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AN ATTEMPT ON SUBGENERIC COMPOSITION OF THE
PALAEARCTIC GENUS STENURELLA VILLIERS, 1974
(CERAMBYCIDAE: LEPTURINAE: LEPTURINI)

Hüseyin Özdikmen*

* Gazi Üniversitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü, 06500 Ankara / TÜRKİYE. E-mail: ozdikmen@gazi.edu.tr


ABSTRACT: The paper was presented an essay on subgeneric composition of the palaearctic genus Stenurella Villiers, 1974. As a result of the present work, four new subgenera were described except the nominotypical subgenus for the genus Stenurella Villiers, 1974 that has not been included any subgenus until now. Also a key was proposed for all valid taxa of the genus in the text.

KEY WORDS: Stenurella, Cerambycidae, Lepturinae, Lepturini.

The genus Stenurella was described by Villiers (1974) with the type species Leptura melanura Linnaeus, 1758 by original designation. A total of 9 species which are placed in the genus Stenurella Villiers, 1974 now, had been described except the new subgenera described by various authors until that time. These species are Strangalia approximans Rosenhauer, 1856: 305, Leptura bifasciata O. F. Müller, 1776: 93, Strangalia hybridula Reitter, 1902: 188, Leptura jaegeri Hummel, 1825: 68, Leptura melanura Linnaeus, 1758: 397, Leptura nigra Linnaeus, 1758: 398, Strangalia novercalis Reitter, 1901: 78, Leptura septempunctata Fabricius, 1792: 346 and Leptura vaucheri Bedel, 1900: 336.

After that time, some new species and subspecies have been described by various authors up to now. These species and subspecies are Stenurella samai Rapuzzi, 1995: 617, Stenurella sennii Sama, 2002: 40, Stenurella intermedia Holzschuh, 2006: 219, Stenurella pamphyliae Rapuzzi & Sama, 2009: 182, Stenurella bifasciata safronovi Danilevsky, 2011: 2, Stenurella zehrae Özdikmen et al., 2012: 18, Stenurella sabinae Rapuzzi & Sama, 2012: 664 and Stenurella solaris Rapuzzi & Sama, 2012: 665 chronologically.

Moreover, Strangalia nigrosuturalis Reitter, 1895: 88 was accepted by Adlbauer (1988) as a subspecies of Stenurella bifasciata. Stenurella intermedia was downgraded by Danilevsky (2011) as a subspecies of Stenurella bifasciata. In the same work, he accepted Strangalia bifasciata v. ferruginipes that was described by Pic (1895: 76) and Strangalia lanceolata Mulsant & Rey, 1863: 177 that was regarded as a synonym of Stenurella bifasciata, as subspecies of Stenurella bifasciata. Also Strangalia bifasciata v. ferruginipes was accepted by Rapuzzi & Sama (2012) as a separate species.

Newly, Löbl & Smetana (2010) gave a total of 15 valid taxa for the genus Stenurella in their catalogue as follows:

Stenurella approximans (Rosenhauer, 1856)
Stenurella bifasciata bifasciata (O. F. Müller, 1776)
Stenurella bifasciata limbiventris (Reitter, 1898)
Stenurella bifasciata nigrosuturalis (Reitter, 1895)
Stenurella hybridula (Reitter, 1902)
Stenurella intermedia Holzschuh, 2006
Stenurella jaegeri (Hummel, 1825)
Stenurella melanura (Linnaeus, 1758)
Stenurella nigra (Linnaeus, 1758)
Stenurella novercalis (Reitter, 1901)
Stenurella samai Rapuzzi, 1995
Stenurella sennii Sama, 2002
Stenurella septempunctata septempunctata (Fabricius, 1792)
Stenurella septempunctata suturata (Reiche & Saulcy, 1858)
and Stenurella vaucheri (Bedel, 1900)

In this manner, the data for the genus were accumulated over the time. Therefore, the data need to be arranged.

Subfamily LEPTURINAE Latreille, 1802: 218
Tribe LEPTURINI Latreille, 1802: 218

Genus STENURELLA Villiers, 1974

Type sp.: Leptura melanura Linnaeus, 1758: 397

The main diagnostic character for the genus is “pronotum evenly rounded behind front margin”.

Also the characters of the genus can be summarized as follows:

Long 5-15 mm. Narrow body, base of elytra rather more large than that of pronotum. Head with more or less lengthened. Eyes big and protruding, emarginated. Antennae strongly at the base, slightly thickened, attaining almost the apex of elytra or slightly longer than elytral apex in the males, about the apical third or the apical fourth in the females, the longest third article, the fifth a little longer than the fourth.

Pronotum trapezoidal, at the front edge narrow, followed by a transverse depression, basal depression weakly and posterior angle very sharpened and strongly extended laterally. Elytra narrow, obliquely truncate or more or less rounded in the apex, if obliquely truncate, then the outer angle of apex pointed or thornlike. Legs long and slender, hind tarsi very narrow, first segment much longer than following two segments together.

The genus Stenurella has Palaeartctic chorotype. Stenurella melanura (Linnaeus, 1758) and Stenurella bifasciata (O. F. Müller, 1776) are the widely distributed species. Stenurella nigra (Linnaeus, 1758) and Stenurella septempunctata (Fabricius, 1792) follow them. The other species have more or less locally distribution. Among them, Stenurella approximans (Rosenhauer, 1856) and Stenurella vaucheri (Bedel, 1900) are endemic to Western Mediterranean area; Stenurella hybridula (Reitter, 1902) is endemic to Iberian Peninsula; and Stenurella pamphyliae Rapuzzi & Sama, 2009 and Stenurella zehrae Özdkmen et al., 2012 are endemic to Turkey.

Relatively, Stenurella approximans (Rosenhauer, 1856) is the biggest, Stenurella nigra (Linnaeus, 1758) is the smallest species for the genus.

