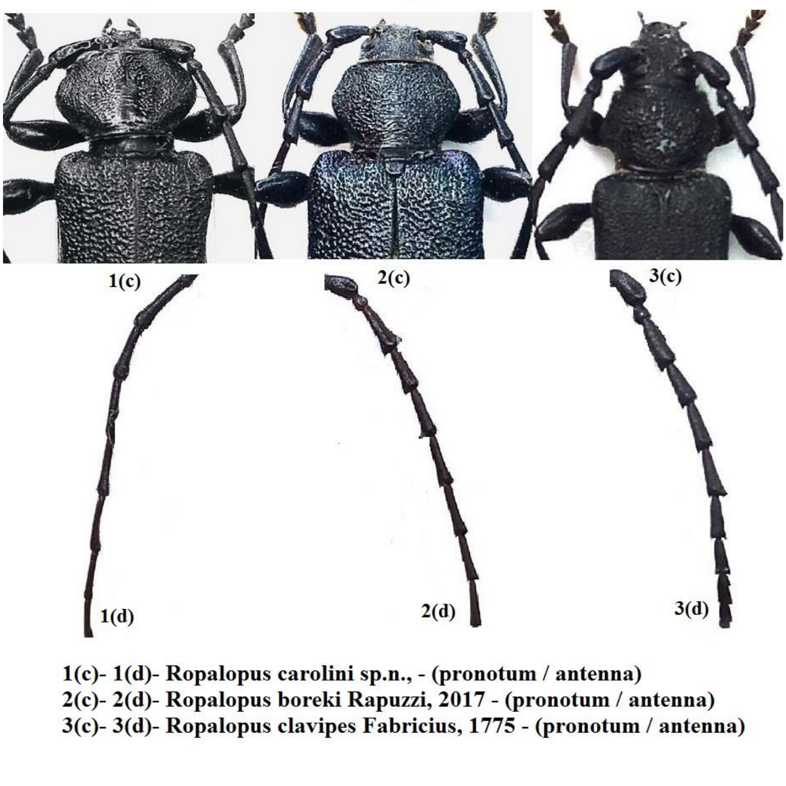


1(a)- 1(b) - Ropalopus carolini sp.n., - (male/female)
2(a)- 2(b) - Ropalopus boreki Rapuzzi, 2017 - (male/female)
3(a)- 3(b) - Ropalopus clavipes Fabricius, 1775 - (male/female)
4(a)- 4(b) - Ropalopus siculus Stierlin, 1864 - (male/female)
5(a)- 5(b) - Ropalopus insubricus insubricus Germar, 1824 - (male/female)
6(a)- 6(b) - Ropalopus mali Holzschuh, 1993 - (male/female)



Ropalopus carolini sp.n., - 1(a)- male / 1(b)- female



1(c)- 1(d)- Ropalopus carolini sp.n., - (pronotum / antenna)
2(c)- 2(d)- Ropalopus boreki Rapuzzi, 2017 - (pronotum / antenna)
3(c)- 3(d)- Ropalopus clavipes Fabricius, 1775 - (pronotum / antenna)

HETEROPTERA SPECIES LIST RECORDED ON *ABIES* SPP. FROM TURKEY

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[**Kıyak, S.** 2019. Heteroptera species list recorded on *Abies* spp. from Turkey. Munis Entomology & Zoology, 14 (2): 615-616]

ABSTRACT: Here, 10 species inhabiting on *Abies* as a hostplant, of 2 families in Heteroptera from Turkey are recorded.

KEY WORDS: Heteroptera, hostplant, *Abies*, Turkey

The aim of this study is presented a list of previously reported Turkish terrestrial Heteroptera species inhabiting on *Abies* spp. in Turkey according to the previous literatures as Hoberlandt (1955), Seidenstücker (1957, 1958), Stichel (1956), Wagner (1971, 1976). Thus, 10 heteropteran species inhabiting on *Abies* as a hostplant, of 2 families from Turkey are determined with this work. 9 species of Miridae and 1 species of Anthocoridae are recorded.

All species are given into a list in the following table.

List of Heteroptera species inhabiting on *Abies* in Turkey

Familia/Species	Host Plant (s)	Province (s)-Locality	Cited Literature (s)
MIRIDAE			
Fulvius oxicarenoides Reuter, 1879	*Abies cilicica*	Adana-Bürücek	Hoberlandt, 1955
Macrotylus seidenstuekkeri Wgn., 1954	*Abies* sp.	İçel-Namrun	Hoberlandt, 1955
Macrotylus ancoratus Sdst, 1959	*Abies* sp.	İçel-Namrun	Seidenstücker, 1958
Atractotomus persquamosus Sdst., 1961	*Abies cilicica*	Toros Mountains	Wagner, 1976
Orthotylus beieri Wgn., 1942	*Abies cilicica*	Konya-Karapınar, Toros Mountains	Hoberlandt, 1955
Calocoris angularis (Fb., 1864)	*Abies cilicica*	Adana-Bürücek; Kayseri-Yılanlı and Erciyes Mountains	Hoberlandt, 1955
Grypocoris amoenus (Dgl.& Sc., 1868)	*Abies cilicica*	İçel-Namrun	Seidenstücker, 1957
Dichrooscytus tauricus Sdst., 1954	*Abies cilicica*	Adıyaman-Nemrut Mountain; İçel-Namrun	Wagner, 1971; Stichel, 1956; Hoberlandt, 1955
**Pinalitus atomarius* (M.-D., 1843)	*Abies* sp., *Abies cilicica*	İçel-Namrun	Stichel, 1956; Wagner, 1971; Seidenstücker, 1958
ANTHOCORIDAE			
Orius minutus ssp. *minutus* (L., 1758)	*Abies cilicica*	Adana-Bürücek	Hoberlandt, 1955

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Wagner, E. 1970-1971. Die Miridae Hahn, 1831, des Mittelmeerraumes und der Makaronesischen Inseln (Hemiptera, Heteroptera), Teil 1, Ent. Abh. Mus. Tierk. Dresden, (Suppl.), 37: 1-484.

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IDENTIFICATION OF BIO-ECOLOGICAL CHARACTERISTICS OF *SAGA EPHIPIGERA SYRIACA* (ORTHOPTERA: TETTIGONIIDAE)

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[Aslan, M. M. & andan, G. 2019. Identification of bio-ecological characteristics of *Saga ephipigera syriaca* (Orthoptera: Tettigoniidae). Munis Entomology & Zoology, 14 (2): 617-625**]**

ABSTRACT: The aim of this study is to identify the bio-ecological characteristics of *Saga ephippigera syriaca* Lucas, 1864 species under Saginae Sub-family of Orthoptera Order. *Cephalaria salicifolia* Post (Dipsacaceae) plant, which is an endemic plant for Kahramanmaraş Province, is the host for *Saga ephippigera syriaca*. The male and female individuals of *Saga ephippigera syriaca* have been collected from *Cephalaria salicifolia* plant from May to late September for a period of 2 years. The male and female individuals have been cultivated in the laboratory and fed with live insects from various families and order collected from the nature. The male and female individuals have been mated and ovulated; and then the eggs have been collected and their lengths and widths have been measured.

KEY WORDS: Saginae, *Saga ephippigera syriaca*, *Cephalaria salicifolia*, bioecology, Kahramanmaraş

Turkey is rather rich in terms of Orthoptera and Tettigoniidae faunas thanks to it topographical and climatic conditions, İyriboz (1938), Erkılıç (1945), Bodenheimer (1958), Karabağ (1958), Karabağ et al. (1971, 1974, 1980), Demirsoy (1974), Tutkun (1981), Lodos (1983), Salman (1983), Tutkun & Ünal (1986), Çıplak (2000, 2004), Sevgili & Çıplak (2000), Çıplak et al. (2002, 2009), Demirsoy et al. (2002), Hellerand & Sevgili (2005), Sevgili et al. (2006), Heller et al. (2008) and Ünal (2005, 2006, 2010, 2011a, 2011b) identified many taxons and provided information in connection with Tettigoniidae family of Orthoptera Order in Turkey.

Although some species of Orthoptera are carnivorous, most species are herbivorous and omnivorous. The carnivorous species include *Saga* genus under the sub-family of Saginae. However, detailed study is lacking in Turkey in terms of grasshopper species of *Saga* genus under Saginae sub-family of Tettigoniidae family. The existing studies focus only on identification of the species. On the other hand, Ünal (2014) reports that there are 11 genus under *Saga* species.

Saga species are defined as captive and low populated, undefended and flightless along their distribution zones with low ability to escape from danger. Despite the fact that *Saga* species are unprotected, they live in low populations in isolated zones of warm southern hills of medium heighted mountains like the xerothermic insects (Kaltenbach, 1970). This sub-family consists of 4 species. The three species in Southern and Sub-Saharan Africa and the Saga species in Southeastern and Western Palearctic Region display rather different distribution from each other. The *Saga* species containing the greatest grasshoppers of Europe consists of 13 genus (Kaltenbach, 1967). 5 genus within this species live in 5 habitats in Europe continent (adapted in Western Siberia region), and the rest live in Asia continent (Caucasus, Turkey, Syria, Lebanon, Israel, Iran and Iraq) (Kaltenbach, 1967).

While *Saga* species hide themselves on plant parts during daytime, they become rather active stem hunters during the nighttime (Kaltenbach, 1967; 1990). For this reason, it is rather difficult to find migrant bush-crickets at the said regions. Due to the low number of the observed samples and the similarity between the species, the studies made on collection of an identification key remains uncomprehensive (Krauss, 1878; Saussure, 1888; Werner, 1905). Almost no study has been conducted in connection with *Saga* species until the mid-way through this century (Burr et al., 1923; Ramme, 1951). The first detailed description of the species was made by Ramme; later on an available identification key was published by Kaltenbach (Kaltenbach, 1967).

This study has been conducted due to lack of previous specific studies on Saga species or focus of the previous studies only on identification of the species in our country and hence this study provides information on description, existence, ecology and biology of *Saga ephippigera syriaca* Lucas, 1864 species.

MATERIAL AND METHODS

The main material of the study is the *Saga ephippigera syriaca* (Orthoptera: Tettigoniidae: Saginae) species collected from Kandil Highlands of Ahir Mountain at a height of 710 meters in Kahramanmaraş. One side of this region is covered with forests and the other side is covered with *Cephalaria salicifolia* Post (Dipsacaceae), which is an endemic perennial herb for Kahramanmaraş. Field visits have been made to this region as of the end of May. The male and female individuals of *Saga ephippigera syriaca* have been collected from the region and cultivated in the laboratory for a period of 2 years. This type of grasshopper collected from the nature has been morphologically adapted to this endemic plant to a great extent. Ecological and faunistical observations have been made during collection of the male and female individuals from the nature.

The samples brought to the laboratory have been cultivated in ten boxes, which have been filled with soil, at a certain height in such a way to contain 1 male + 1 female individual. These samples, which were observed to have been fed with living materials in the nature, has been fed with insect species of Orthoptera, Coleoptera, Odonata ve Neuroptera orders collected during the field visits (Fig. 1). The individuals, which were mated at different times, have been observed daily. The lengths of the eggs, which were obtained from each culture, have been measured with calipers and counted daily. In addition, morphometric measurements of the male and female individuals and their eggs have been made and the averages have been noted down.

RESULTS

During this study, the mature male and female individuals of *Saga ephippigera syriaca* species have been collected from *Cepholoria salicifolia* Post, which is an endemic plant for Kahramanmaraş and Turkey, from Kandil highlands of Ahir Mountain and cultivated (Fig. 2). Such individuals have been fed with insects from Coleoptera, Orthoptera, Neuroptera and Odonata Orders collected from the nature as Saginea fed with live insects.

Description and Distribution

The lengths of the mature female individuals of *S.ephippigera syriaca* are rather longer than the lengths of mature male individuals (Fig. 3). The antennas are generally filiform and thickened at the proximally and mostly do not outreach the abdomen. All species have strong jaws; the forelegs and mid-legs are rather big; and the lower part of the thorax is covered with strong quills (Fig. 4). The body parts such as mandibula, ovipositor and legs are generally sclerotized clearly (Kaltenbach, 1990).

The wings of female *S. ephippigera syriaca* are shortened and even atrophied. However, a couple of small wings may be observed on the male individuals. The length of these wings is as long as ¼ of the length of the pronotum (Fig. 5). The ovipositor of the female individuals shift upward. *S. ephippigera syriaca* are yellow, brown or greenish in color (Fig. 6). Their bodies usually contain at least one these colors. The lower part of the head is reddish brown (Fig. 7). They live in Syria and Turkey (http://www.wikiwand.com/fr/Saga_ephippigera_syriaca).

It has been observed that *S. ephippigera syriaca* live at the outskirts of mountainous areas and forests and within the bushes (Figure 8). *Cephalaria salicifolia* Post, endemic for Kahramanmaraş, is the host for this species (Figure 9). Such plant is a perennial bushy plant with a stem reaching 45 cm upwards; the lowest parts of the leaves are long and thin; the tips of the leaves are oval and bare. The diameter of the flowers vary between 1 and 1,5 cm; and the receptacle is wide. The color of the flower is not known absolutely (Szabó, 1940; Matthews, 1972).

Feeding

S. ephippigere syriaca, which hunts actively at nights, approaches its victim slowly or waits the victim to come to it; and catches its victim quickly when the victim approaches. The forelegs are adapted to hold the caught victim. It also uses bid-legs to hold the victim. It has strong quills at the inner and outer edges of the tibia and femur on the leg (Kaltenbach, 1990). It has been observed that it starts eating its victim from the neck or the hind legs (Fig. 10).

Mating and Oviposition

The male individuals of Saginae are smaller than the female individuals. Former studies revealed that male individuals make ultrasonic sounds through rubbing their wings in order to attract the females (Kolics et al., 2008). The female saga hold on to the abdomen of the male Saga during mating (Fig. 11). Female *S. ephippigera syriaca* lays her eggs during the warmer hours of the day. While ovipositioning, the female controls the ground, where she will lay her eggs, through dipping her ovipositor or with her antennas (Fig. 12). Then she dips her ovipositor 2 or 2,5 cm deep in the soft part of the soil and lays her eggs. It has been observed that the female does not lay her eggs to a single place, but leaves her eggs into several places in such a way to bring several eggs together (Fig. 13).

The female individuals usually die after ovipositioning. As in the case of other insects, the growth process of the laid eggs of *S. ephippigera sriayaca* varies depending on the temperature and humidity of the environment. Despite varying according to the species, the number of eggs of *S. ephippigera sriayaca* varies between 80 and 120 during their life span. The eggs generally hatch after a diapause of 2 to 3 years; and the eggs may remain under the soil for a period of 5 years. No egg parasitoid has been identified until now (Van Helsdingen et al., 1996). The *S. ephippigera syriaca* species, which we have cultivated, has been observed to lay 126 eggs (Figure 14); and the eggs collected after ovipositioning has been measured with calipers (Schedule 1).

DISCUSSION

As a conclusion, it has been identified that *S. ephippigera syriaca* lives on *Cephalaria salicifolia* Post plant, which is endemic to the region and to Kahramanmaraş, as well as at forests. Since the species is very well adapted to *Cephalaria salicifolia* Post plant, it hides itself from its natural enemies and catches its victims easily. It has been observed that male individuals make sounds at nights through rubbing their wings in order to attract the females and find their places. As in the case of other Saga species, it has been determined that *S. ephippigere syriaca* approaches its victim slowly and silently and catches the victim while hunting at nights and that it lays its eggs at the warm hours of the day. It has been detected that the number of eggs is rather high compared to several other saga species (*Saga pedo*) and that it may lay about 120 eggs (Burr et al., 1923; Quiet, 1988; 1991).

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Figure 1. Cultivation of the collected samples and feeding of such samples with the insects collected from the nature.

Figure 2. *Cephaloria salicifolia* Post.