The genus can be divided into 7 groups as follows:

Group I (melanura species-group)
Including Stenurella melanura, Stenurella pamphyliae, Stenurella samai samai, Stenurella samai sennii, Stenurella zehrae.
Group II (bifasciata species-group)
   Including Stenurella bifasciata bifasciata, Stenurella bifasciata intermedia, Stenurella bifasciata lanceolata, Stenurella bifasciata limbiventris, Stenurella bifasciata nigrosuturalis, Stenurella bifasciata safronovi, Stenurella ferruginipes (=Stenurella solaris), Stenurella sabinae.

Group III (septempunctata species-group)
   Including Stenurella septempunctata septempunctata, Stenurella septempunctata latenigra, Stenurella vaucheri.

Group IV (jaegeri species-group)
   Including Stenurella jaegeri, Stenurella novercalis.

Group V (nigra species-group)
   Including Stenurella nigra.

Group VI (approximans species-group)
   Including only Stenurella approximans.

Group VII (hybridula species-group)
   Including only Stenurella hybridula.

A KEY OF THE GENUS STENURELLA VILLIERS, 1974

1. Posterior part of head (neck) with shallow transverse depression…………………2
   -. Posterior part of head (neck) with deeper transverse depression…………………4

2. Pronotum with erect hairs; elytral apex more or less rounded………………………………Subgen. nov. IBEROSTENURELLA
   Stenurella hybridula (Reitter, 1902)
   -. Pronotum without erect hairs; elytral apex more or less obliquely truncate….…3

3. Larger body; Upperside bicolored, head and pronotum black, elytra dark brownish-red………………………………Subgen. nov. CRASSOSTENURELLA
   Stenurella approximans (Rosenhauer, 1856)
   -. Smaller body; Upperside unicolored, completely black………………………………Subgen. nov. NIGROSTENURELLA
   Stenurella nigra (Linnaeus, 1758)

4. Elytral apex more or less rounded; In females, elytra completely black except brown-yellow or reddish colored basal quarter of elytra………………………………Subgen. nov. STENURELLOIDES….5
   -. Elytral apex more or less obliquely truncate; In females, elytra never so like…..6

5. Elytra brown-yellow with grayish pubescence; antennae extend to the elytral apex………………………………Subgen. nov. STENURELLOIDES.5
   -. Elytra reddish with black pubescence; antennae slightly longer than elytral apex………………………………Subgen. novercalis Reitter, 1901

6. Abdomen completely black; pronotal punctuation strongly or deeper; legs always completely black………………………………melanura-species group...
   Subgen. STENURELLA Villiers, 1974….7
- Abdomen completely or partly reddish or yellowish; pronotal punctuation finely; legs completely black or at least partly reddish or brown-yellow. bifasciata-species group and septempunctata-species group.

Subgen. nov. PRISCOSTENURELLA.12

7. Elytra with black pubescence; In females, black sutural spot extends elytral apex to base. Stenurella melanura (Linnaeus, 1758)

- Elytra with yellow or golden-yellow pubescence; In females, black sutural spot extends elytral apex to about first quarter of elytra, not base. Stenurella septempunctata Özdikmen, Mercan & Cihan, 2012


- Pronotal punctuation relatively strongly and deeper. Stenurella samai sennii Sama, 2002 stat. nov.

9. Elytra reddish in both sexes. Stenurella pamphyliae Rapuzzi & Sama, 2009

- Elytra yellowish in males, reddish in females. Stenurella samai samai Rapuzzi, 1995

10. Elytra yellowish with black or darkened areas. septempunctata-species group.

- Elytra reddish with black or darkened areas. bifasciata-species group.

11. Pronotum completely yellowish. Stenurella septempunctata septempunctata (Fabricius, 1792)

- Pronotum completely black. Stenurella septempunctata latenigra (Pic, 1915)

12. Vertex brownish-yellow. Stenurella septempunctata latenigra (Pic, 1915)

- Vertex black. Stenurella vaucheri (Bedel, 1900)

13. Elytra widely darkened along the suture. septempunctata-species group.

- Elytra not widely darkened along the suture. bifasciata-species group.

14. Pronotal punctuation rough. Stenurella septempunctata septempunctata (Fabricius, 1792)

- Pronotal punctuation rough not so like; Western European subspecies. Stenurella bifasciata lanceolata (Mulsant & Rey, 1863)

15. Legs completely black. Stenurella bifasciata limbiventris (Reitter, 1898)

- Legs at least partly reddish. Stenurella bifasciata nigrosuturalis (Reitter, 1895)

16. Abdomen completely black. Stenurella bifasciata limbiventris (Reitter, 1898)

17. Elytra widely darkened along the suture. Stenurella bifasciata limbiventris (Reitter, 1898)

- Elytra not widely darkened along the suture. Stenurella bifasciata septempunctata (Fabricius, 1792)

18. Pronotal punctuation rough. Stenurella bifasciata limbiventris (Reitter, 1898)

- Pronotal punctuation rough not so like; Western European subspecies. Stenurella bifasciata lanceolata (Mulsant & Rey, 1863)
- Elytral black area less developed............................. Stenurella bifasciata safronovi Danilevsky, 2011

20. Pronotal punctuation finely and dense........................................... Stenurella bifasciata bifasciata (Müller, 1776)
- Pronotal punctuation relatively bigger........................................... Stenurella bifasciata intermedia Holzschuh, 2006

21. Elytral apex more or less rounded........................................... Stenurella ferruginipes (Pic, 1895)
- Elytral apex more or less obliquely truncate.................................... Stenurella sabinae Rapuzzi & Sama, 2012 syn. nov.

Subgenus STENURELLA Villiers, 1974

Type sp.: Leptura melanura Linnaeus, 1758: 397

Group I (melanura species-group)

Including Stenurella melanura, Stenurella pamphyliae, Stenurella samai samai, Stenurella samai sennii, Stenurella zehrae.