Figure 3. a. *S. ephippigera syriaca* (♂), b. *S. ephippigera syriaca* (♀)

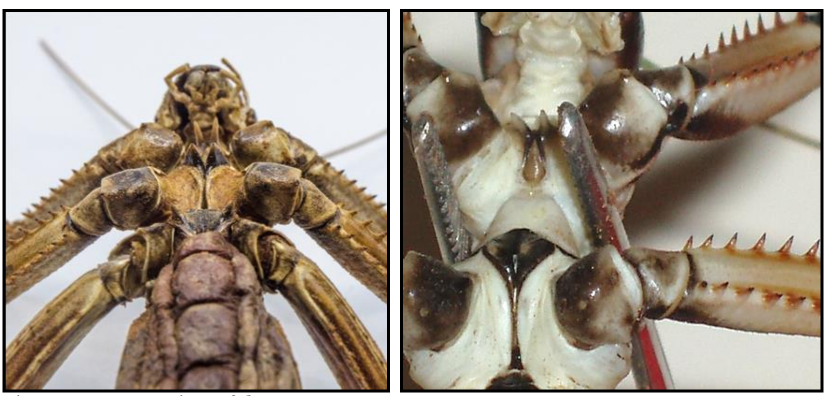

Figure 4. Bottom view of thorax.

Figure 5. View of the wings in male individuals (♂).

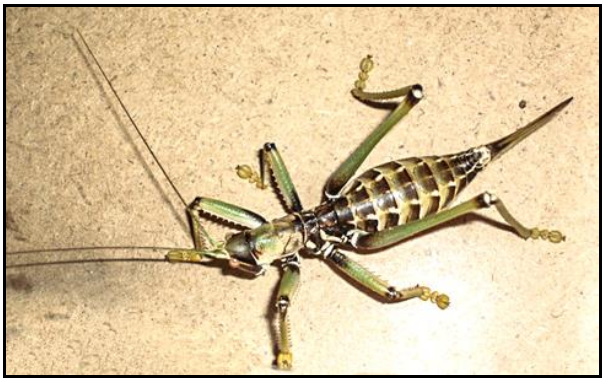

Figure 6. Upper view of *S. ephippigera syriaca* (♀)

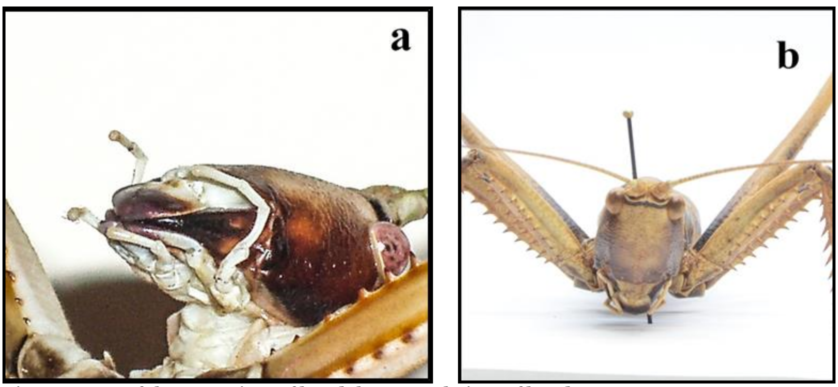

Figure 7. a. Left bottom view of head, b. Frontal view of head.

Figure 8: *Cephaloria salicifolia* zone at the edge of a forest

Figure 9. *S. ephippigera syriaca* (♀) living within *C. salicifolia* Post plant.

Figure 10. Feeding with insects from Melonoidea and Tettigoniidae families

Figure 11. Mating of male and female individuals (male on the left and female on the right)

Figure 12. Dipping the ovipositor in the soil

Figure 13. Laying eggs in the soil

Figure 14. Eggs laid by *S. ephippigera syriaca*

Schedule 1. Length and width measurements of the collected eggs Length and width measurements of the randomly selected eggs. Color: Dark greyish - black

1st Repetition	Length	Width	2nd Repetition	Length	Width	3rd Repetition	Length	Width
1	1,1cm	2mm	1	1,0cm	3mm	1	1,1cm	2mm
2	1,1cm	2mm	2	1,0cm	2mm	2	1,1cm	2mm
3	1,0cm	3mm	3	1,0cm	2mm	3	0,9cm	2mm
4	1,1cm	2mm	4	1,1cm	2mm	4	1,1cm	2mm
5	1,1cm	2mm	5	1,0cm	2mm	5	1,0cm	2mm

CATALOGUE OF THE FAMILY DRYOMYZIDAE (DIPTERA) OF CHINA

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[Hassan, M. A., Fatima, N. & Yang, D. 2019. Catalogue of the family Dryomyzidae (Diptera) of China. Munis Entomology & Zoology, 14 (2): 626-628**]**

ABSTRACT: A present catalogue of the family Dryomyzidae attempts to all known species (5) including the new country records, *Dryomyza pakistana* Kurahashi, 1989 is updated for the mainland of China. The valid name of all known species for China, their synonyms and distribution including the photographs of new records are provided.

KEY WORDS: Dryomyzidae, *Dryomyza pakistana*, China, new record

The family Dryomyzidae (Diptera: Insecta) comprises about 25 valid species in 8 genera, including 2 fossil genera, each having single species (*Palaeotimia* Meunier, 1908 and *Prodryomyza* Hennig, 1908) and 2 fossil species under genus *Dryomyza* Fallén, 1820, mainly distributed in the northern hemisphere (Mathis & Sueyoshi, 2011). According to the most recent catalog of Dryomyzidae (Mathis & Sueyoshi, 2011), this family comprises four species from the Oriental and Palearctic region of China; genus *Paradryomyza* Ozerov, 19873 includes only one species from Oriental and three species of genus *Dryomyza* Fallén from the Palearctic region. The genus *Paradryomyza* Ozerov currently includes 4 species while *Dryomyza* Fallén comprises 12 species in the world, mainly distributed in the Palaearctic region.

Here, we have presented the new record of Palaearctic species of the genus *Dryomyza* Fallén, *Dryomyza pakistana* Kurahashi, 1989 from Guizhou Province of China. Now, the geographical range of this species extended from the Indo-Pak subcontinent (India and Pakistan) to the mainland of China.

MATERIALS AND METHODS

This catalogue covers all the valid species of this ground known from China, based on the previous references' literature and present collection of new records from, Guizhou Province, Jiangkou, Fanjingshan, 1600-1800m. The specimens were identified by the help Kurahashi (1989) and Wachkoo et al. (2017). The identified specimens are deposited at Department of Entomology, China Agricultural University, Beijing. An alphabetical arrangement of genera and species are presented hitherto from China. For the generic classification "World catalog and conspectus on the family Dryomyzidae (Diptera: Schizophora)" (Mathis & Sueyoshi, 2011) was followed. Photographs were taken by using Zeiss SteREO Discovery V12 microscope and the figures were cleaned with Adobe Photoshop CS6.

RESULTS AND DISCUSSION

During the present study the species list of family Dryomyzidae are updated from China. A total of 5 species are listed, including one fossil taxa and one new record for the mainland of China. Before Mathis and Sueyoshi (2011), world catalog of family Dryomyzidae, only a single species, *Neuroctena formosa* (Wiedemann, 1830), was listed from Zhejiang and Hunan provinces of China, and Taiwan (Hua, 2006; List of Chinese Insects, Vol. IV; 159). Later, Mathis and Sueyoshi (2011) added four species to the list for family Dryomyzidae of China. Here we have recorded *Dryomyza pakistana* Kurahashi, 1989 as new record for the fauna of China. This species was previously known from Pakistan (Punjab: Murree; Khyber Pakhunkhawa: Ayubia, Dungagali and Nathiagali, 2000-2500 m; Azad Jammu and Kashmir: Banjosa, 1829 m) and India (Jammu and Kashmir: Srinagar, Kashmir University Botanical Garden, 1600-1640 m). The detail description (Kurahashi, 1989) and diagnosis of this species are provided by (Wachkoo et al., 2017; Hassan et al., 2018). Here, we have provided the detail diagnostic characters on the photographs of lateral and dorsal habitus (Figs. 1A-B) of this species.

Catalogue

Family Dryomyzidae
Subfamily Dryomyzinae
Genus *Dryomyza* Fallén, 1820

Synonyms: *Dryomyza* Fallén, 1820a: 15. Type species: *anilis* Fallén, by subsequent designation (Zetterstedt 1846: 2082); *Neuroctena Rondani*, 1868: 56; *Neuroctena* (*Stenodryomyza*) Hendel, 1924: 214; *Stenodryomyza* Hendel, 1937: 186.

Dryomyza formosa Wiedemann, 1830

Synonyms: *Dryomyza formosa* Wiedemann, 1830; *Scatophaga formosa* Wiedemann, 1830: 447; *Dryomyza maculipennis* Macquart, 1851: 246; *Dryomyza formosa* Loew 1858: 112; *Dryomyza gigas* Snellen von Vollenhoven, 1862: 18; *Eggizoneura formosa* Coquillett 1898: 339; *Neuroctena* (*Stenodryomyza*) *formosa* Hendel 1924: 214; *Stenodryomyza formosa* Czerny 1930: 5.
Distribution: Oriental: India, Taiwan, Vietnam. **Palaearctic:** China, Japan, Korea, Russia (Hua, 2006; Mathis & Sueyoshi, 2011).

Dryomyza pakistana Kurahashi, 1989

Synonyms: *Dryomyza pakistana* Kurahashi, 1989: 44.
Material Examined: China: Guizhou Prov., Jiangkou, Fanjingshan, 1600-1800 m, 2♂, 2♀, 7.x.18, leg, (4m, China Agricultural University, Beijing), Zhengkun Hu.
Distribution: Oriental: Pakistan, India (Kurahashi, 1989; Mathis & Sueyoshi, 2011; Wachkoo et al., 2017).

Dryomyza puellaris Steyskal, 1957

Synonyms: *Dryomyza puellaris* Steyskal, 1957: 65.
Distribution: Palaearctic: China: Szechwan: Suifu (Sichuan) (Mathis & Sueyoshi, 2011).

Dryomyza shanwangensis Zhang, 1989

Synonyms: *Dryomyza shanwangensis* Zhang, 1989: 364.
Distribution: Palaearctic: China: Fossil species; China. Shandog: Shanwang (Mathis & Sueyoshi, 2011).

Genus *Paradryomyza* Ozerov, 1987

Synonyms: *Paradryomyza* Ozerov, 1987: 38. Type species: *Odontomera setosa* Bigot, by original designation.

Paradryomyza orientalis Ozerov & Sueyoshi, 2002

Synonyms: *Paradryomyza orientalis* Ozerov & Sueyoshi, 2002: 564.
Distribution: Oriental: Taiwan. Taichun xian: Hoping xiang, Suchilanchi (Ozerov & Sueyoshi, 2002; Mathis & Sueyoshi, 2011).

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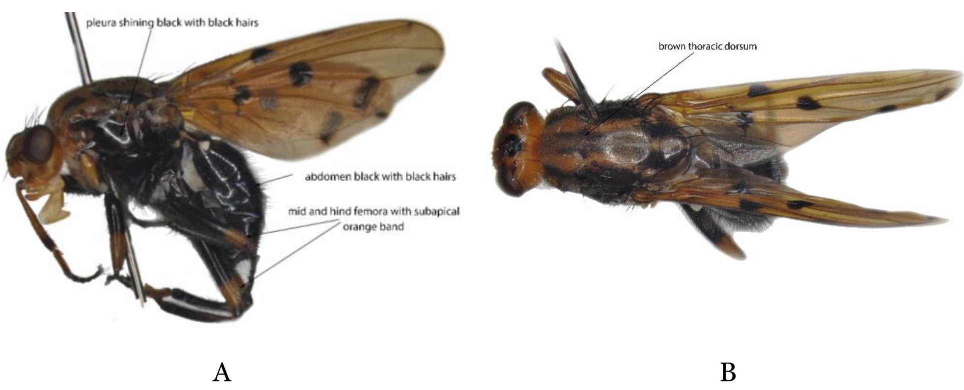

Figure 1. *Dryomyza pakistana* Kurahashi, 1989. Photo: M. A. Hassan: A; Lateral habitus, B; dorsal habitus.

EVALUATION OF OAK TASAR SILKWORM HYBRIDS IN DIFFERENT SEASONS FOR IMPROVEMENT IN PRODUCTIVITY

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ABSTRACT: The rearing performance of sixteen hybrid combinations were evaluated to find out the superior hybrids. Rearing of the F_1 hybrid progenies was conducted as per standard procedures during spring and summer crop in the years 2017 and 2018.The data generated in respect of eight economically important traits during spring and summer seasons of two years was recorded replication wise and pooled. The data was analyzed statistically and subjected to multiple trait evaluation index by following Mano's evaluation index method. The breeds were ranked as per the cumulative score and the value of a particular trait in a particular breed was compared with the ranking. Seven hybrid combinations scored higher E.I. values greater than 50, out of which C_{27} × RPP and RPP × C_{27} displayed significantly superior performance in all the traits under study during both spring and summer seasons. The highest average cumulative evaluation index score of 70.11 was recorded in C_{27} × RPP hybrid. The superior hybrids may be considered for large scale trials for assessing their commercial exploitability under specified environmental conditions in the valley regions of Manipur.

KEY WORDS: Oak tasar, silkworm, *Antheraea proylei*, hybrid, evaluation index

Sericulture is the art and science of producing silk, the elegant natural fibre, which has an ever-increasing demand in the global scenario. India boasts of being the only country in the world to produce five different types of silk, *viz.*, Mulberry, Muga, Eri, Tropical Tasar and Temperate/Oak Tasar. Oak Tasar silk is a unique textile fibre which has a huge domestic demand due to its ethnicity and elegance. India and China are the only two major countries producing Oak Tasar silk in the global context. Manipur is the leading producer of Oak tasar silk in the country. However, the production in the state ranges between 5-7 metric tonnes per annum and is not sufficient to meet the domestic demand. Among various reasons for low productivity, the lack of highly productive breeds suitable to the prevailing environmental conditions and poor performance of the breeds due to continuous inbreeding stand prominent.

Enrichment of silkworm breeds has always been an important factor contributing to increase the productivity in sericulture. Continuous renewal and combination of existing breeds/hybrids with new superior varieties and their commercialization is essential to improve silk productivity and to meet the consumer demand. The choice of a breed/hybrid depends not only on the genotype but also on its performance under diverse environmental conditions (Rahman & Ahmed, 1988). In this regard, it is of paramount importance to know the seasonal performance of the different hybrid combinations of oak tasar silkworm breeds. Keeping the above aspects in view, the seasonal performance of sixteen hybrid progenies was assessed by using Multiple trait evaluation index

(E.I.) to identify most promising hybrid (s) so as to maximize Oak tasar cocoon yield and productivity.

MATERIALS AND METHODS

Diseases free layings of sixteen hybrid progenies were obtained by utilizing the parental oak tasar silkworm species/breeds, *viz.*, RPP, RP, *A. pernyi*, PRP_5, BY_1, B_6, *A. proylei*, Blue, PRP_{12} and C_{27} in different cross combinations based on their combining abilities (unpublished data). The rearing was conducted on *Quercus serrata* plants at the experimental farm of RSRS, Imphal during spring (March-April) and summer (July-August) seasons of 2017 and 2018 by following standard package of practices (Singh et al., 2012). The silkworms were reared on *Quercus serrata* plants.

The larvae of each breed were reared in three replications and each replication comprised of 200 larvae. During the rearing period, larvae and cocoons were assessed for different parameters *viz.*, fecundity, hatching percentage, larval weight, larval duration, cocoon yield, cocoon weight, shell weight and shell ratio. The data recorded with regard to different parameters was pooled separately and subjected to multiple trait evaluation index method as per the procedure described by Mano et al. (1993). The evaluation index value for negative traits *viz.*, larval duration was computed separately by using the modified formula (Talebi & Subramanya, 2009).

$$\textit{Evaluation index } (EI) = \frac{A - B}{C} \times 10 + 50$$

Where,
A = Value of a particular breed for particular trait,
B = Mean value for a particular trait of all the breeds,
C = Standard Deviation of a particular trait for all the breeds,
10 = Standard unit,
50 = Fixed value.

The average E.I. value fixed for selection of a breed is >50. The breeds that scored above the limit were considered to possess greater economic value.

RESULTS AND DISCUSSION

The data pertaining to rearing performance of sixteen hybrids of oak tasar silkworm under RSRS, Imphal farm conditions during spring and summer seasons along with E.I. scores are presented in Tables 1 and 2 respectively. The spring crop performance showed that among the sixteen hybrids, $C_{27} \times$ RPP recorded highest values for the traits fecundity (152 nos), cocoon/Dfl (68 nos.), larval weight (23.81 g), cocoon weight (7.58 g) and shell weight (0.78 g) and shortest larval duration (34 days), whereas RPP × C_{27} exhibited highest hatching percentage (80 %) and $PRP_{12} \times BY_1$ showed highest shell ratio (10.35 %). Similarly during summer crop, $C_{27} \times$ RPP outperformed all the other hybrids with higher values for the traits, hatching percentage (88 %) cocoon/Dfl (36 nos.), larval weight (22.11 g), cocoon weight (7.01 g), shell weight (0.72 g) and shell ratio (10.27 %) and lowest value for the trait, larval duration (39 days), RPP × C_{27} exhibited highest fecundity of 171 numbers.