Description:

6-12 mm;
Head black except yellowish maxillae; Antennae black in both sexes; In males, antennae extend to the elytral apex or slightly longer than elytral apex; In females, antennae as long as about three fourth or about four fifth of elytra; In both sexes, 3rd the longest antennal segment, 5th and 4th follow it; 4th segment as long as about two third- four fifth (0.64-0.82) of 3rd segment; 4th segment as long as about four fifth-nine tenth (0.76-0.93) or about the same length (0.98) of 5th segment; 5th segment as long as about three fourth-nine tenth (0.73-0.96) of 3rd segment; Posterior part of head (neck) with deeper transverse depression;

Pronotum completely black and as long as about one fourth-two fifth (0.24-0.39) of elytra;
Elytral coloration with sexual dimorphism; In males, elytra brown-yellow, reddish or yellowish with darkened apex and suture; In females, red or reddish with apex and along the suture widely black (apex to base of elytra or never reaches to scutellum (extends apex to first quarter or about one fifth of elytra)); Elytral apex oblique truncate; Elytral width slightly more than half of elytral length (0.50-0.54) or as long as about two fifth (0.38-0.39) of elytra;
Pygidium black;
Abdomen completely black in both sexes;
Legs completely black or completely black, but especially tibiae clothed very dense yellow pubescence; First segment of metatarsus slightly longer than the remaining segments together (1.06-1.13 times); First segment of metatarsus as long as 1.50-1.92 times of the 2-3rd segments together; Hind tibia shorter than metatarsus and as long as about two third (0.62) or more (up to 0.88) of metatarsus; Hind tibia longer than first segment of metatarsus. First segment of metatarsus as long as about three fifth-four fifth (0.56-0.81) of hind tibia;
Punctuation of head, pronotum and elytra almost same each other: strongly or deeply; very dense, dense or densely; contiguous or not contiguous;
Upperside with variable pubescence; Head and anterior half of pronotum sometimes with short black pubescence; Pronotum with yellowish or golden yellow pubescence especially in the basal half; Elytra with black or golden-yellow pubescence; Underside with dense yellowish or golden yellow pubescence; Pronotum without erect hairs.

Chorotype: Sibero-European [It distributed in almost all Europe, Siberia, Russian Far East, Japan, China, Mongolia, Kazakhstan, all Caucasus, Turkey].
This group includes five species-group taxa as *Stenurella melanura* (Linnaeus, 1758), *Stenurella pamphyliae* Rapuzzi & Sama, 2009, *Stenurella samai samai* Rapuzzi, 1995, *Stenurella samai sennii* Sama, 2002 and *Stenurella zehrae* Öz dikmen et al., 2012 now. The above mentioned characters for the group, therefore, are obtained from them.

**Species** *Stenurella melanura* Linnaeus, 1758: 397 (*Leptura*

- *diversiventris* Dufour, 1843: 103 (*Strangalia*
- *georgiana* Pic, 1891g: 63 (*Strangalia*
- *latesuturata* Pic, 1891g: 63 (*Strangalia*
- *melanurella* Reitter, 1901b: 78 (*Strangalia*
- *rubellata* Reitter, 1901b: 77 (*Strangalia*
- *semicrassa* Pic, 1901n: 58 (*Leptura*
- *similis* Herbst, 1784: 101 (*Leptura*
- *suturanigra* DeGeer, 1775: 138 (*Leptura*

Type loc.: Europa (Europe)

Chorotype: Sibero-European [It distributed in almost all Europe, Siberia, Russian Far East, Japan, China, Mongolia, Kazakhstan, all Caucasus, Turkey].

**Species** *Stenurella pamphyliae* Rapuzzi & Sama, 2009: 182

Type loc.: Antalya (Turkey)

It is endemic to Turkey now.

Chorotype: Anatolian [It distributed only in SW Turkey].

**Species** *Stenurella samai* Rapuzzi, 1995: 617

**Subspecies** *Stenurella samai samai* Rapuzzi, 1995: 617

Type loc.: Ildiz dag: Demirköy (European Turkey: Kırklareli prov.)

It is Eastern subspecies.

Chorotype: SE European [It distributed only in Balkans: Bulgaria, Greece, NW Turkey].
Subspecies Stenurella samai sennii Sama, 2002: 40 stat. nov.

Type loc.: France

It is Western subspecies. The taxon was described by Sama (2002) from France. He distinguished only from Stenurella melanura in his original description. The taxon, however, is very close to Stenurella samai Rapuzzi, 1995. It differs from Stenurella samai by denser and deeper pronotal punctuation as the main character. So, it is a subspecies of Stenurella samai Rapuzzi, 1995.

Chorotype: S-European [It distributed in France, Switzerland, Italy, Greece].

Species Stenurella zehrae Özdikmen et al., 2012: 18

Type loc.: Düzce (Turkey)

It is endemic to Turkey now.

Chorotype: Anatolian [It distributed only in NW Turkey].

Subgen. nov. PRISCOSTENURELLA

Type sp.: Leptura bifasciata O. F. Müller, 1776: 93

The subgenus includes 2 species-groups as follows:

Group II (bifasciata species-group)
Including Stenurella bifasciata bifasciata, Stenurella bifasciata intermedia, Stenurella bifasciata lanceolata, Stenurella bifasciata limbiventris, Stenurella bifasciata nigrosuturalis, Stenurella bifasciata safronovi, Stenurella ferruginipes (=Stenurella solaris), Stenurella sabinae.

Group III (septempunctata species-group)
Including Stenurella septempunctata septempunctata, Stenurella septempunctata latenigra, Stenurella vaucheri.

So, the following description obtained from the taxa that mentioned above.

Description:
6-12.5 mm;
Head completely black or black except yellowish maxillae, or orange or brown-yellow mouth parts and vertex; Antennae completely black, reddish or orange, or orange or brown-yellow except darkened basal segments; In males, antennae extend to the elytral apex, or slightly longer or slightly shorter than elytral apex; In females, antennae as long as about three fourth or four fifth of elytra; In both sexes, 3rd the longest antennal segment, 5th and 4th follow it, or 3rd antennal segment as long as the same length (0.95-1.05) of 5th and 4th follow it; 4th segment as long as about two third-nine tenth (0.64-0.89) of 3rd segment; 4th segment as long as about three fourth-nine tenth (0.76-0.94) of 5th segment; 5th segment as long as about three fourth (0.72-0.75)-nine tenth (0.82-0.90) of 3rd segment; Posterior part of head (neck) with deeper transverse depression;
Pronotum completely black or almost completely orange; Pronotum as long as about three tenth—one third (0.28-0.37) of elytra;
Elytral coloration with or without sexual dimorphism; If with that, then, in males, elytra dark reddish with darkened apex and the suture, or elytra yellowish with darkened apex, black suture and the base widely or narrowly; In females, reddish or dark red with black apex and behind the middle black widely transversal spot that sometimes very widened along the suture to elytral base; If without that, then, elytra orange (brown-yellow) or yellow with variable black spots in both sexes, but with or without sutural black band; Elytral apex more or less oblique truncate or more or less rounded; Elytral width slightly more than half of elytral length (0.50-0.60);

Pygidium completely black, orange, brown-yellow or reddish, or reddish with black apex;

Abdomen completely or mostly red with last segment blackened in both sexes, or completely orange or brown-yellow except black last segment, or reddish except darkened laterally in males;

Legs completely black, or red or reddish with at least hind tibiae entirely or only apically black, tarsi black, or legs not completely black, in both sexes, mostly orange or brown-yellow with black apex of hind femora and also top of hind tibiae and sometimes middle and hind tarsi darkened, or if legs black except all femora reddish in males, then legs completely reddish in females; First segment of metatarsus slightly shorter or slightly longer than the remaining segments together (0.94-0.97 or 1.04-1.08 times); First segment of metatarsus as long as 1.44-1.64 times of the 2-3rd segments together; Hind tibia shorter than metatarsus and as long as about three fifth (0.58-0.59) or more (up to 0.86) of metatarsus; Hind tibia slightly longer or longer than first segment of metatarsus; First segment of metatarsus as long as about two third- nine tenth (0.66-0.92) of hind tibia;

Punctuation of head, pronotum and elytra almost same each other: finely or deeply; moderately dense or dense; slightly contiguous or not contiguous;

Upperside and underside with yellowish or golden yellow pubescence; Pronotum without erect hairs.

Chorotype: Palaearctic [It is distributed in almost all Europe, European Russia, Caucasus (Armenia, Azerbaijan, Georgia), Turkey, Iran, Iraq, Siberia, Kazakhstan, China, North Africa (Morocco)].

Etymology: From the Latin word “priscus” (meaning in English “ancient, early, former”).

The subgenus includes 2 species-groups. Therefore, descriptions of these groups are also given separately as follows:

**Group II (bifasciata species-group)**

Including *Stenurella bifasciata bifasciata*, *Stenurella bifasciata intermedia*, *Stenurella bifasciata lanceolata*, *Stenurella bifasciata limbiventris*, *Stenurella bifasciata nigrosuturalis*, *Stenurella bifasciata safronovi*, *Stenurella ferruginipes (=Stenurella solaris)*, *Stenurella sabinae*.

**Description:**

6-10 mm;

Head black except yellowish maxillae; Antennae black in both sexes; In males, antennae slightly longer or slightly shorter than elytral apex; In females, antennae as long as about four fifth of elytra; In both sexes, 3rd the longest antennal
segment, 5th and 4th follow it, or 3rd antennal segment as long as the same length (0.95-1.05) of 5th and 4th follow it; 4th segment as long as about two third-nine tenth (0.64-0.89) of 3rd segment; 4th segment as long as about three fourth-nine tenth (0.76-0.93) of 5th segment; 5th segment as long as the same length (0.95-1.05) or as long as about nine tenth (0.85-0.90) of 3rd segment; Posterior part of head (neck) with deeper transverse depression;

Pronotum completely black; Pronotum as long as about one third (0.32-0.37) of elytra;

Elytral coloration with sexual dimorphism; In males, elytra dark reddish with darkened apex and the suture, or elytra yellowish with darkened apex, black suture and the base widely or narrowly; In females, reddish or dark red with black apex and behind the middle black widely transversal spot that sometimes very widened along the suture to elytral base; Elytral apex more or less oblique truncate or more or less rounded; Elytral width slightly more than half of elytral length (0.54-0.60);

Pygidium completely black or reddish with black apex;

Abdomen completely or mostly red with last segment blackened in both sexes;

Legs completely black, or red or reddish with at least hind tibiae entirely or only apically black, tarsi black; First segment of metatarsus slightly shorter or slightly longer than the remaining segments together (0.94-0.96 or 1.04-1.07 times); First segment of metatarsus as long as 1.44-1.64 times of the 2-3rd segments together; Hind tibia shorter than metatarsus and as long as about two third (0.63) or more (up to 0.86) of metatarsus; Hind tibia longer than first segment of metatarsus. First segment of metatarsus as long as about two third-three fourth (0.66-0.73) of hind tibia;

Punctuation of head, pronotum and elytra almost same each other: finely or deeply; moderately dense or dense; slightly contiguous or not contiguous;

Upperside and underside with yellowish or golden yellow pubescence; Pronotum without erect hairs.

Chorotype: Sibero-European [It is distributed in almost all Europe, European Russia, Caucasus (Armenia, Azerbaijan, Georgia), Turkey, Iran, Iraq, Siberia, Kazakhstan, China].
This group includes eight species-group taxa as *Stenurella bifasciata bifasciata* (O. F. Müller, 1776), *Stenurella bifasciata intermedia* Holzschuh, 2006, *Stenurella bifasciata lanceolata* (Mulsant & Rey, 1863), *Stenurella bifasciata limbiventris* (Reitter, 1898), *Stenurella bifasciata nigrosuturalis* (Reitter, 1895), *Stenurella bifasciata safronovi* Danilevsky, 2011, *Stenurella ferruginipes* (Pic, 1895) [=*Stenurella solaris* Rapuzzi & Sama, 2012] and *Stenurella sabinae* Rapuzzi & Sama, 2012 now. The above mentioned characters for the group, therefore, are obtained from them.