Evaluation index assessment is the multiple performance of a population for selection/short-listing of the breeds/hybrid combinations by taking into consideration all the economic traits. The multiple trait evaluation index of all the traits of the hybrids are shown in parentheses in Tables 1 and 2. In spring crop rearing, five hybrids exhibited E.I. scores above 50 with highest E.I. value of 71.22 by C_{27} × RPP, followed by RPP × C_{27} (66.23), BY_1 × *A. proylei* (58.74), Blue × PRP_{12} (56.25) and PRP_5 × BY_1 (54.99). For the trait hatching percentage, six hybrids scored E.I. values above 50, the highest being in RPP × C_{27} (79.82). The highest E.I. value for cocoon yield/Dfl was exhibited by C_{27} × RPP (75.64) followed by RPP × C_{27} (72.56), RP × *A.pernyi* (55.13) and *A.pernyi* × RP (53.07). For the trait, larval duration, E.I. scores greater than 50 was calculated in C_{27} × RPP (70.54) followed by RPP × C_{27} (63.7) and PRP_5 × BY_1 (63.7), BY_1 × PRP_5 (56.85), BY_1 × *A.proylei* (56.85) and BY_1 × PRP_{12} (56.85). For the cocoon characters, C_{27} × RPP scored highest E.I. values of 73.44 and 72.5 respectively for cocoon weight and shell weight, with scores above 50 in four hybrids for cocoon weight and five hybrids for shell weight. Nine hybrids scored above 50 for the trait shell ratio and PRP_{12} × BY_1 exhibited highest E.I. value of 64.54. The cumulative evaluation index scoring for performance during spring season ranked the hybrids in the order- C_{27} × RPP > RPP × C_{27}, BY_1 × *A. proylei* > PRP_{12} × BY_1 > RP × *A. pernyi* > Blue × PRP_{12} > BY_1 × PRP_{12}.

Summer crop performance revealed higher (>50) E.I. values in seven out of sixteen breeds where RPP × C_{27} scored 68.77. For the remaining seven traits, C_{27} × RPP exhibited highest E.I. values of 75.21 (hatching percentage), 71.74 (cocoon/Dfl), 71.13 (larval duration), 67.39 (cocoon weight), 67.50 (shell weight) and 66.96 (shell ratio). The cumulative evaluation index scoring from the performance during summer season ranked the hybrids in the order- C_{27} × RPP > RPP × C_{27} > PRP_{12} × BY_1 > PRP_5 × BY_1 > RP × *A. pernyi* > BY_1 × *A. proylei*.

Utilization of E.I. methods to identify potential pure races and hybrids is remained as powerful tool in adjudicating promising parental races and hybrids (Krishnaswami et al., 1964; Singh & Subbarao, 1993; Sudhakara Rao et al., 2001; Ramesh Babu et al., 2002; Rao et al., 2006 and Ramesha et al., 2009). Any effort to improve the yield requires consideration of cumulative effect of the major traits, which influences the silk yield impartially. A selection index makes it possible to select for a character by selecting simultaneously for two or more characters related to it. Evaluation index is one method that increases the precision of selection of breed among an array of breeds by a common index giving due weightage to all the yield component traits (Bhargava et al., 1994). The present study has yielded good information in identifying promising oak tasar silkworm hybrids having greater economic value in terms of maximum traits. Based on the performance and evaluation of sixteen Oak tasar silkworm hybrids, C_{27} x RPP, RPP x C_{27}, BY_1 x *proylei*, PRP_{12} x BY_1 and RP x *pernyi* were well-suited for both rearing seasons in the valley regions of Manipur. The hybrids Blue x PRP_{12} and BY_1 x PRP_{12} exhibited better performance only in the spring crop, while PRP_5 x BY_1 scored an overall high E.I. value during summer crop. Evaluation and identification of promising hybrids should be the first step to judge the optimum potential of the hybrid before popularizing them in the field. It is therefore evinced that large scale trials can be taken up for assessing the commercial exploitability of these superior hybrids and can also be considered for designating season specific hybrids in the interest of the industry.

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Table 1. Rearing performance of F_1 hybrids of *Antheraea* species during spring season (Average of two years).

Sl. No.	Crosses	Fec (No.)	H%	Coc/ Dfl	LW (g)	LD (days)	CW (g)	SW (g)	SR (%)	C.EI	Rank
1	RP × *A.pernyi*	126 (38.76)	71 (48.24)	48 (55.13)	21.64 (54.17)	38 (43.15)	7.13 (59.37)	0.72 (57.50)	10.10 (53.18)	51.19	**V**
2	*A.pernyi* × RP	129 (42.51)	69 (41.23)	46 (53.07)	21.07 (49.42)	38 (43.15)	6.80 (49.06)	0.69 (50.00)	10.15 (55.45)	47.98	
3	RPP × C_{27}	148 (66.23)	80 (79.82)	65 (72.56)	23.57 (70.25)	35 (63.70)	7.47 (70.00)	0.76 (67.50)	10.17 (56.36)	68.30	**II**
4	C_{27} × RPP	152 (71.22)	76 (65.79)	68 (75.64)	23.81 (72.25)	34 (70.54)	7.58 (73.44)	0.78 (72.50)	10.29 (61.81)	70.40	**I**
5	PRP_5 × BY1	139 (54.99)	73 (55.26)	42 (48.97)	20.72 (46.50)	35 (63.70)	6.58 (42.19)	0.65 (40.00)	9.93 (45.45)	49.63	
6	BY1 × PRP_5	132 (46.25)	69 (41.23)	40 (46.92)	21.13 (49.92)	36 (56.85)	6.61 (43.12)	0.67 (45.00)	10.10 (53.18)	47.81	
7	B_6 × PRP_5	134 (48.75)	69 (41.23)	41 (47.95)	21.21 (50.58)	38 (43.15)	6.73 (46.87)	0.68 (47.50)	10.14 (53.24)	47.41	
8	PRP_5 × B_6	127 (40.01)	70 (44.74)	40 (46.92)	20.33 (43.25)	39 (36.30)	6.49 (39.37)	0.64 (37.50)	9.84 (41.36)	41.18	
9	PRP_{12} × *A.proylei*	130 (43.76)	71 (48.24)	42 (48.97)	20.85 (47.58)	38 (43.15)	6.76 (47.81)	0.67 (45.00)	9.91 (44.54)	46.13	
10	*A.proylei* × PRP_{12}	122 (33.77)	69 (41.23)	38 (44.87)	19.35 (35.08)	39 (36.30)	6.53 (40.62)	0.63 (35.00)	9.58 (29.54)	37.05	
11	PRP_{12} × Blue	131 (45.01)	70 (44.74)	37 (43.85)	18.78 (30.33)	38 (43.15)	6.44 (37.81)	0.62 (32.50)	9.62 (31.36)	38.59	
12	Blue × PRP_{12}	140 (56.25)	72 (51.75)	36 (42.82)	21.15 (50.05)	37 (50.00)	6.81 (49.37)	0.69 (50.00)	10.12 (54.09)	50.54	**VI**
13	BY1 × *A.proylei*	142 (58.74)	72 (51.75)	43 (50.00)	21.18 (50.33)	36 (56.85)	6.94 (53.44)	0.72 (57.50)	10.31 (62.73)	55.17	**III**
14	*A.proylei* × BY1	127 (40.01)	70 (44.74)	38 (44.87)	20.86 (47.67)	38 (43.15)	6.58 (42.19)	0.65 (40.00)	9.87 (42.73)	43.17	
15	BY1 × PRP_{12}	136 (51.25)	73 (55.26)	36 (42.82)	21.05 (49.25)	36 (56.85)	6.77 (48.12)	0.68 (47.50)	10.01 (49.09)	50.02	**VII**
16	PRP_{12} × BY1	139 (54.99)	71 (48.24)	35 (41.79)	21.52 (53.17)	37 (50.00)	7.02 (55.94)	0.73 (60.00)	10.35 (64.54)	53.58	**IV**
	Mean	135	71.5	43	21.14	37	6.83	0.69	10.03		
	S.D.	8.01	2.85	9.75	1.20	1.46	0.32	0.04	0.22		
	S.E.	2.53	1.45	2.35	0.30	0.36	0.08	0.01	0.05		
	C.D. @ 5%	7.01	4.01	6.51	0.83	1.01	0.22	0.03	0.15		

Table 2. Rearing performance of F_1 hybrids of *Antheraea* species during summer season (Average of two years).

Sl. No.	Crosses	Fec (No.)	H%	Coc/ Dfl	LW (g)	LD (days)	CW (g)	SW (g)	SR (%)	C.EI	Rank
1	RP × *A.pernyi*	151 (49.01)	78 (57.94)	28 (46.42)	18.82 (48.68)	43 (41.05)	6.73 (55.22)	0.67 (55.00)	9.95 (53.04)	50.80	V
2	*A.pernyi* × RP	144 (42.09)	76 (54.49)	30 (52.75)	18.59 (46.98)	43 (41.05)	6.54 (46.96)	0.64 (47.50)	9.78 (45.65)	47.19	
3	RPP × C_{27}	171 (68.77)	86 (71.76)	35 (68.58)	21.95 (71.69)	40 (63.61)	6.92 (63.48)	0.70 (62.50)	10.11 (50.00)	65.05	II
4	C_{27} × RPP	168 (65.81)	88 (75.21)	36 (71.74)	22.11 (72.87)	39 (71.13)	7.01 (67.39)	0.72 (67.50)	10.27 (66.96)	69.82	I
5	PRP_5 × BY1	156 (53.95)	74 (51.03)	33 (62.25)	18.62 (47.21)	40 (63.61)	6.57 (48.26)	0.65 (50.00)	9.89 (50.43)	53.34	IV
6	BY1 × PRP_5	146 (44.07)	68 (40.67)	27 (43.26)	19.04 (50.29)	42 (48.57)	6.78 (57.39)	0.66 (52.50)	9.73 (43.48)	47.53	
7	B_6 × PRP_5	152 (50.00)	71 (45.84)	26 (40.09)	18.16 (43.82)	42 (48.57)	6.63 (50.87)	0.65 (50.00)	9.80 (46.52)	46.96	
8	PRP_5 × B_6	149 (47.03)	69 (42.40)	30 (52.75)	18.13 (43.60)	41 (56.09)	6.31 (36.96)	0.62 (42.50)	9.82 (47.39)	46.09	
9	PRP_{12}×*A.proylei*	162 (59.88)	72 (47.58)	31 (55.91)	18.65 (47.43)	43 (41.05)	6.52 (46.09)	0.64 (47.50)	9.81 (46.96)	49.05	
10	*A.proylei*×PRP_{12}	153 (50.99)	70 (44.13)	26 (40.09)	17.59 (39.63)	44 (33.54)	6.33 (37.83)	0.61 (40.00)	9.63 (39.13)	40.67	
11	PRP_{12} × Blue	159 (56.92)	70 (44.13)	30 (52.75)	16.88 (34.41)	42 (48.57)	6.08 (26.96)	0.56 (27.50)	9.21 (20.87)	39.01	
12	Blue × PRP_{12}	158 (55.93)	70 (44.13)	27 (43.26)	18.43 (44.85)	43 (41.05)	6.48 (44.35)	0.65 (50.00)	10.03 (56.52)	47.51	
13	BY1 × *A.proylei*	142 (40.12)	69 (42.40)	27 (43.26)	18.66 (47.50)	41 (56.09)	6.71 (54.35)	0.68 (57.50)	10.13 (60.87)	50.26	VI
14	*A.proylei* × BY1	137 (35.18)	73 (49.31)	27 (43.26)	18.74 (48.09)	43 (41.05)	6.65 (51.74)	0.66 (52.50)	9.92 (51.74)	46.61	
15	BY1 × PRP_{12}	133 (31.23)	69 (42.40)	25 (36.93)	19.15 (51.10)	42 (48.57)	6.67 (52.61)	0.66 (52.50)	9.89 (50.43)	45.72	
16	PRP_{12} × BY1	147 (45.06)	71 (45.84)	28 (46.42)	20.48 (60.88)	41 (56.09)	6.88 (61.74)	0.69 (60.00)	10.03 (56.52)	54.07	III
	Mean	152	73.4	29.13	19.00	41.81	6.61	0.65	9.88		
	S.D.	10.12	5.79	3.16	1.36	1.33	0.23	0.04	0.23		
	S.E.	2.53	1.45	0.79	0.34	0.33	0.06	0.01	0.06		
	C.D.@5%	7.01	4.01	2.19	0.94	0.92	0.16	0.03	0.16		

HALYMORPHA HALYS (HEMIPTERA:PENTATOMIDAE): A NEW INVASIVE SPECIES IN NORTH-WESTERN OF TURKEY

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ABSTRACT: The invasive species *Halymorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae) was found for the first time in hazelnuts (*Corylus avellana* L.) in the Western Black Sea Region, Turkey in 2018. It is native to Eastern Asia and expected to be entered and spread from Georgia in 2017 to the Cental and Eastern Black Sea Region of Turkey, and has reached the Western Black Sea Region in 2018 with its rapid distribution. Considering the potential of pest damage to hazelnuts, eradication and management programs should be developed in order to prevent its spread and damage immediately.

KEY WORDS: Brown marmorated stink bug, *Halymorpha halys*, hazelnuts, invasive, new record, north-western Turkey

Brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stäl), belongs to the order Hemiptera, family Pentatomidae. It is native to China, Japan, Korea and Taiwan (Hoffman, 1931; Rider et al., 2002; Bernon, 2004; Son et al., 2009; Lee et al., 2013), and introduced into North America in the 1990s, European countries in 2000s (Hemala & Kment, 2017), in Russia and Georgia in 2016 (Gapon, 2016) and in Turkey from Georgia in 2017 (Ak et al., 2018; Guncan & Gumus, 2019). The invasive species showed rapid distribution in 6 provinces of the Eastern and Central Black Sea Region (Ak et al., 2018; Guncan & Gumus, 2019) and Istanbul province from Marmara Region of Turkey in 2017 (Cerci & Kocak, 2017). In the World, the family of Pentatomidae is known to have around 4722 species in the. belonging to 900 genera (Rider, 2006). In Turkey, 170 species belonging to 57 genera of this family are known (Onder et al., 2006; Fent & Aktaç, 2007). *Halyomorpha halys* is a polyphag and has been recorded on various host plants belonging to a total of 49 different families (EPPO 2010; CPC 2011). That's why, it is a serious pest for agricultural plants (Gapon, 2016). Since the Turkey climate is likely to be suitable for distribution and establishment of pests, further studies are needed to evaluate the distribution and pest eradication. As populations of *H. halys* continue to increase in agricultural areas, pest control should be performed as soon as possible. The aim of this study provide new information about the distribution of this species introduced in Turkey.

MATERIAL AND METHODS

Sampling was made on hazelnuts in Sakarya and Duzce provinces during November and December 2018 (Fig. 1). Materials have been collected by visual inspections of the plants. The material collected was brought to the laboratory. The samples were separated individually and labelled for identification. Dried specimens were used for the description. The confirmation of the species determination was made by first author. The specimens were deposited in the Duzce University, Faculty of Agriculture and Natural Science, Turkey.

RESULTS AND DISCUSSION

Details of the examined material of the species is given below:

Order: Hemiptera Linnaeeus, 1758
Family: Pentatomidae Leach, 1815
Subfamily: Pentatominae Leach, 1815
Tribe: Cappaeini Atkinson, 1888
Genus: *Halyomorpha* Mayr, 1864
Species: *Halyomorpha halys* (Stål, 1855)
Synonyms: *Pentatoma halys* (Stål, 1855), *Poecilometis mistus* Uhler, 1860, *Dalpada brevis* Walker, 1867, *Dalpada remota* Walker, 1867.