**Species** *Stenurella bifasciata* O. F. Müller, 1776: 93 (*Leptura*)

**Subspecies** *Stenurella bifasciata bifasciata* O. F. Müller, 1776: 93 (*Leptura*)

*albarracina* Wagner, 1927a: 45 (*Leptura*)
*cruciata* Olivier, 1795: 7 (*Leptura*)
*immaculata* Pic, 1889b: 55 (*Strangalia*)
*nigriventris* Pic, 1891b: 15 (*Strangalia*)
*sedakovii* Mannerheim, 1852b: 307 (*Stenura*)
*ustulata* Laicharting, 1784: 157 [HN] (*Leptura*)

Type loc.: Dania (Denmark)

Chorotype: Sibero-European [It is distributed in almost all Europe, European Russia, Caucasus (Armenia, Azerbaijan, Georgia), Turkey, Iran, Iraq, Siberia, Kazakhstan, China].

**Subspecies** *Stenurella bifasciata intermedia* Holzschuh, 2006: 219

Type loc.: Magnisia (Greece)

It was described by Holzschuh (2006) as a separate species. Danilevsky (2011) accepted it as a subspecies of the species.

Chorotype: SE-European [It is distributed only in south-eastern Europe (Balkans: Albania, Macedonia, Bulgaria, Greece)].

**Subspecies** *Stenurella bifasciata lanceolata* Mulsant & Rey, 1863: 177 (*Strangalia*)

Type loc.: L’Espagne (Spain)

It was described by Mulsant & Rey (1863) as a variety of *Strangalia bifasciata*. Danilevsky (2011) upgraded it as a subspecies of the species.
Chorotype: W-European [It is distributed only in western Europe (Spain, France)].

**Subspecies** *Stenurella bifasciata limbiventris* Reitter, 1898: 21 (*Strangalia*)

Type loc.: Caucasus

It was described by Reitter (1898) as a separate species *Strangalia limbiventris*.

Chorotype: SW-Asiatic (Anatolo-Caucasian) [It is distributed only in Caucasus (Georgia) and NE Turkey].

**Subspecies** *Stenurella bifasciata nigrosuturalis* Reitter, 1895: 88 (*Strangalia*)

Type loc.: Akbes (Turkey: Hatay: Akbez)

It was described by Reitter (1895) as a separate species *Strangalia nigrosuturalis*.

Chorotype: E-Mediterranean (Palestino-Taurian) [It is distributed only in Lebanon, Syria, S Turkey].

**Subspecies** *Stenurella bifasciata safronovi* Danilevsky, 2011: 2

Type loc.: Antalya and Isparta provinces (Turkey)

It is endemic to Turkey now.

Chorotype: Anatolian [It is distributed only in SW Anatolia].

**Species** *Stenurella ferruginipes* (Pic, 1895: 76)

*solaris* Rapuzzi & Sama, 2012: 665 **syn. nov.**

Type loc.: Bitlis (E Turkey)

It is endemic to Turkey now. *Stenurella solaris* that was newly described by Rapuzzi & Sama (2012) also from Bitlis province in East Turkey, is only a color form of the species.

Chorotype: Anatolian [It is distributed only in E Anatolia].

**Species** *Stenurella sabinae* Rapuzzi & Sama, 2012: 664

Type loc.: Hakkari (SE Turkey); Kordestan (W Iran)

Chorotype: SW-Asiatic (Irano-Anatolian) [It is distributed only in SE Anatolia and W Iran].
Group III (septempunctata species-group)

Including Stenurella septempunctata septempunctata, Stenurella septempunctata latenigra, Stenurella vaucheri.

Description:
7-12.5 mm;
Head completely black or black except orange or brown-yellow mouth parts and vertex; Antennae completely black, reddish or orange, or orange or brown-yellow except darkened basal segments; In males, antennae extend to the elytral apex; In females, antennae as long as about three fourth or four fifth of elytra; In both sexes, 3rd the longest antennal segment, 5th and 4th follow it; 4th segment as long as about two third (0.66-0.67) - about three fourth (0.74-0.77) of 3rd segment; 4th segment as long as about nine tenth (0.88-0.94) of 5th segment; 5th segment as long as about three fourth (0.72-0.75) - four fifth (0.82-0.87) of 3rd segment; Posterior part of head (neck) with deeper transverse depression;
Pronotum completely black or almost completely orange; Pronotum as long as about three tenth (0.28-0.31) – about one third (0.34) of elytra;
Elytral coloration with or without sexual dimorphism; Elytra orange (brown-yellow) or yellow with variable black spots in both sexes, but with or without sutural black band; Elytral apex more or less obliquely truncate; Elytral width slightly more than half of elytral length (0.50-0.53);
Pygidium orange, brown-yellow or reddish;
Abdomen completely orange or brown-yellow except black last segment, or reddish except darkened laterally in males;
Legs not completely black; In both sexes, mostly orange or brown-yellow with black apex of hind femora and also top of hind tibiae and sometimes middle and hind tarsi darkened, or if legs black except all femora reddish in males, then legs completely reddish in females; First segment of metatarsus slightly shorter or slightly longer than the remaining segments together (0.97 or 1.07-1.08 times); First segment of metatarsus as long as 1.48-1.60 times of the 2-3rd segments together; Hind tibia shorter than metatarsus and as long as about three fifth (0.58-0.59) or more (up to 0.78) of metatarsus; Hind tibia slightly longer or longer than first segment of metatarsus. First segment of metatarsus as long as about three fourth (0.71) - four fifth (0.80) or about nine tenth (0.86-0.92) of hind tibia;
Punctuation of head, pronotum and elytra almost same each other: finely; dense or moderately dense; not contiguous;
Upper and underside with yellow pubescence; Pronotum without erect hairs.

Chorotype: W-Palaearctic [It distributed in Europe, Caucasus (Armenia, Georgia), European Russia, Turkey, North Africa (Morocco)].
This group includes three species-group taxa as *Stenurella septempunctata septempunctata* (Fabricius, 1792), *Stenurella septempunctata latenigra* (Pic, 1915) and *Stenurella vaucheri* (Bedel, 1900) now. The above mentioned characters for the group, therefore, are obtained from them.