Material examined: Sakarya: Hendek, Turkey, 40° 48' 18.3564'' N and 30° 44' 57.4800'' E, 197 m, 12.XI.2018, 19.XI.2018, 27.XI.2018 and 04. XII.2018, leg. Y. Adak, S. Oztemiz det. (1 specimen, 4 samples: 3 ♀♀; 3 ♂♂), on hazelnut (Fig. 2).

Distribution in the World: Japan, China, Korea, Taiwan, New Zealand, Georgia, Russia, America, Canada, Switzerland, Germany, Italy, France and Hungary (Wermelinger et al., 2008; Arnold, 2009; Fogain & Graff, 2011; Heckmann, 2012; Hoebeke & Carter, 2003; Callot & Brua, 2013; Lee et al., 2013; Pansa et al., 2013; Vetek et al., 2014; Gapon, 2016; Hemala & Kment, 2017).

Distribution in Turkey: This species was previously reported in Rize, Artvin, Trabzon, Samsun, Ordu, Gresun, Istanbul (Cerci & Kocak, 2017; Ak et al., 2018; Guncan & Gumus, 2019).

Its host range includes fruit trees, vegetable crops, legumes, and ornamentals (Kobayashi 1967, 1977). Economically important host food crops include apple, cherry, peach, pear, cucumber, eggplant, tomato, soybean and corn (Hoffman, 1931; Fukuoka et al., 2002, Hoebeke & Carter 2003; Bernon, 2004; Nielsen & Hamilton 2009a,b; Nielsen et al., 2011; Jacobs, 2012). In the study, we found on hazelnut in Hendek, Sakarya.

CONCLUSION

With the results obtained from this study, a new one was added to the distribution area of the pest in Turkey. It would be neccesary to carry out further research into the distribution of the species and monitoring of its population in Turkey to determine the spread of *H. halys* in different hosts.

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Figure 1. The locality of *Halyomorpha halys* in North-Western of Turkey.

Figure 2. Adults of *Halyomorpha halys*.

FIRST REPORT OF *STEATODA CINGULATA* (THORELL, 1890) (ARANEAE: THERIDIIDAE) FROM NANDA DEVI BIOSPHERE RESERVE, WESTERN HIMALAYA

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[**Quasin, S., Siliwal, M. & Uniyal, V. P.** 2019. First report of *Steatoda cingulata* (Thorell, 1890) (Araneae: Theridiidae) from Nanda Devi Biosphere Reserve, Western Himalaya. Munis Entomology & Zoology, 14 (2): 638-642]

ABSTRACT: Here, the theridid species *Steatoda cingulata* (Thorell, 1890) is reported from Nanda Devi Biosphere Reserve, Western Himalaya, with the description of the female for the first time from India. In this paper, we provide detailed description of both male and female specimens.

KEY WORDS: Comb-footed spiders, tangled webs, new report, Himalaya

Steatoda, Sundevall 1833 are small to medium, sized ecribellate, entelegyne Theridiids. They are widely distributed, constituting a diverse group of spiders occurring in a variety of habitats. The genus Steatoda differs from other genera of the family theridiidae by their comparatively large body; male pedipalps with strongly sclerotized internal paracymbium; embolus long and sickle or screw-shaped (Wunderlich, 2008). They build irregular tangle web of sticky silken fibres which is used to wrap prey. The web usually consist of sparse, central, sheet like structure supported by partly viscous, sticky threads, running in all directions (Levy & Amitai, 1982). There are 125 species of the genus steatoda reported from the world (WSC, 2018). In India six species of the genus Steatoda are reported so far: *Steatoda triangulosa* Walckenaer, 1802, *Steatoda grossa* C. L. Koch, 1838, *Steatoda albomaculata* De Geer, 1778, *Steatoda alboclathrata* Simon, 1897 and *Steatoda rufoannulata* Simon, 1899 (WSC, 2018). *Steatoda cingulata* (Thorell, 1890) is reported from China, Korea, Vietnam, Laos, Japan, Indonesia (WSC, 2018). It was first reported by Rajoria (2016) based on male specimens collected from Mahendri region of Satpuda Range, India, but it lacks detailed description. Here, we describe both the male and female specimens with detailed descriptions and SEM images of the genetalia.

MATERIAL AND METHODS

Specimens were collected from NDBR, which is located in the northern part of the Western Himalaya and comprises parts of Chamoli district in Garhwal, Bageshwar and Pittoragarh districts in Uttarakhand state. Adult specimens were collected by hand collection method. They were then preserved and examined under a stereomicroscope (MOTIC^{TM}). All measurements are taken in millimetres (mm) using an ocular micrometer. Epigyna were dissected and cleaned using Lactic acid. Photographs were taken with a Leica DFC 290 stereomicroscope. Type material was deposited in the public museum of Wildlife Information Liaison Development Society (WILD), Coimbatore, Tamil Nadu, India.

Abbreviations:

ALE = anterior lateral eye; AME = anterior median eye; Nanda Devi Biosphere Reserve =NDBR, PME= Posterior median eyes, PLE= Posterior lateral eyes; Fe=femur; Mt=metatarsus; MOQ= Median Ocular Quadrat; OQ= Ocular Quadrate; Pa=patella; SEM= scanning electron microscopy; Ta=tarsus; Ti=tibia; WILD = Wildlife Information Liaison Development Society.

TAXONOMY

Steatoda cingulata (Thorell, 1890)

(Fig. A-I)

Materials examined: 2 males, 3 females, Lata village, NDBR, Uttarakhand, India, N 30°41´56.3´´- E 079°42´43.9´´, 2089 m, 27 July 2009, 2 males WILD-09-ARA-1316, WILD-09-ARA-1317, 3 females WILD-09-ARA-1318, WILD-09-ARA-1319, WILD-09-ARA-1320 (Shazia Quasin).

Description.

Male: (WILD-09-ARA-1316)

Colour: Specimen is decolourised. Spider in live jet black with white markings on the dorsal side of the abdomen. In alcohol decolourised and is pale yellow in colour. Abdomen blackish with white horizontal 5-6 lines dorsally.

Total length 3.53. Carapace 2.1 long, 1.47 wide. Abdomen 2.16 long, 1.42 wide. Carapace oval, longer than wide, rough covered with warts more dense laterally and towards margins; margins serrated row of tubercles. Fovea pit like recurved broad. Posterior eyes larger than anterior eyes. Caput absent or very negligibly raised and covered with few small pallid hairs. Cervical and radial grooves distinct. Eyes eight AER is distinctly recurved, PER slightly recurved. Eyes: AME= 0.12, PME=0.11, ALE 0.12, PLE 0.14. Distance between eyes: PME-PLE= 0.07, ALE-PLE=adjacent, AME-ALE=0.06, AME-AME= 0.11, PME-PME= 0.09, OQ=0.22 long, 0.7 wide, MOQ (0.28 long and 0.3 wide). Clypeus 0.38 high. Chelicerae with two promarginal teeth and no retromaginal tooth. Endite, sternum and chelicerae tubercles present, Sternum 0.92 wide 1.2 long. Sternum broader between anterior legs and narrowing down between the posterior legs and extending like a pedicle beyond coxa IV. Endites 0.21 wide 0.32 long, longer than broad; facing prolaterally; labium perfectly fits between the endites. Labium 0.32 wide 0.2 long, roughly rectangular; slightly longer than wide. Five pairs of sigilla; Chelicerae with two promarginal teeth and no retromaginal tooth. Legs: all legs with row of ventral tubercles, very distinct on femur and tibia of anterior legs. Leg measurements (femur, patella, tibia, metatarsus, tarsus, total length): 2.5, 0.7, 2.0, 1.9, 1.0, 8.1; Leg II: 1.9, 0.7, 1.5, 1.5, 0.8, 6.3; Leg III: 1.6, 0.6, 1.1, 1.2, 0.7, 5.2; Leg IV 2.3, 0.7, 1.7, 1.8, 0.9, 7.4; Leg formula 1432. Abdomen sub-oval with collar like sclerotised ring around pedicle and extending ventrally as scutum covering the book lungs and epigastric furrow. A single row of tubercles on dorsal and lateral sides of sclerotised ring. Two colulus large. Abdomen laterally having several striulatory ridges or folds more prominent posterior-laterally. Ventrally abdomen with few broad folds mottled with white spots. Spinnerets three pairs, integument around spinnerets with yellow spots. Colulus large.

Palp: Tibia is cup shaped broader distally with broad DTA with rounded margin distally. Cymbium covered with long bristles and stiff hairs. Embolic base longer with distal embolus which emerges as screw-like apical tip. Supported by long flap like conductor for length of embolus on the right side. Median apophysis, broad long loosely curling to form hollow tube with outer distal end triangular pointed.

Female (WILD-09-ARA-1318)
Colour: Orangish yellow carapace, legs, endites and sternum. Abdomen greyish brown with white horizontal and mid dorsal lines.

Total length 8.10. Carapace 3.0 long, 2.45 wide. Abdomen 5.1 long, 4.55 wide. Carapace with reticulation markings on lateral and posterior side. Caput not raised; Carapace as long as wide. Cervical and radial grooves distinct. Eye: posterior row straight AER recurved, Eyes: AME= 0.16, PME=0.16, ALE 0.18, PLE 0.16. Distance between eyes: PME-PLE= 0.06, ALE-PLE=adjacent, AME-ALE=0.06, AME-AME= 0.08, PME-PME= 0.06, OQ=0.36 long, 0.92 wide, MOQ (0.38 long and 0.4 wide). Clypeus 0.4 high. Chelicerae with two promarginal teeth and no retromaginal tooth. Endites 0.27 wide 0.82 long, longer than wide, widely spaced anteriorly; Labium 0.45 wide 0.27 long, wider than long; Sternum 1.73 wide 2.18 long, sternum same as male; warts on sternum, endites, and labium present but smaller in size in comparison to males. Warts on legs resembling male. Integument like broad ring band surrounding spinnerets outer side. Leg measurements (femur, patella, tibia, metatarsus, tarsus, total length): 2.6, 0.7, 2.1, 2.1, 1.1, 8.6; Leg II: 2.0, 0.6, 1.5, 1.5, 0.9, 6.5; Leg III: 1.6, 0.5, 1.8, 1.1, 0.7, 5.7; Leg IV 2.5, 0.7, 2.0, 1.8, 1.0, 8.0; Leg formula 1432. Abdomen: globular, ventral side with few yellow patches, book lungs and Epigyne covered sclerelotised plate. Three horizontal lines connected laterally, mid-dorsal discontinuous line; five pairs sigilla.

Epigyne: Externally the atrium with small round opening. Internally two large round spermathecae with copulatory ducts emerging posterior-laterally and fusing before opening in the atrium, fertilization ducts small and just above copulatory ducts.

Distribution. Spider specimens were collected from stony beds of Lata Village, NDBR along the river banks of Rishi Ganga, with low and sparse vegetation.

Habitat: Specimens were collected from under stones; the species prefers open dry areas, stony or sandy fields with low and scattered vegetation. They built irregular tangled web of white threads, females carried the egg sac which consists of a dense round centre, surrounded by loosely woven silk threads giving it a fluffy appearance; egg-sacs were light pink in colour. The spider was observed to prey on grasshoppers, moths, beetles and ants.

Conflicts of interest

The authors declare that there is no conflict of interest.

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Figure 1. A, C, external epigynum; B, internal epigynum; D, female habitus; E, female with egg sac; F, typical tangled webs build under rocks. Scale bar = 0.5 mm.

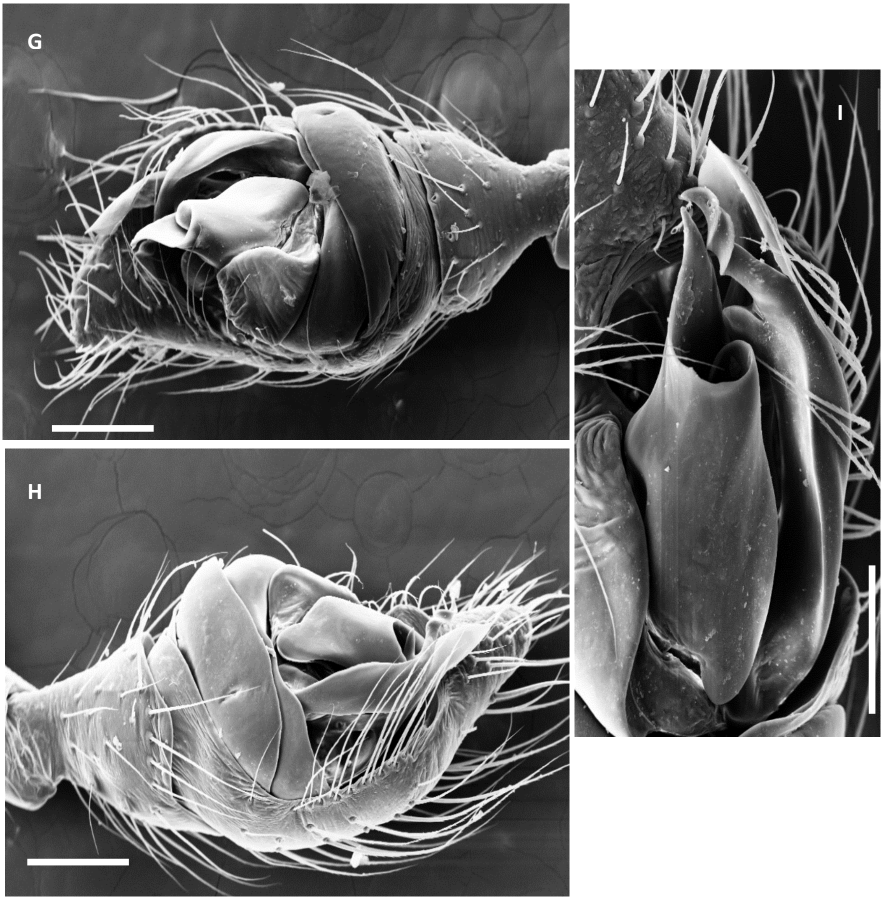

Figure 2. G-I, SEM image of male palp, scale bar: 100 µm.

BIOLOGY AND MORPHOMETRICS OF *PHALERA RAYA* MOORE (LEPIDOPTERA: NOTODONTIDAE) INFESTING *QUERCUS SERRATA* THUNB.

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[Subharani, S., Debaraj, Y., Chaudhuri, R. S. & Ibotombi Singh, N. 2019. Biology and morphometrics of *Phalera raya* Moore (Lepidoptera: Notodontidae) infesting *Quercus serrata* Thunb.. Munis Entomology & Zoology, 14 (2): 643-647**]**

ABSTRACT: The hairy caterpillar*, Phalera raya* Moore is a major defoliator infesting *Quercus serrata*, the primary food plant of oak tasar silkworm, *Antheraea proylei*. Studies on biological parameters of *P. raya* revealed that females laid light brown colour eggs and fecundity was 610 ± 24.80 eggs per female. Incubation period of the eggs was 8.4 ± 0.24 days and measured 0.91 ± 0.03 mm in diameter. The larvae passed through 6 larval instars. The duration of the 1st, 2nd, 3rd, 4th, 5th and 6th instar was 5.8 ± 0.37, 8.0 ± 0.45, 6.2 ± 0.37, 6.6 ± 0.24, 6.8 ± 0.20 and 11.0 ± 0.32 days respectively. Larval and pupal period was 43.4 ± 1.81 and 13.4 ± 0.67 days. The mean adult longevity was 4.5 ± 0.43 days and the average length and breadth of the adult was 30.50±0.10 mm and 7.55±0.24 mm respectively. The total developmental period was completed in 65 - 72 days.

KEY WORDS: *Phalera raya,* biology, morphometric, developmental stages, *Quercus serrata*

The saw tooth oak, *Quercus serrata* Thunberg is the primary food plant of the sericigenous insect, *Antheraea proylei.* This food plant is prone to attack of various insect pests, the severity of which is related to season and other environmental and management factors. Among the insect pest infesting *Q. serrata*, *Phalera raya* Moore, commonly known as hairy caterpillar is the most voracious and abundant (Devi & Singh, 2011) causing considerable loss to the silk industry. Yi-Ren et al. (2013) reported *Phalera* species as a major defoliating pest of Oak. There are also reports that *Phalera* species is also known to feed gregariously on Oak leaves as young larvae (Turacani et al., 2010). It has been recorded to affect various species of Oak throughout the world (Kalapanida & Petrakis, 2017). The damage due to this caterpillar is enormous as they skeletonise the leaves consuming the cell walls and its watery cell contents. The highest infestation of 12.1 population density per plant was reported by Goel & Rao (2004). The loss of the leaf tissues reduces the food making capability resulting in weakening and stunting growth of the oak plant. The adult of *P. raya* is characterized by having a pale brown apical moon spot and less conspicuous blackish tornal spot in the broad forewings (Schintlmeister, 2008). He further reported that the adult of *P.raya* appears from March to November upto 2000 m.

Since, production of better quality oak tasar silk depends on the leaf quality of food plant, the slightest loss from the insect pest are a great concern to the oak tasar rearers. Inspite of the importance of oak tasar farming which supports livelihood of a number of people of this region, the work on the insect pests damaging the food plants are more or less neglected (Singh & Tikoo, 1990). Rao, et al. (1996) had reported that fairly large numbers of insect pests of diversified groups have been found to be attacking and damaging *Quercus* spp. during their different developmental stages. Singh & Kulshrestha, (1990) also reported that inspite of having abundant oak, the main constraints being faced in oak tasar culture is the attack of the food plants by a large number of insect pests causing potential threat to the tasar silk industry.

From the available literatures, it appears that attempts have been made by few workers to study the seasonal incidence of major insect pests infesting oak but the study on biology of this insect have not been carried out so far. Hence, the present study was undertaken to know the total developmental statistics of *P. raya* which can be used as a predictive basis for its control.

MATERIAL AND METHODS

Phalera raya was reared in wired mesh cages of size (2.5′ x 2′ x 7″) under laboratory conditions at Regional Sericultural Research Station, Mantripukhri, Imphal, Manipur, India. To maintain the culture newly hatched larvae were randomly selected and individually transferred with the help of moist camel hair brush to the rearing trays with *Q. serrata* leaves and reared till completion of their life stages in ten replications. Fresh leaves were changed whenever required and the rearing cages were cleaned regularly. Adult moths were kept in specially prepared cages provided with fine wire grills from the sides. The top of the cage was provided with movable glass to study the reproductive and ovipositional behaviour of the adults. The adults were fed with 10 % sucrose solution and honey mixture (3:1). The number of eggs laid by the individual females was recorded as fecundity. The duration of larva and pupa were recorded. Incubation period of the eggs were also recorded. The hatchability of the eggs were then determined. The length and breadth of the different instars of the larvae and pupae of *P. raya* was determined using Vernier Calliper Gauge micrometer just after moulting. Observations were made from ten randomly selected samples and the average was calculated. In case of adults the body length, wing span by spreading the insect in horizontal position in a standard setting board and the sex ratio was determined.

RESULTS AND DISCUSSION

The biology of *Phalera raya* was studied under laboratory conditions and the results were presented in Table 1 & 2.

Egg: Freshly laid eggs were light brown in colour. The eggs were laid in single layer glued the dorsal surface of the oak-leaf. The shape of the eggs was round and the size varied from 0.80 mm to 1.0 mm in diameter. The incubation period varied from 8-9 days with a mean of 8.4 ± 0.24 days, the average diameter of the eggs was 0.91 ± 0.03 mm. The colour of the egg changed from brown to blue on the 8th day of oviposition before hatching. *P. raya* eggs hatched in about 9 days under the normal room temperature and relative humidity and the hatching percentage recorded was in the range of 95-98 %.

Larval period: In the present study, six larval instars were recorded. The newly hatched larvae were black in colour and the duration of 1st instar lasted for 5-7 days with a mean of 5.8 ± 0.37 days depending on the natural environmental condition. The length of the first instar larvae varied from 6.95 -7.20 mm and 0.38 – 0.45 mm in wide. Tiny soft hairs were present all over the segmental region. The second instar larvae were very active in movement. The body colour changed into brick red with brown body hairs. The larval duration of second instar ranged from 7 to 9 days with a mean of 8.0 ± 0.45 days. The larval body ranged from 11.90 mm to 12.45 mm in length and 1.10 mm to 1.25 mm in width respectively. The third instar larvae were brick red to chocolate colour in the third instar and lasted for 5 to 7 days with a mean of 6.2 ± 0.37 days. It measured 18.45 mm to 19.67 mm in length and 2.62 mm to 2.86 mm in breadth with a mean of 19.04 ± 0.193 and 2.42 ± 0.102 mm respectively. Body colour of fourth instar larvae was the same as the one in the third instar larvae and the larval duration varied from 6 to 7 days with an average of 6.6 ± 0.24 days. The body hairs became longer and more conspicuous and changed from white to brown. The body size ranged from 26.12 mm to 27.15 mm in length and 3.34 mm to 3.94 mm in width with an average of 26.72 ± 0.223 and 3.66 ± 0.104 mm respectively. The fifth instar larva was darker in colour than that of the fourth instar. The segmental hair turned white or yellow. The duration of the fifth stage larva also lasted for 6 to 7 days with an average of 6.8 ± 0.20 days. The larvae remained in cluster hanging downwards with the help of fine threads released from the mouth .Length of the fifth instar larva measured 34.61 mm to 36.13 mm and 5.04 mm to 5.95 mm in width respectively. The final and sixth instar larvae were dark red in colour with white segmental hairs. The larval duration of the sixth instar lasted for a period of 10 to 12 days with a mean of 11.0 ± 0.32 days. The total larval period ranged from 39-49 days with an average of 43.4 ± 1.81 days.

Prepupal and pupal period: The mature larvae became shorter and sluggish in movement. The prepupal varied from 2-3 days with a mean of 2.4 ± 0.24 days. The larva started crawling down the stem towards the soil and burrowed in the soil upto a depth of 2 to 2½″ deep. Within a period of 3 to 4 days the last instar larva underwent pupation leaving its exuviae and assumed the obtec adecticous pupa. The pupal period lasted for 12-15 days with an average of 13.4 ± 0.67 days. The male pupa is slender than female pupa. The length and width of the pupa were 24.45 to 26.74 mm in length and 8.10 to 8.61 mm in width with a mean of 25.64 ± 0.40 and 8.30 ± 0.08 respectively.

Adult Moth: The adult moth was dirty white or light brown in colour having one or two blackish strips on the wing. Adult longevity was recorded 4 – 5 days. The fore wing expanse of female moth measured 73.2 to 75.6 mm and hind wing 18.3 to 20.9 mm. The abdominal length of female adult ranged from 30.2 to 37.5 mm and width ranged from 7.5 to 8.0 mm. The antenna was bipectinate type with a length of 13.7 to 14.3 mm. The fore wing of male moth was 57.1 to 59.6 mm and hind wing with a length of 12.2 to 13.4 mm. The abdominal length of adult male measured 22.6 to 24.7 mm bearing bushy antenna measuring 12.4 to 13.3 mm in length. The total developmental period from egg to adult was 65-72 days.

Oviposition period and fecundity: The sex ratio observed was 1 : 1.5 (male to female). Pairing took place after half an hour to one hour of emergence and continued for 12 to 18 hours, if not disturbed. The moths detached themselves after copulation. The male moths died 2-3 days after emergence while female moth continued surviving for 4-5 days. Sometimes, it was also observed that female moth died during oviposition. The fecundity ranged from 543 to 680 eggs/ female (average of 610 ± 24.80 eggs/ female).

CONCLUSION

The present study on the biology of *Phalera raya* will surely lead to development of a feasible pest management programme and further help in the development of the oak tasar silk industry and boost the oak tasar cocoon productivity.

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Table 1. Biological attributes of *Phalera raya*.

Sl. No.	Parameters	Range	Mean ± SD
1.	Incubation Period (days)	8 - 9	8.4 ± 0.24
2.	Fecundity (no.)	543 - 680	610.8 ± 24.80
3.	Hatching %	95 - 98	97.05 ± 0.58
4.	Larval Instars (days)	-	-
	1st instar	5 - 7	5.8 ± 0.37
	2nd instar	7 - 9	8.0 ± 0.45
	3rd Instar	5 - 7	6.2 ± 0.37
	4th instar	6 - 7	6.6 ± 0.24
	5th instar	6 - 7	6.8 ± 0.20
	6th instar	10 - 12	11.0 ± 0.32
5.	Total Larval period (days)	39 - 49	43.4 ± 1.81
6.	Pre-pupal period (days)	2 - 3	2.4 ± 0.24
7.	Pupal Period (days)	12 - 15	13.4 ± 0.67
8.	Adult longevity (days)	4 - 5	4.5 ± 0.43
9.	Sex ratio	1 : 1.5	--
10.	Total Life cycle (days)	65 - 72	--

*Mean of 10 replications

Table 2. Morphometric dimension of life stages of *Phalera raya*.

Life Stages	Body length (mm)	Body width (mm)
Egg		0.91 ± 0.03 (diameter)
1st instar	7.06 ± 0.046	0.41 ± 0.012
2nd instar	12.12 ± 0.092	1.17 ± 0.025
3rd instar	19.04 ± 0.193	2.42 ± 0.102
4th instar	26.72 ± 0.223	3.66 ± 0.104
5th instar	35.11 ± 0.268	5.43 ± 0.19
6th instar	59.45 ± 0.642	7.44 ± 0.088
Pupa	25.64 ± 0.401	8.30 ± 0.08
Adult	30.50 ± 0.103	7.55 ± 0.242

Figure 1. Life stages of *Phalera raya*, a-egg, b-larva, c-pupa, d-adult.

A

B

Figures 2-3. A. Leaf damage caused by *P. raya* colony, B. Gregarious nature of *P. raya* larva.

SOME ORIBATID MITES (ACARI) FROM THE HARŞIT VALLEY (TURKEY)

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[Ayyıldız, N., Toluk, A., Taşdemir, A., Taşkıran, M. & Arık, B. 2019. Some oribatid mites (Acari) from the Harşit valley (Turkey). Munis Entomology & Zoology, 14 (2): 648-654**]**

ABSTRACT: Six oribatid mites are reported from the Harşit Valley of Turkey. Of these, *Tricheremaeus serratus* (Michael, 1885), *Zetorchestes flabrarius* Grandjean, 1951 and *Oribatella* (*O.*) *nigra* Kulijev, 1967 are new records for the Turkish fauna; *Platynothrus peltifer* (C. L. Koch, 1839), *Gustavia fusifer* (Koch, 1841), *Scutovertex sculptus* Michael, 1879 have been determined as a previously reported from Turkey.

KEY WORDS: Taxonomy, new records, Turkish fauna, ecology, Western Palearctic

Oribatid mites are the dominant group of the soil-inhabiting mites, which play a significant role in maintaining the porosity of soils, in decomposing dead organic materials and in spreading soil biota (Gergócs et al., 2012; Seastedt, 1984; Wallwork, 1983). They comprise 10.923 described species and subspecies worldwide (Subías, 2004). Until now, 240 oribatid species and subspecies are known from Turkey (Ayyıldız & Toluk, 2016; Baran et al., 2018; Erman et al., 2007). There is only very scarce information available about the oribatid mites of Harşit Valley. Until now, 16 taxa have been reported from this region (Ağcakaya, 2015; Gökçe, 2015; Karabörklü, 2018; Zoroğlu & Ayyıldız, 2018).

In this study; in order to contribute to the knowledge of the oribatid mite fauna of Turkey, the mites inhabiting in the Harşit valley were evaluated from the taxonomic point of view, based on samples collected between 2013 and 2015.

MATERIAL AND METHODS

A total of 700 samples were collected from Harşit Valley located in Eastern Black Sea Region of Turkey in 2013 and 2014. In the extraction of mites from soil, litter, moss and lichen collected from the investigation area was used a Berlese-Tullgren funnel extractor. Extracted mites were killed, fixed and stored in 80% ethanol. The light and scanning electron microscopes (SEM) were used to examine mites. The compound microscopic examinations of specimens were made in lactic acid, mounted in temporary cavity slides. Scanning electron microscope images of all determined taxa were taken. Terminology follows Norton & Behan-Pelletier (2009).

RESULTS AND DISCUSSION

***Tricheremaeus serratus* (Michael, 1885)** (Fig. 1)
Measurements. Body length, 606 µm and body width, 326 µm (n = 1).

Diagnostic characters. Sensilli long, short stalked, thick clavate and finely granulated; notogastral surface with large, rounded, sharply defined pits; 17 pairs of very long notogastral setae present.
Material examined. Harşit Valley, Örümcek Forests, 40° 41' 11''K, 39° 02' 47''D, 1046 m, litter and soil under forest; 29.X.2014, 1 ex.
Distribution. Palaearctic (Western Europe) (Subías, 2004).
Remarks. This species is recorded for the first time in Turkey. The body length for the species is given as 550-595 µm by Weigmann (2006). In this regard, the Turkish specimens (606 x 326 µm) are in the range of the known dimensions of the species. According to some known literature, it has been found in lichens, mosses and liverworts (Grandjean, 1963; Schatz, 2009; Schweizer, 1992; Travé, 1963; Weigmann, 2006). We captured this species in litter and soil under forest. From these data, it is understood that the species lives in the soil and litter in addition to lichens, mosses and liverworts on trees.

***Zetorchestes flabrarius* Grandjean, 1951** (Fig. 2)

Measurements. Body length, 454-468 µm and body width, 324-332 µm (n = 3).
Diagnostic characters. Rostrum rounded. Rostral setae inserted on very conspicuous tubercles. Sensilli with a leaf-like expanded, densely granulated; the interlamellar setae half as long as the lamellar setae and equal in length to the diameter of the bothridia. 11 pairs of notogaster setae (c_1 and p_1-p_3 available) present. Trochanter IV without bristle.
Material examined. Harşit Valley, Araköy, 40° 35' 54''K, 39° 06' 53''D, 986 m, mixed forest (*Populus* sp. and *Rosa canina*) litter; 10.X.2014, 3 exs.
Distribution. Palaearctic (Mediterranean) (Ghilarov & Krivoluckij, 1975; Grandjean, 1951; Subías, 2004; Weigmann, 2006).
Remarks. This species is recorded for the first time in Turkey. The known body length for the species is between 428-480 µm (Grandjean, 1951; Pérez-Iñigo, 1997; Weigmann, 2006). In this regard, the Turkish specimens (454-468 x 324-332 µm) are in the range of the known dimensions of the species. Schatz (2016) considered this species as silvicolous, muscicolous, xerophilous. According to Pérez-Iñigo (1997), it is a jumping species and lives in the forest litter and mediterranean type shrub. This species also lives deciduous forest soils and moss (Weigmann, 2006). We found it in forest litter. From these data, it is understood that the habitat information of the Turkish samples is consistent with the previous data.

***Oribatella* (*Oribatella*) *nigra* Kulijev, 1967** (Fig. 3)

Measurements. Body length, 660-670 µm and body width, 422-435 µm (n = 2).
Diagnostic characters. The interlamellar setae long, projecting beyond margin of rostrum, covered with small spines; lamellae broad, with two long dens , inner and lateral dens nearly equal in length, sensillus seta like, surface of lamellae at outer margin covered with fine longitudinal sclerotized carinae, notogastral surface smooth; notogaster with 13 pairs setae, tarsi with 3 claws.
Material examined. Harşit Valley, Çatalağaç village, 40° 46' 11''K, 38° 59' 09''D, 850 m, litter under *Corylus avellana*; 21.V.2015, 2 exs.
Distribution. Palaearctic (Caucasia) (Ghilarov & Krivoluckij, 1975; Subías, 2004).
Remarks. This species is recorded for the first time in Turkey. The body length for the species is given as 740–750 X 450–600 by Shtanchaeva & Subías (2009). The Turkish specimens (660-670 X 422-435 µm) are smaller than the known specimens. Arabuli et al. (2007) found this species in alder woodland with boxwood. We found it in litter under *Corylus avellana*.

Platynothrus peltifer **(Koch, 1839)** (Fig. 4)

Material examined. Harşit Valley, Çatalağaç village, 40° 46' 33''K, 38° 59' 32''D, 1035 m, roadside grassy soil; 21.V.2015, 2 exs.

Distribution. Semicosmopolitan (Holarctic, Oriental, Australian, Neotropical) (Subías, 2004).

Remarks: This species was previously recorded in Turkey (Bayram & Çobanoğlu, 2009).

Gustavia fusifer **(Koch, 1841)** (Fig. 5)

Material examined. Cehennem Valley, Yaylalar crossroad, 40° 33' 13''K, 39° 28' 49''D, 1385 m, litter and soil under *Salix* tree; 14.V.2015, 2 exs.