**Species** *Stenurella septempunctata* Fabricius, 1792: 346 (*Leptura*)

**Subspecies** *Stenurella septempunctata septempunctata* Fabricius, 1792: 346 (*Leptura*)
- *atrosuturalis* Pic, 1915a: 38 (*Leptura*)
- *coreyrica* Pic, 1915e: 5 (*Strangalia*)
- *dobiachi* Pic, 1916b: 4 (*Strangalia*)
- *gasturica* Pic, 1915a: 38 (*Leptura*)
- *holtzi* Pic, 1916b: 5 (*Strangalia*)
- *montandoni* Pic, 1915e: 5 (*Strangalia*)
- *notaticollis* Pic, 1915e: 5 (*Strangalia*)
- *pallidicolor* Pic, 1915e: 5 (*Strangalia*)
- *rubronotata* Pic, 1916b: 5 (*Strangalia*)
- *semireducta* Pic, 1915e: 5 (*Strangalia*)
- *suturata* Reiche & Saulcy, 1858: 22 (*Strangalia*) ["Péloponése"]
- *velebitica* Pic, 1916b: 4 (*Strangalia*)

Type loc.: Hungaria (Hungary)

It is the Western subspecies of *Stenurella septempunctata*.

Chorotype: European [It distributed in Europe (Central and South Europe (Germany and Italy) to Balkans and East Europe (up to Ukraine and European Russia)).

**Species** *Stenurella septempunctata latenigra* Pic, 1915: 5 (*Strangalia*)
- *anatolica* Heyrovský, 1961a: 45 (*Strangalia*)
- *roberti* Pic, 1915a: 38 (*Leptura*) ["Transsylvanie et Turquie"]
Type loc.: Asie Mineure (Turkey)

It is the Eastern subspecies of *Stenurella septempunctata*.

Chorotype: E-European [It distributed in Europe (Bulgaria, European Turkey, European Russia), Caucasus (Armenia, Georgia), Turkey].

**Species** *Stenurella vaucheri* Bedel, 1900: 336 (*Leptura*)

Type loc.: Maroc (Morocco)

It is endemic to Western Mediterranean area.

Chorotype: W-Mediterranean [It distributed only in W-Europe (Spain) and North Africa (Morocco)].

**Subgen. nov.** *STENURELLOIDES*

Type sp.: *Leptura jaegeri* Hummel, 1825: 68

**Group IV (jaegeri species-group)**

Including *Stenurella jaegeri*, *Stenurella novercalis*.

**Description:**

7-11.5 mm;

Head black except brown-yellow maxillae; Antennae completely black; In males, antennae extend to the elytral apex or slightly longer than elytral apex; In females, antennae as long as about four fifth of elytra; In both sexes, 3\textsuperscript{rd} the longest antennal segment, 5\textsuperscript{th} and 4\textsuperscript{th} follow it; 4\textsuperscript{th} segment as long as about three fourth (0.74-0.76) or four fifth (0.79-0.80) of 3\textsuperscript{rd} segment; 4\textsuperscript{th} segment as long as about nine tenth (0.87-0.91) of 5\textsuperscript{th} segment; 5\textsuperscript{th} segment as long as about four fifth (0.77)- nine tenth (0.87-0.94) of 3rd segment; Posterior part of head (neck) with deeper transverse depression;

Pronotum completely black; Pronotum as long as about one fourth (0.26-0.27)-three tenth (0.28-0.30) of elytra;

Elytral coloration with sexual dimorphism; In males, brown-yellow or reddish with black apex, the suture and side edges; In females, black with brown-yellow or reddish basal one third of elytra or sometimes almost basal half of elytra; Elytral apex rounded; Elytral width slightly more than half of elytral length (0.52-0.56);

Pygidium black;

Abdomen completely black;

Legs not completely black; In both sexes, at least all femora brown-yellow or reddish; First segment of metatarsus slightly shorter or slightly longer than the remaining segments together (0.92 or 1.11 times); First segment of metatarsus as long as 1.33-1.59 times of the 2-3rd segments together; Hind tibia shorter than metatarsus and as long as about three fourth (0.70) or more (up to 0.90) of metatarsus; Hind tibia longer than first segment of metatarsus. First segment of metatarsus as long as about three fifth (0.56-0.61) or about two third (0.68) of hind tibia;

Punctuation of head, pronotum and elytra almost same each other: strongly; very dense; contiguous;
Upper and underside with grayish or black pubescence; Pronotum without erect hairs.

Chorotype: E-European [It distributed in Caucasus (Armenia, Azerbaijan, Georgia), Ukraine (Crimea), European Russia, Turkey, Iran].

Etymology: From the Latin suffix “oides” (meaning in English “like, resembling”).

This subgenus includes two species as *Stenurella jaegeri* (Hummel, 1825) and *Stenurella novercalis* Reitter, 1901 now. The above mentioned characters for the subgenus, therefore, are obtained from them.

**Species** *Stenurella jaegeri* Hummel, 1825: 68 (*Leptura*)
- *fenestrata* Reitter, 1901b: 79 (*Strangalia*)
- *jekeli* Pic, 1901u: 236 (*Strangalia*)
- *mingrelica* Tournier, 1872: 344 (*Strangalia*)
- *oxyptera* Faldermann, 1837: 318 (*Stenura*)

Type loc.: Rossia meridionali (Southern Russia)

Chorotype: E-European [It distributed in Caucasus (Armenia, Azerbaijan, Georgia), Ukraine (Crimea), European Russia, Turkey, Iran].