Distribution. Palaearctic (Subías, 2004).

Remarks. This species was previously recorded in Turkey (Urhan & Özmen, 2006).

Scutovertex sculptus **Michael, 1879** (Fig. 6)

Material examined. Harşit Valley, Çatalağaç village, 40° 46' 33''K, 38° 59' 32''D, 1035 m, roadside grassy soil; 21.V.2015, 3 exs.

Distribution. Palaearctic and Australian (New Zealand) (Subías, 2004).

Remarks. This species was previously recorded in Turkey (Ayyıldız et al. 2013).

CONCLUSION

Harşit Valley has a transition climate between the moist-temperate sea climate of the coastal zone and the continental climatic conditions of the transgression zone. When the valley is examined in terms of vegetation, it is seen that it carries the characteristics of transition climate. Therefore, the research region is expected to be rich in species diversity. In addition to the 6 taxa given in this study, 22 taxa were recorded from the research area previously. Considering the results of this study, further detailed researches are needed, with a view to explain the oribatid fauna of Harşit Valley.

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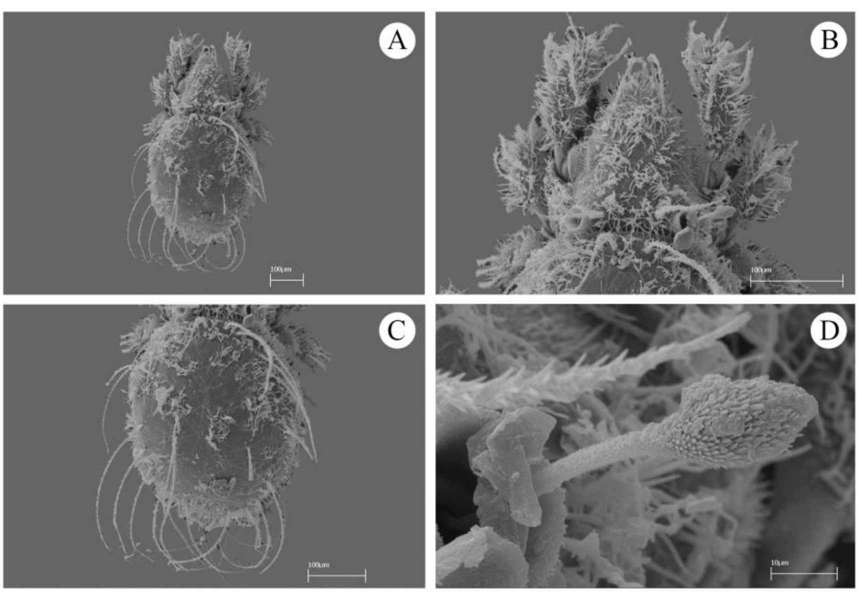

Figure 1. *Tricheremaeus serratus* (Michael, 1885) A: Dorsal view, B: Prodorsum, C: Notogaster, D: Sensillus.

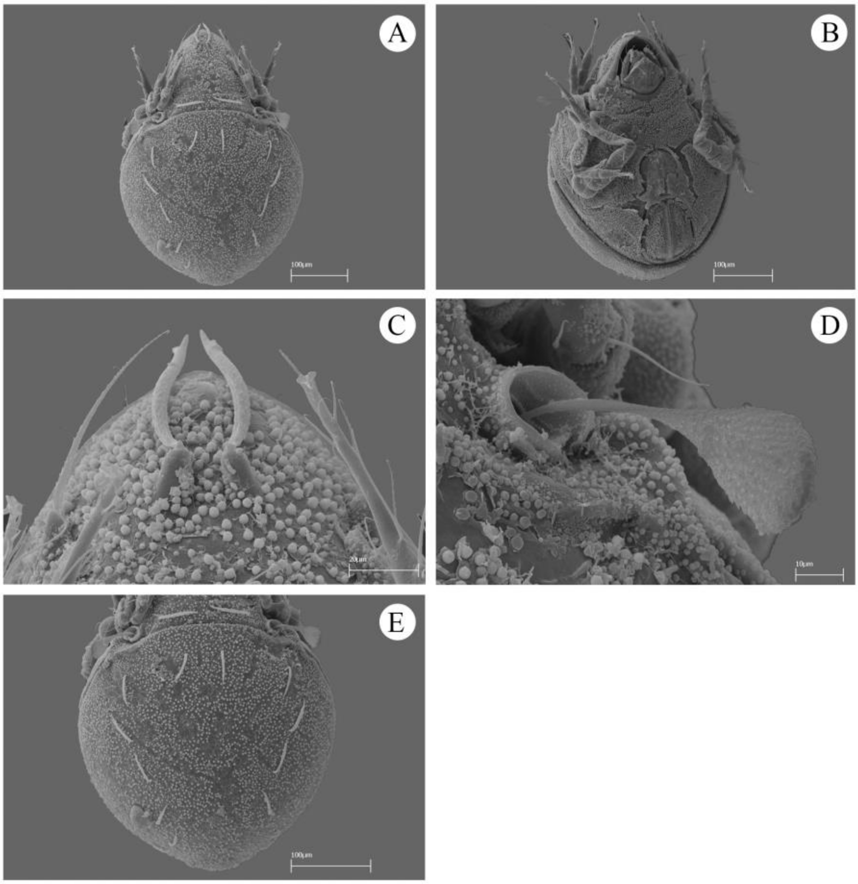

Figure 2. *Zetorchestes flabrarius* Grandjean, 1951 A: Dorsal view, B: Ventral view, C: Rostral setae, D: Sensillus, E: Notogaster.

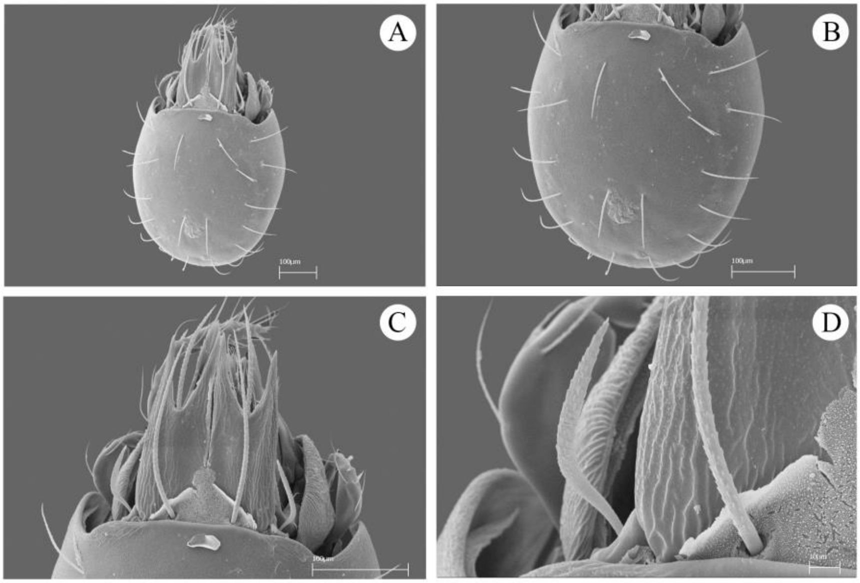

Figure 3. *Oribatella* (*Oribatella*) *nigra* Kulijev, 1967 A: Dorsal view, B: Notogaster, C: Prodorsum, D: Sensillus and setae *in*.

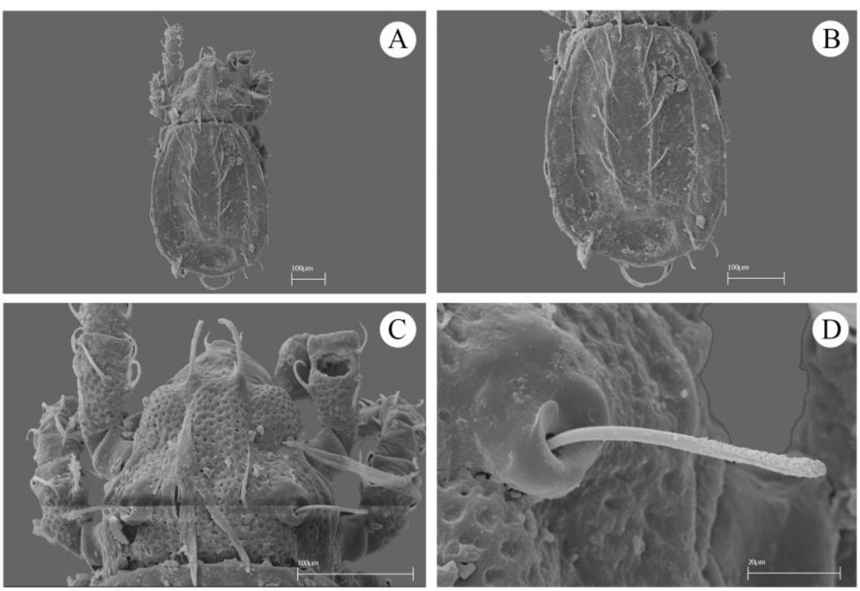

Figure 4. *Platynothrus peltifer* (Koch, 1839) A: Dorsal view, B: Notogaster, C: Prodorsum, D: Sensillus.

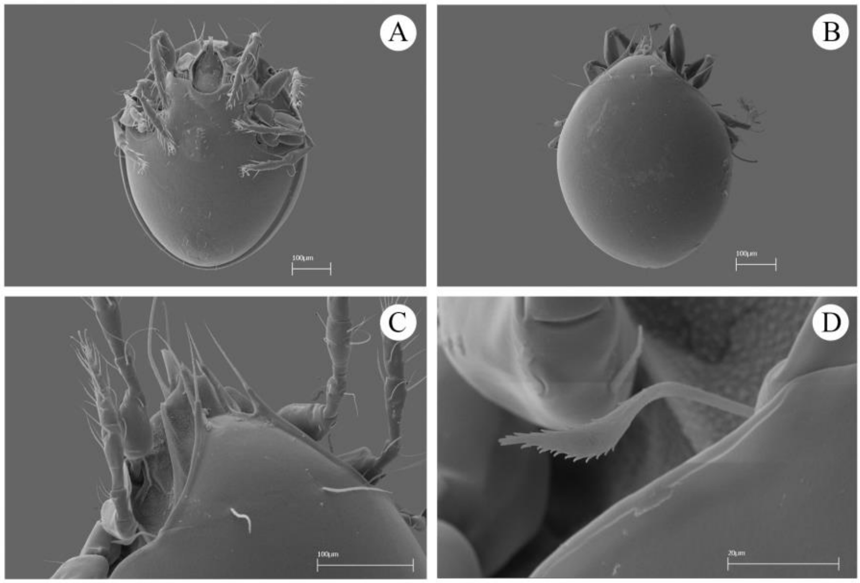

Figure 5. *Gustavia fusifer* (Koch, 1841) A: Ventral view, B: Dorsal view, C: Prodorsum, D: Sensillus.

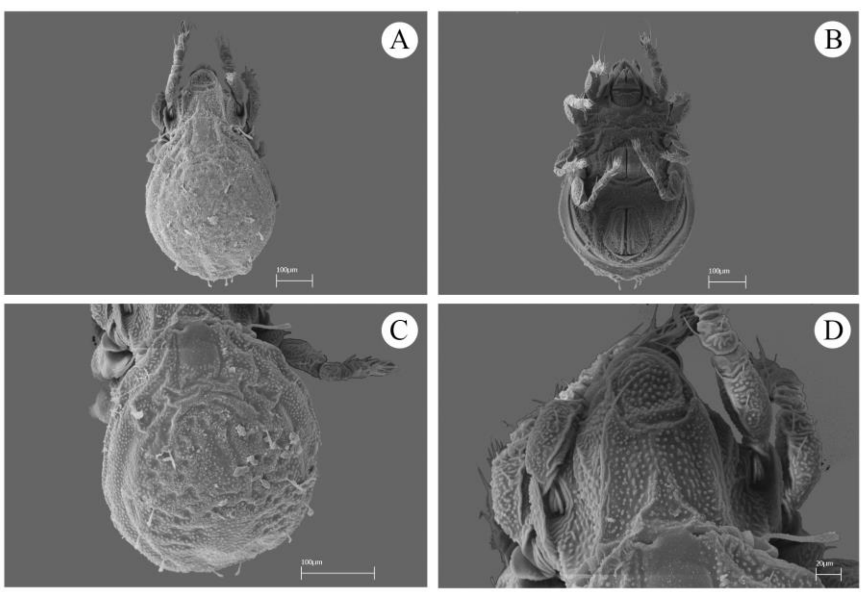

Figure 6. *Scutovertex sculptus* Michael, 1879 A: Dorsal view, B: Ventral view, C: Notogaster, D: Prodorsum.

PRELIMINARY SCREENING OF SELECTED TROPICAL BOTANICALS AS COWPEA PROTECTANTS AGAINST COWPEA SEED BRUCHID, *CALLOSOBRUCHUS MACULATUS* F. (COLEOPTREA: CHRYSOMELIDAE: BRUCHINEAE)

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[Babarinde, S. A. & Pitan, O. O. R. 2019. Preliminary screening of selected tropical botanicals as cowpea protectants against cowpea seed bruchid, *Callosobruchus maculatus* F. (Coleoptrea: Chrysomelidae: Bruchineae). Munis Entomology & Zoology, 14 (2): 655-660**]**

ABSTRACT: A preliminary screening was conducted to investigate the potentials of thirteen botanical powders as cowpea seed protectant against cowpea seed bruchid, *Callosobruchus maculatus,* Fabricius using seed damage parameters. The botanicals included *Azadirachta indica, Ekebergia senegalensis, Urginea altissima, Ancistrophyllum secundiflorum, Pseudocedrela kotschyi, Lannea welwitschii, Xylopia parviflora, Usteria guineensis* and *Antiaris toxicaria.* Others were *Indigofera arrecta, Hoslundia opposita, Cleome ciliata* and *Lagerra aurita.* All the botanicals, except *L. aurita,* showed potentials for cowpea protectant ability against the seed bruchid. Using Bruchid Perforation Index (BPI) values, the most effective powders were *A. indica* (2.95), *A. toxicoria* (2.07) and *H. opposita* (2.64) which BPI values were significantly ($p<0.05$) lower than that of *L. aurita* (26.46). Percentage Seed damage (PSD) varied with the studied botanicals (2.10-41.32%) and significantly ($p<0.05$) lower in the botanical-treated seeds compared to the untreated control (98.28%). The effective botanicals are, therefore, recommended for tropical resource-poor subsistent farmers for use in their small scale cowpea postharvest storage and for further studies to elucidate other effective formulations and their active ingredients.

KEY WORDS: Botanical powders, bruchid perforation index, *Callosobruchus,* grain protectant, seed damage

Cowpea, *Vigna unguiculata* (L.) Walpers, is an important food legume and an essential component of cropping systems in many developing countries. Rich in protein and carbohydrate, it is the preferred pulse in large parts of Africa, where the seeds are processed into various products for human consumption or to appease to gods among the traditional worshippers. Seeds are medicinally used as a poultice to treat skin infections and boils. Despite its various uses, the post-harvest infestation by bruchids, especially the genus *Callosobruchus* (Coleoptera: Chrysomelidae: Bruchinae) poses a serious threat to its all-year round availability (Tuda et al., 2005).

The use of plant products to protect stored products from insect pest infestation is an age-long practice in developing world and is recently receiving a renewed attention as an important component of integrated pest control scheme. The reasons for this renewed interest include their abundance and cost effectiveness. Also, the use of botanicals reduces the ecological problems and health hazards of over-dependence on synthetic pesticides. Thirdly, some botanical formulations like powder and ash could be prepared by local resource-poor farmers, because they require no skilled technicality. Although, a large array of plant species has been documented for their insecticidal properties against bruchids (Dales, 1996; Ileke & Bulus, 2012; Ashamo et al., 2013; Musa et al., 2015; Babarinde et al., 2016a,b; Chauhan et al., 2016; Vijayaraghavan & Zadda, 2016; Kosini & Nukenine, 2017; *Usman* et al., 2017), screening more botanicals for potential efficacies cannot be inappropriate in bio-rational innovations for bruchids control. This is because bioactivity of botanicals could be species-specific which necessitates the attempt to establish the spectrum of bioactivity of any chosen botanical species. Plants selected for the study were those known to possess medicinal, pesticidal or nutritional values.

In this study, powder formulation was used being a preliminary study which was designed to provide baseline information for further studies on the insecticidal properties of the selected botanical species. Interestingly, the selected species are naturally available in many tropical countries. Therefore, the aim of the study was to evaluate thirteen selected tropical botanicals for their protectant ability of cowpea seed against the seed bruchid, *Callosobruchus maculatus* using seed damage parameters due to the bruchid's infestation.

MATERIALS AND METHODS

Insect culture

C. maculatus was reared on clean seeds of "Ife Brown", a bruchid-susceptible cowpea cultivar, under ambient environmental temperature of 30±2°C and 70±5% using standard method earlier described by Babarinde & Ewete (2008).

Botanical procurement and preparation

Thirteen botanicals were collected from different towns in south western Nigeria, where they are found in abundance (Table 1). Identification of the botanicals was done with the help of local ethno-botanists and matching of the vernacular names with the scientific names contained in Gbile (2006). The root and stem bark of the woody species used for the study were exposed to sun drying for 2 days and subsequently air-dried, while the leaves were air-dried under shade until crisp to prevent destroying the thermo-labile compounds in them. Thereafter, the dried plant parts were pulverized with the aid of a hammer mill and sieved with the aid of 50 μm sieve. The plant powder were then stored in labelled plastic airtight jars until use.

Botanical screening for insecticidal potentials

The plant powders were screened according to Fatope et al. (1995) with some modifications. Cowpea seeds (30 g each) were put in a 1 L Kilner jar covered with muslin cloth into which 3 g plant powder corresponding to 10% (w/w) was added to the cowpea seeds. A Kilner jar containing 30 g cowpea seeds without botanical treatment served as control. Three pairs (sex ratio 1:1) 1- to 3-day old *C. maculatus* were introduced into each covered jar. Six replicates of the setup was maintained for seven days in order to infest the stock after which the insects were removed from the stock. At 3 months after infestation, data were collected on the number of damaged (NDS) and number of undamaged seeds (NUdS), weight of damaged and undamaged seeds from both treated and untreated grains.

Percentage seed damage (PSD) was calculated as

$$PSD = \frac{NDS \times 100}{NDS+NUdS}$$

Bruchid perforation index (BPI) was calculated to determine the seed damage level according to Fatope *et al.* (1995), using the formula:

$$BPI = \frac{(\%TP) \times 100}{(\%TP+\%CP)}, \quad \text{where}$$

%TP = % treated cowpea seeds perforated
%CP = % control cowpea seeds perforated
BPI > 50 = negative protectant of plant material tested (i.e. enhancement of infestation of the bruchid) BPI < 50 = positive protectant (i.e. prevention of infestation of the bruchid).

Experimental design and data analysis

The experiments were laid out in completely randomized design. Data were subjected to analysis of variance and significant treatment means were separated using Tukey's HSD at 5% probability level, with the aid of SPSS Software (SPSS, 2006).

RESULTS AND DISCUSSION

The highest BPI was observed in cowpea treated with *Lagerra aurita* (26.46), which was not significantly different from the BPI observed in cowpea treated with *U*riginea *altissima*, *Lannea welwitschii, Xylopia parviflora, Usteria guineensis, Indigofera arrecta* and *Cleome ciliata*. The BPI obtained from cowpea treated with *Azadirachta indica* (2.95), Antiaris *toxicoria* (2.07) and *Hoslundia. opposita* (2.64), *Ancistophyllum secundiflorum* (6.88), *Ekebergia senegalensis* (5.57), *H. opposita* (2.64) were not significantly different from one another but were significantly lower than the BPI obtained from cowpea treated with *L. aurita* (26.46) (Table II). Based on the BPI, *A. indica, A. toxicoria* and *H. opposita* were ranked to possess very strong grain protectant effect; while *E. senegalensis, U. altissima, A. secundiflorum, P. kotschyi U. guineensis* and *I. arrecta* were ranked to possess strong grain protectant effect. Three of the studied botanicals, *L. welwitschii, X. parviflora* and *C. ciliata* were ranked to possess fairly strong grain protectant effect; while only one (*Laggera aurita)* was ranked to be weak in its grain protectant potential. Seed damage varied significantly with the botanicals used (2.10 - 41.20%), but generally lower in the botanical-treated seeds compared to the untreated control (98.28%). The most effective powders were *A. toxicaria* (2.10%)*, H. opposita* (2.68%) *A. indica* (3.05%), *E. senegalensis* (5.94%) and *A. secundiflorum* (7.59%). The least effective botanical was *L. aurita* (with 41.32% PSD) (Fig. I).

According to Fatope et al. (1995), of the various screening procedures available, the cowpea bruchid bioassay is the most convenient for general use in the laboratory. A BPI value of 50 shows that equal amounts of botanical-treated and untreated cowpea seeds were perforated. This bioassay procedure thus allows plant materials with strong, weak or negative grain protectant effects to be identified, irrespective of their mode of action. In this study, all the tested botanicals showed varying levels of protection potentials of cowpea seeds against *C. maculatus*. BPI value of ≤ 15 is good and considered to be a strong effect. The low BPI values obtained from the seed treated with *A. toxicaria, A. indica* and *H. opposita,* made them good candidates for further study towards establishment of their bioactivity against *C. maculatus*. Earlier studies on the insecticidal potentials of *A. indica* against *C. maculatus* were on its seeds (Lale & Mustapha, 2000; Tofel et al., 2016), known to possess azadirachtin. This work examines the insecticidal potentials of the leaves. The study of Cepeda-Palacios et al. (2014) reported the bioactivity of the neem leaves against insect. Based on their results, we included the leaf to investigate its bioactivity against the cowpea seed bruchid.

Of the ten species assayed at 10-30% w/w by Fatope et al. (1995), *Hyptis suaveolens* (Labiatae) and *Spenoclea zeylanica* (Sphenocleceae) were the only ones with a BPI value of < 15 when the botanical powders were assayed at 10% w/w. The result from this study where the BPI of the majority of the tested materials was < 15 suggests that the majority of the plants have cowpea protectant potentials against the bruchid. The result of this study agrees with previous authors on the efficacy of botanical powders in controlling *C. maculatus* (Ileke & Bulus, 2012; Ojo & Ogunleye, 2013; Tefsu & Amana, 2013).

Plant species with lower PSD had lower BPI. *Xylopia parviflora* had a BPI of 15.76, despite the fact that some members of its family (Annonaceae) had been reported to be insecticidal against stored product pests (Babarinde et al., 2008; Babarinde & Adeyemo, 2010; Akinyemi et al., 2016; Babarinde et al., 2017). Similar report exists for another member of Annonaceae family (*Annona senegalensis)* included in Fatope *et al.* (1995), that was not effective in the protection of cowpea seeds against *C. maculatus*. The insecticidal properties of Meliaceae against *C. maculatus* has been reported by Babarinde and Ewete (2008). However, this is the first report of *A. toxicaria* (Family Moraecea), for its pesticidal potentials against stored product insect. The fact that the powders showed protectant ability justifies their recommendation for local farmers who may not have the technicality of essential oil extraction or production of inorganic extracts.

CONCLUSION

Majority of the screened species showed insecticidal potentials against bruchids. Since the formulation investigated in this study was powder, it is necessary to investigate other formulations like organic and inorganic extracts and essential oil. Also, their modes of action and bioactive ingredients should be well studied as prerequisites to the understanding of their mechanism of actions and the production of synthetic products from the species.

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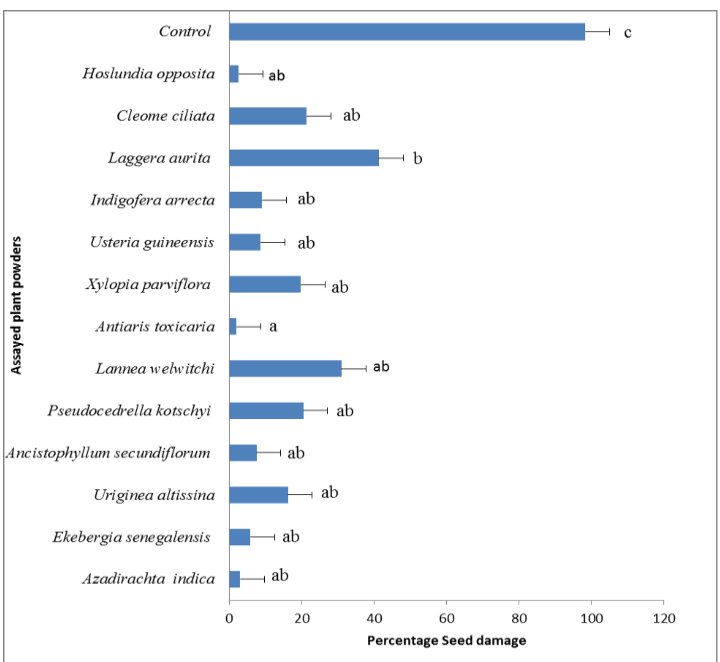

Figure I. Percentage seed damage by *Callosobruchus maculatus* of cowpea seeds treated with selected plant powder {Number of replicates = 6; ANOVA Result: F = 9.929; d f =13, 70; p<0.0001}.

Table 1. List of the thirteen plant species screened for insecticidal properties against *Callosobruchus maculatus*.

Plant species	**Common name**	**Family**	**Part used**	**Bioactivity information**	**Point of collection**
Azadirachta indica	Neem	Meliaceae	Leaf	Medicinal, insecticidal	Ogbomoso
Ekebergia senegalensis	Stavewood	Meliaceae	Leaf	Antibacterial	Ibadan
Urginea altissima	Tall squill	Liliaceae	Leaf	Medicinal	Ibadan
Ancistrophyllum secundiflorum	Large Benin rattan	Arecaceae	stem bark	Chewing stick	Ogbomoso
Pseudocedrela kotschyi	Cedar mahogany	Meliaceae	root bark	Antibacterial, chewing stick,	Ogbomoso
Lannea welwitschii	Kumbi	Anacardiaceae	Leaf	Antibacterial, medicinal, furniture	Ibadan
Antiaris toxicaria	False iroko	Moraceae	Stem bark	Insecticidal, medicinal	Ibadan
Xylopia parviflora	Bushveld bitterwood	Annonaceae	root bark	Medicinal, Chewing stick	Alapa-Ilorin
Usteria guineensis	-	Loganiaceae	Aerial	Medicinal	Akure
Indigofera arrecta	Indigo	Papilonaceae	Leaf	Dye production	Ogbomoso
Lagerra aurita	Laggera	Asteraceae	leaf	Antibacterial, insecticidal	Ogbomoso
Cleome ciliata	Wild mustard	Capparaceae	seed	Green manure, vegetable	Ogbomoso
Hoslundia opposita	Hoslundia	Lamiaceae	Leaf	Medicinal, insecticidal	Ilorin

Table 2. Cowpea grain protectant potentials of the selected botanicals against *Callosobruchus maculatus* using Bruchid Perforation Index.

Plant powder	**Bruchid Perforation Index**	**Grain Protectant Potentials***
Azadirachta indica	2.95±.1.05a	Very strong
Ekebergia senegalensis	5.57±1.48ab	Strong
Uriginea altissina	13.25± 3.78ab	Strong
Ancistophyllum secundiflorum	6.88 ± 2.45ab	Strong
Pseudocedrella kotschyi	12.51 ± 7.71ab	Strong
Lannea welwitchi	16.48 ± 10.04ab	Fairly strong
Antiaris toxicaria	2.07 ±0.76a	Very strong
Xylopia parviflora	15.76 ±3.97ab	Fairly strong
Usteria guineensis	7.76 ± 2.79ab	Strong
Indigofera arrecta	7.66 ± 3.67ab	Strong
Laggera aurita	26.46 ± 6.75b	Weak
Cleome ciliata	17.30 ± 3.16ab	Fairly strong
Hoslundia opposita	2.64 ± 0.37a	Very strong
ANOVA Results	F=2.586; df=12, 65; p=0.007	

Means followed by same alphabet along a column are not significantly different from one another using Tukey's HSD test (p<0.05).
*BPI of < 15 depicts a strong grain protectant effect {Adapted with modification from Fatope et al. (1995)}

SOME DATA FOR THE COLOR/PATTERN POLYMORPHISM OF *PHILAENUS SPUMARIUS* (L.) (HEMIPTERA: APHROPHORIDAE) IN SINOP POPULATION, TURKEY

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ABSTRACT: The color/pattern polymorphism of *Philaenus spumarius* L. (Hemiptera: Aphrophoridae) was investigated in Sinop, Turkey (West- Black Sea Region). 660 adult spittlebugs were analyzed according to their phenotype and phenotype frequency in Sinop populations. The adult spittlebugs were collected between April-September 2016. In the study area eight different phenotypes; three of them which were non melanics and five melanics were detected. Non melanics are POP (*populus)*, TYP (*typicus*) ve TRI (*trilineatus*); melanics are MAR (*marginellus)*, LAT (*lateralis*), FLA (*flavicollis*), LCE (*leucopthalmus*) and QUA (*quadromaculatus*). Without sex difference, non melanic frequency was 94.55% and melanic frequency was 5.45% in Sinop populations and melanic forms limited to females. TYP is predominant in females whereas POP in males.

KEY WORDS: *Philaenus spumarius*, color polymorphism, Sinop, Turkey

The meadow spittlebug *P. spumarius* (L.) is one of the most common species occurring in terrestrial habitats in temperate regions (Stewart & Lees, 1996). Because of its color/pattern variation, it has become a focal point for polymorphism studies for many years (Drosopoulos, 2003). *P. spumarius* fed on a variety of plants including nitrogen-fixing plants, and distributed in forests, grasslands and scrubs (Thompson, 1984).

Adults of this taxon have inherited color/pattern polymorphism on the dorsal and ventral surfaces (Halkka & Halkka, 1990; Yurtsever, 2000). Although it is known that there are more than 16 phenotypes worldwide, 11 of these phenotypes are more common (Halkka & Halkka, 1990). These phenotypes are categorized as melanics and non-melanics. Three of phenotypes are non-melanics and called as POP (*populus*), TYP (*typicus)* and TRI (*trilineatus*). The non-melanic forms are light-COLORed and have shapes and lines of dark colors. Melanic phenotypes are termed as MAR (*marginellus*), LAT (*lateralis*), FLA (*flavicollis*), GIB (*gibbus*), LCE (*leucocephalus*), QUA (*quadrimaculatus*), ALB (*albomaculatus*) and LOP (*leucopthalmus*), and they show color lines or shapes. The dorsal color/pattern polymorphism is determined by seven alleles at a single locus with complex dominance and co-dominance relationships (Yurtsever et al., 2010).

The occurrence and frequencies of phenotypes have a distinct geographic variation. Although 11 phenotypes are common in the natural populations, some phenotypes are rare or absent in several populations (Halkka et al., 2001). In New Zealand populations, there are only TYP, POP and FLA phenotypes. In addition, melanics are usually limited to females. But, a few populations deviate from this general rule. For example, melanics are expressed in both sexes in several British populations (Lees & Dent, 1983). These variations arise from environmental conditions and different evolutionary forces. Because of that, numerous studies have been carried out on ecology and genetics of this species that has a wide distribution in the Holarctic Region (Halkka & Halkka, 1990). In Turkey, faunistic records have been reported from different areas related to *P. spumarius* (Lodos & Kalkandelen, 1981). Also, there are a few polymorphism studies in Turkey populations: Istranca mountain population (Yurtsever & Sal, 2003), some Thrace populations (Yurtsever, 2001), The Central Black Sea-Samsun populations (Zeybekoğlu et al., 2004), North Western Black Sea populations (Yurtsever et al., 2010) and island populations of western parts of Turkey (Yurtsever, 2018).

The present study reports some data about phenotypes and phenotype frequencies of *P. spumarius* for the first time from Sinop (Turkey). Sinop Peninsula located in the northern part of Turkey and it's also a transition area between Western and Middle Black Sea region.