**Species** *Stenurella novercalis* Reitter, 1901: 78

Type loc.: Caucasus

Chorotype: E-European [It distributed in Caucasus (Georgia), European Russia, Turkey].
Subgen. nov. **NIGROSTENURELLA**

Type sp.: *Leptura nigra* Linnaeus, 1758: 358

**Group V (nigra species-group)**
Including *Stenurella nigra*.

**Description:**
5-9 mm;
Head black except yellowish maxillae; Antennae black in both sexes; In males, antennae slightly longer than elytral apex; In females, antennae as long as about four fifth of elytra; In both sexes, 3rd and 5th antennal segment as long as about the same length; 4th segment always shorter; 4th antennal segment as long as about four fifth (0.83-0.87) of 3rd or 5th segments; Posterior part of head (neck) with shallow transverse depression;
Pronotum completely black; Pronotum as long as about one third (0.31-0.35) of elytra;
Elytral coloration without sexual dimorphism; completely black; Elytral apex oblique truncate; Elytral width slightly more than half of elytral length (0.52);
Pygidium reddish with black apex;
Abdomen 4-5th sternites reddish except black apex of last segment in males; 1-5th sternites (abdomen completely) reddish except black apex of last segment in females;
Legs completely black; First segment of metatarsus slightly longer than the remaining segments together (1.09 times); First segment of metatarsus as long as 1.52 times of the 2-3rd segments together; Hind tibia shorter than metatarsus and as long as two third (0.62-0.66) of metatarsus; Hind tibia longer than first segment of metatarsus. First segment of metatarsus as long as about three fourth (0.75)-about four fifth (0.81) of hind tibia;
Punctuation of head, pronotum and elytra almost same each other: finely; moderately dense; not contiguous;
Upperside and underside with grayish pubescence; Pronotum without erect hairs.

Chorotype: European [It distributed in almost all Europe, European Russia, Caucasus (Armenia, Azerbaijan, Georgia), Turkey, Iran].

Etymology: From the completely black upperside coloration.

This subgenus includes only one species as *Stenurella nigra* (Linnaeus, 1758) now. The above mentioned characters for the subgenus, therefore, are obtained from *Stenurella nigra*. 
Species *Stenurella nigra* Linnaeus, 1758: 398 (*Leptura*)  
*giraudi* Pic, 1946a: 14 (*Strangalia*)  
*picea* Geoffroy, 1785: 87 (*Stenocorus*)  
*varicollis* Schaefer, 1932: 31 (*Stenura*)

Type loc.: Europa (Europe)

Chorotype: European [It distributed in almost all Europe, European Russia, Caucasus (Armenia, Azerbaijan, Georgia), Turkey, Iran].

**Subgen. nov. CRASSOSTENURELLA**

Type sp.: *Strangalia approximans* Rosenhauer, 1856: 305

**Group VI (*approximans* species-group)**  
Including only *Stenurella approximans*.

**Description:**

10-15 mm;

Head black; Antennae completely black; In males, antennae slightly longer than elytral apex; In females, antennae as long as about four fifth of elytra; In both sexes, 3rd the longest antennal segment, 5th and 4th follow it; 4th segment as long as about four fifth (0.77-0.84) of 3rd segment; 4th segment as long as about nine tenth (0.90-0.91) of 5th segment; 5th segment as long as about nine tenth (0.85-0.94) of 3rd segment; Posterior part of head (neck) with shallow transverse depression;

Pronotum completely black; Pronotum as long as three tenth (0.30) of elytra;

Elytral coloration with sexual dimorphism; In males, dark brownish-red sometimes with darkened elytral apex and the suture; In females, dark brownish-red (forma typica), and sometimes with a very large black sutural stripe that extends elytral base to apex and clothed the most part of elytra (ab. *edmundi* Pic); Elytral apex oblique truncated; Elytral width slightly more than half of elytral length (0.54-0.55);

Pygidium black;

Abdomen black;

Legs completely black; First segment of metatarsus slightly shorter than the remaining segments together (0.90); First segment of metatarsus as long as 1.5 times of the 2-3rd segments together; Hind tibia shorter than metatarsus and as long as three fourth (0.75) or more (up to 0.88) of metatarsus; Hind tibia longer than first segment of metatarsus. First segment of metatarsus as long as about three fifth (0.57) or two third (0.64-0.69) of hind tibia;

Punctuation of head, pronotum and elytra almost same each other: strongly; very dense; contiguous;

Upper and underside with grayish pubescence; Pronotum without erect hairs.

Chorotype: W-Mediterranean [It is distributed only in Western Mediterranean area (Portugal, Spain and Morocco)].

Etymology: From the Latin word “crassus” (meaning in English “big”).
This subgenus includes only one species as Stenurella approximans (Rosenhauer, 1856) now. The above mentioned characters for the subgenus, therefore, are obtained from Stenurella approximans.

**Species** Stenurella approximans Rosenhauer, 1856: 305 (Strangalia)
purpuripennis Mulsant, 1863: 515 (Strangalia)
edmundi Pic, 1901u: 237 (Strangalia)
Type loc.: bei Algericas (Spain: Cadiz)

It is endemic to Western Mediterranean area.

Chorotype: W-Mediterranean [It is distributed only in Western Mediterranean area (Portugal, Spain and Morocco)].

**Subgen. nov. IBEROSTENURELLA**

Type sp.: Strangalia hybridula Reitter, 1902: 188

**Group VII (hybridula species-group)**
Including only Stenurella hybridula.

**Description:**

9-12 mm;

Head black except yellowish maxillae; Antennae yellowish-brown with darkened basal segments; In males, antennae longer than elytral apex; In females, antennae as long as about four fifth of elytra; In both sexes, 3rd and 5th antennal segment as long as the same length; 4th segment always shorter; 4th antennal segment as long as about four fifth (0.80-0.83) of 3rd or 5th segments; Posterior part of head (neck) with shallow transverse depression;

Pronotum completely black; Pronotum as long as about three tenth (0.27-0.33) of elytra;

Elytral coloration without sexual dimorphism; Elytra yellowish-brown with suture and lateral margins black, apex darkened; Elytral apex more or less rounded; Elytral width slightly more than half of elytral length (0.52-0.56);

Pygidium black;

Abdomen black in males, red except black 1st tergite and apex of last tergite in females;

Legs predominantly black sometimes with partly more or less yellowish-brown tibiae; First segment of metatarsus longer than the remaining segments together (1.25 times); First segment of metatarsus as long as almost 2 times (1.93) of the 2-3rd segments together; Hind tibia shorter than metatarsus and as long as
three fourth (0.75) or more (up to 0.88) of metatarsus; Hind tibia longer than first segment of metatarsus. First segment of metatarsus as long as about three fifth (0.57)-two third (0.67-0.70) of hind tibia;

Punctuation of head, pronotum and elytra almost same each other: finely; dense; not contiguous;
Upper and underside with yellowish pubescence; Pronotum with erect hairs.