MATERIAL AND METHOD

The samples evaluated in the study are collected from Sinop (41°12 - 42° 06 N and 34°14 - 35°26) and its surroundings which is located to the east of the Western Black Sea region of Turkey. The collection of samples was carried out periodically between April and October 2016. Adults were collected by using sweeping net over the plants and removed with an aspirator. At each locality an hour was spent on average of one hour was spend forthnightly. The localities were selected from three main routes of Sinop. The first route is the center of the city, Ayancık, Türkeli and Erfelek districts. The localities in this route are at the height of 30-1049 m. Plants which belongs to the family Rosacee, Fabeceae, Poaceae, Ranunculacae and Asteraceae are widely spread, including *Quercus* spp., *Phillyrea latifolia*, *Cistus creticus*, *Smilax* sp., *Geranium* sp., *Taraxacum officinale* and various species. The second route is Gerze and Boyabat districts. The selected localities are at the height of 150-870 m. *Fagus* sp, *Ulmus* sp., *Pinus* spp., *Triticum* spp. and other species of Poaceae and Asteraceae are among the common plants of this route. This region also includes agricultural areas. Saraydüzü, Durağan and Dikmen districts make up the third route and the determined localities are at the height of 150-470 m. *Populus* spp., *Clematis* sp. are common plant species and also various taxa of Fabacae, Poaecae, Salicaceae in this route. Adults were collected from selected meadows, open areas in the forests, forests and over the vegetation cover at the edge of the water.

Collected specimens were labeled and brought to the laboratory. The specimens were prepared by binocular stereomicroscope, diagnosed and made into museum material. Phenotypes were categorized according to Halkka et al. (1973) and Stewart and Lees (1996).

RESULTS

A total of 660 specimens (312 males and 348 females) were collected from the localities of Sinop province (Table 1). 8 phenotypes with different colors and patterns were determined. Non-melanic phenotypes are POP (populus), TYP (typicus) TRI (trilineata); melanic phenotypes are MAR (marginellus), LAT (lateralis), FLA (flavicollis), LCE (leucophtalmus) and QUA (quadrimaculatus) (Fig. 1). Without sex difference, the ratio of non-melanic phenotypes (POP + TYP + TRI) was 94.55%, and the ratio of melanic phenotypes (MAR + LAT + FLA + LCE + QUA) 5.45% (Fig. 2). The proportion of melanic phenotypes seen in the whole population was 1.5%, LAT 1.5%, FLA 1.4%, LCE 0.45% and QUA 0.45%. Among male and female adults, the POP phenotype was 56% and 27%, TYP 36%

and 52%, TRI 8% and 10.6%, respectively. The rates of melanic phenotypes frequency was 3.2% for MAR, 2.9% for LAT, 2.5% for FLA, 0.9% for LCE and 0.9% for QUA. In the present study, it was also determined that melanic forms were in low frequency and limited only to females (Fig. 3).

DISCUSSION

P. spumarius exhibits exuberant polymorphism. It is known that the majority of *P. spumarius* populations have a rate of over 80% of non-melanic phenotypes (Halkka et al., 1975; Boucelham & Ratikainen, 1988). The frequency values of non-melanic and melanic phenotypes in Sinop populations are similar to those. Furthermore, in some populations in the UK, melanic phenotypes have 95% and they can be seen in both sexes. But the populations examined in Sinop, melanic phenotypes are limited to females as similar to the reported other populations from Turkey as well as. Melanic form was not found in male specimens. This distinction between the sexes is associated with another locus interacting with the main color/pattern locus (Yurtsever, 2001). The dominant phenotypes were POP by 56% in males and TYP by 52% in females. These results are similar to other Turkey populations too (Yurtsever, 2001; Yurtsever & Sal, 2003; Zeybekoğlu et al., 2004).

There are seven different alleles responsible from different phenotypes. Expression of ‘’t, T, M, L, F, C and O’’ alleles results in ‘’POP+TYP, TRI+VIT, MAR, LAT, FLA, LCE+GIB+FLA and QUA+ALB+LOP’’ phenotypes, respectively (Halkka et al., 1973; Stewart & Lees, 1996). The alleles responsible from other morphs are unknown. When eight phenotypes were evaluated, it was determined that there were at least six different alleles in the Sinop population. In Samsun population, the phenotypes expressed by ‘O’ allele could not determine (Zeybekoğlu et al., 2004). In the contrary, Sinop population has this allele. There is no similar study from the Eastern Black Sea Region, and it should be studied to compare the results.

In previous studies, nine phenotypes (POP, TYP, TRI, MAR, FLA, LCE, GIB, ALB, LOP) were identified from the Western Black Sea region of Turkey. LAT and QUA phenotypes were not reported in Western Black Sea populations previously (Yurtsever et al., 2010). In the present study, these two morphs were found in the Sinop population. On the other hand, GIB, ALB and LOP phenotypes which were reported by Yurtsever et al. (2010) were not observed in Sinop.

The variation in the frequency of 16 morphs worldwide is explained by factors such as vegetation type, urban industrial pollution, thermal selection and elevation. The melanics may be directly by urban industrial pollution and height. In the some European and North American populations, the frequency of TRI phenotype shows a negative correlation with height. In addition, the presence or absence of some alleles in populations is thought to be the result of selective effects such as the founder effect and genetic drift, like as Gökçeada case (Turkey). Only POP and TYP phenotypes were found in this island population, and it was thought that the population established by the individuals carrying only the alleles causing to these two morphs (Yurtsever, 2018).

It is seem that the temperature factor is very effective on the population density of *P. spumarius*, because population sizes are small in Sinop provinces according to the hot areas. Sinop province has a cool and rainy Mediterranean climate (Kılınç & Karaer, 1995). It is thought that the temperature and humidity is not suitable sufficiently for survive the nymphs in this region. Because the most important climatic factors in distribution of *P. spumarius* are temperature and humidity (Akdeniz, 2008).

P. spumarius is a polyphagous species and has a wide variety of host plants. It has been reported so far that 20 different plant species belonging to Boraginaceae, Celastraceae, Iridaceae, Ranunculaceae, Apiaceae, Salicaceae, Asteraceae, Fabaceae and Poaceae in Turkey (Kaygın & Ekici, 2017). In the present study, the numbers of different morphs changed according to localities. Five phenotypes in Gerze and Erfelek; four phenotypes in Boyabat and Ayancık; and two phenotypes were determined in other localities. However Boztepe Peninsula all of these eight phenotypes. Boztepe Peninsula (Fig. 4) is at 0-200 m height and surrounded by sea on three sides. It is connected to mainland by a tombolo. *Sarcopoterium spinosum* (L.) Spach, which is a spiny dwarf shrub, constitutes 70-80% of the woody plants in the area and this vegetation is termed as phrygana (Elmas & Kutbay, 2017). Also, the number of individuals collected from this peninsula was more than it's in the other localities. Having all the morphs and high number of individuals can be related to Mediterranean type vegetation. Microclimate of this area could maintain more suitable conditions for nymphs. In addition, spiny vegetation could protect the individuals from predators, and ensure to be a population with high number.

Polymorphic species provide good examples to understand evolutionary process. It is very important to determine the factors affecting the distribution of alleles in populations. Evolutionary forces or other selective factors that shape this variation in natural *P. spumarius* populations can be demonstrated by comparisons and genetic studies. (Yurtsever & Sal, 2003).

ACKNOWLEDGEMENTS

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Figure 1. Eight dorsal COLOR/pattern phenotypes distributed in Sinop populations. First row from right; POP, TYP ve TRI; second row from right; MAR, LAT, LCE; third row from right; FLA and QUA.

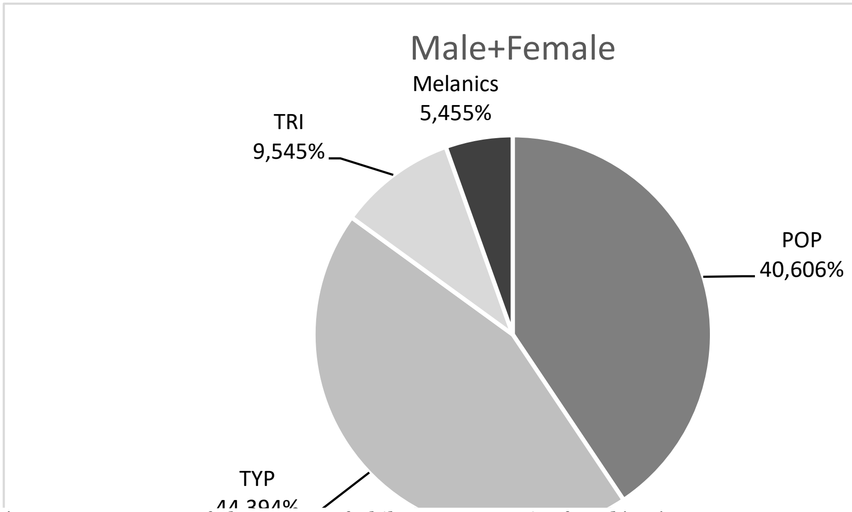

Figure 2. Percentage of phenotypes of *Philaenus spumarius* found in Sinop.

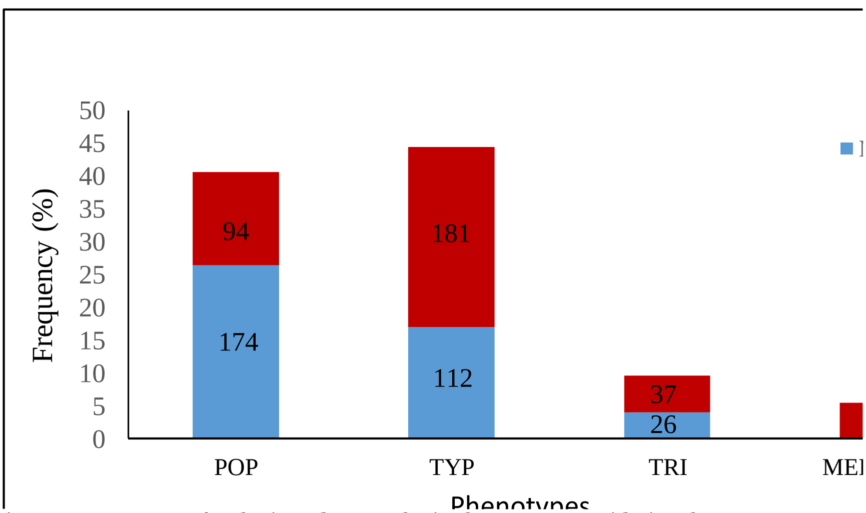

Figure 3. Frequency of melanic and non melanic phenotypes considering the sexes.

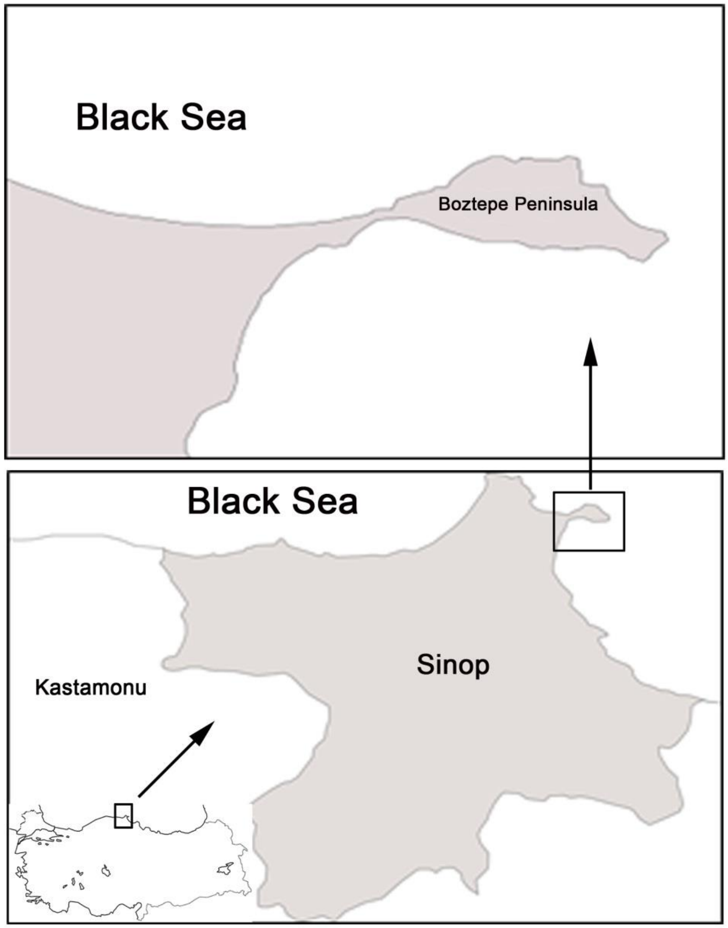

Figure 4. Boztepe Peninsula (Sinop).

Table 1. Frequencies of 8 phenotypes collected from Sinop.

Phenotypes	Male	Female	Total
POP	174	94	268
TYP	112	181	293
TRI	26	37	63
MAR	0	11	11
LAT	0	10	10
FLA	0	9	9
LCE	0	3	3
QUA	0	3	3
Total	**312**	**348**	**660**

A CONFIRMED SPECIES TO TURKISH MIRIDAE FAUNA: *MYRMECORIS GRACILIS* (SAHLBERG, 1848) (HETEROPTERA)

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[**Kıyak, S.** 2019. A confirmed species to Turkish Miridae fauna: *Myrmecoris gracilis* (Sahlberg, 1848) (Heteroptera). Munis Entomology & Zoology, 14 (2): 668]

ABSTRACT: The paper presents *Myrmecoris gracilis* (Sahlberg, 1848) as a second record for Turkish Miridae (Heteroptera) from Ankara: Ayaş in Central Anatolian region of Turkey. Thus, its occurrence in Turkey is confirmed.

KEY WORDS: Miridae, *Myrmecoris gracilis*, Ayaş, Ankara, Turkey

Family Miridae
Myrmecoris gracilis (Sahlberg, 1848)

Material Examined: Turkey, Ankara, Ayaş, Başbereket village, 1080 m, 13-14 July 1998, 2 females specimens collected by net trap from grass-vegetation.

Distribution in Palaearctic region: Austria, Bulgaria, Byelorussia, Czech Republic, Denmark, Finland, France, Great Britain, Germany, Hungary, Italy, Latvia, Lithuania, Luxembourg, Moldavi, Nnetherlands, Norway, Poland, Romania, Russia (Central, North, South; East-West Siberia), Slovakia, Slovania, Spain, Sweden, Switzerland, Kazakhstan, China (North), Korea, Uzbekistan (Stichel, 1956-58; Wagner,1971; Aukema & Rieger, 1999).

Remarks: The Palaearctic genus *Mymecoris* (Miridae) is monotypic with the type species *Myrmecoris gracilis* (Sahlberg, 1848). The species is a predator and have an ant mimic. It was formerly classed by the IUCN as "Rare" in its pre-1994 system *(*Natural History Museum, May 2019).

Myrmecoris gracilis (Sahlberg, 1848) sucks plant juices, but feed mainly on aphids, other small insects which are exclusively herbivorous and insect eggs.

The species was firstly reported by Bozbuğa & Elekçioğlu (2008) from Antalya province. With this study, it is recorded for the second time from Turkey with exact locality information.

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SCIENTIFIC NOTES

ERRORS AND OMISIONS FOR DOĞANLAR, M. & YİĞİT, T. 2019. A NEW SPECIES OF *GASTRANCISTRUS* WESTWOOD (HYMENOPTERA: PTEROMALIDAE)…. MUNIS ENTOMOLOGY & ZOOLOGY, 14 (1): 24-27

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[**Doğanlar, M. & Yiğit, T.** 2019. Errors and omisions for Doğanlar, M. & Yiğit, T. 2019. A new species of *Gastrancistrus* Westwood (Hymenoptera: Pteromalidae)…. Munis Entomology & Zoology, 14 (1): 24-27. Munis Entomology & Zoology, 14 (2): 669**]**

The published article unfortunately has an error stated below:

Fig. 1a-f: *Colotrechnus karatasensis* should be replaced as *Gastrancistrus pruniflorumus* **sp. nov.** a-g. female. a. body, in dorsal view; b. head, in frontal view; c. mandible; d. female antenna. e. mesosoma, in dorsal view; f. scutellum and propodeum; g. forewing; h. male antenna (Scale bar for a = 1.5 mm; for b= 0.41 mm; for c= 0.18 mm; for d, h= 0.28 mm; for e, f= 0.46 mm; for g= 1.45 mm).

LITERATURE CITED

Doğanlar, M. & Yiğit, T. 2019. A new species of *Gastrancistrus* Westwood (Hymenoptera: Pteromalidae) reared from apricot flower midge, *Contarina pruniflorum* Coutin & Rambier (Diptera: Cecidomyiidae) in Malatya province, Turkey. Munis Entomology & Zoology, 14 (1): 24-27.