Chorotype: Iberian endemic [It is distributed only in Iberian Peninsula (Portugal, Spain)].

Etymology: From the distribution area, Iberian Peninsula.

This subgenus includes only one species as *Stenurella hybridula* (Reitter, 1902) now. The above mentioned characters for the subgenus, therefore, are obtained from *Stenurella hybridula*.

**Species** *Stenurella hybridula* Reitter, 1902: 188 (*Strangalia*)
*atriventris* Pic, 1905a: 8 (*Leptura*) [DA]
*atronotata* Pic, 1918d: 5

Type loc.: Asturien: Albas (Spain); Sierra do Gerez (Portugal)

It is endemic to Iberian Peninsula.

Chorotype: Iberian endemic [It is distributed only in Iberian Peninsula (Portugal, Spain)].

**A necessary explanation:** Löbl & Smetana (2010) gave the species as follows:

*hybridula* Reitter, 1901h: 188 (*Strangalia*)  E: PT SP
*atriventris* Pic, 1905a: 8 (*Leptura*) [DA]
*atronotata* Pic, 1918d: 5

And also they gave as the mentioned reference:

However, the publication does not include the description of *Strangalia hybridula*. The species was described by Reitter (1902). The reference that missing in the Catalog, is presented as follows:

So, *Stenurella hybridula* should be attributed to Reitter (1902: 188) as correct.
Consequently, the genus *Stenurella* Villiers, 1974 can be arranged in accordance with Löbl & Smetana (2010) as follows:

**genus Stenurella Villiers, 1974:** 217 type species *Leptura melanura* Linnaeus, 1758

**subgenus Crassostenurella** Özdikmen, 2013: 526 type species *Strangalia approximans* Rosenhauer, 1856


**subgenus Iberostenurella** Özdikmen, 2013: 527 type species *Strangalia hybridula* Reitter, 1902

*hybridula* Reitter, 1902e: 188 (*Strangalia*) E: PT SP *atriventris* Pic, 1905a: 8 (*Leptura*) [DA]

**subgenus Nigrostenurella** Özdikmen, 2013: 525 type species *Leptura nigra* Linnaeus, 1758


**subgenus Priscostenurella** Özdikmen, 2013: 516 type species *Leptura bifasciata* O. F. Müller, 1776


**sabinae** Rapuzzi & Sama, 2012: 664 A: IN TR

rubronotata Pic, 1916b: 5 (Strangalia)
semireducta Pic, 1915e: 5 (Strangalia)
suturatana Reiche & Saulcy, 1858: 22 (Strangalia) [“Péloponése”]
velebitica Pic, 1916b: 4 (Strangalia)
septempunctata latenigra Pic, 1915: 5 (Strangalia)
E: AR BU GG A: TR
anatolica Heyrovský, 1961a: 45 (Strangalia)
roberti Pic, 1915a: 38 (Leptura) [“Transsylvanie et Turquie”]
vaucheri Bedel, 1900: 336 (Leptura) E: SP N: MO
subgenus Stenurella Villiers, 1974: 217 type species Leptura melanura Linnaeus, 1758
melanura Linnaeus, 1758: 397 (Leptura) E: AB AL AR AU BE BH BU BY CR CT CZ DE EN FI FR GB GE GG GR HU IR IT LA LS LT LU MC MD NL NT NR PL PT RO SK SL SP ST SV SZ YU UK MD A: ES FE JA KZ MG TR WS XIN diversidentris Dufour, 1843: 103 (Strangalia)
georgiana Pic, 1891g: 63 (Strangalia)
latesuturatana Pic, 1891g: 63 (Strangalia)
melanurella Reitter, 1901b: 78 (Strangalia)
rubellata Reitter, 1901b: 77 (Strangalia)
semicrassa Pic, 1901m: 58 (Leptura)
similis Herbst, 1784: 101 (Leptura)
suturanigra DeGeer, 1775: 138 (Leptura)
pamphyliæ Rapuzzi & Sama, 2009: 182 A: TR
samai samai Rapuzzi, 1995: 617 E: BU GR TR A: TR
samai senni Sama, 2002: 40 E: FR GR IT SZ
zehrae Özdikmen et al., 2012: 18 A: TR
subgenus Stenurelloides Özdikmen, 2013: 523 type species Leptura jaegeri Hummel, 1825
jaegeri Hummel, 1825: 68 (Leptura) E: AB AR GG ST UK A: TR
fenestrata Reitter, 1901b: 79 (Strangalia)
jekeli Pic, 1901u: 236 (Strangalia)
mingrelica Tournier, 1872: 344 (Strangalia)
oxyperta Faldermann, 1837: 318 (Stenura)
novercalis Reitter, 1901b: 78 E: GG ST A: TR
Notes: The taxon, Strangalia lindbergi Villiers, 1943: 233, that sometimes is placed in the genus Stenurella, definitely belongs to the genus Nustera Villiers, 1974.

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REVISION OF THE CYANELLUS SPECIES GROUP OF ENTEDON DALMAN (HYMENOPTERA: EULOPHIDAE), WITH DESCRIPTIONS OF NEW SPECIES

Mikdat Doğanlar* and Oğuzhan Doğanlar**

* Mustafa Kemal University, Faculty of Agriculture, Department of Plant Protection, TR-31034, Hatay, TURKEY. E-mail: doganlar@mku.edu.tr
** Ağrı İbrahim Çeçen University, Science and Art Faculty, Department of Biology, 04200, Ağrı, TURKEY. E-mail: doganlaro@yahoo.com.tr


ABSTRACT: Eight species of the cyanellus species group of genus Entedon Dalman (Hymenoptera: Eulophidae: Entedoninae) were collected in Turkey: E. cyanellus Dalman, E. biroi Erdős, E. parvicalcar Thomson, E. pallicrus Erdős, and the four new species, E. arabanensis n. sp., E. sarkislaensis n. sp., E. susuzensis n. sp., E. gumushanensis n. sp. Hypopygia of the species, except E. susuzensis and E. gumushanensis, were studied. Identification keys to the Turkish species of the cyanellus species group of Entedon were provided.

KEY WORDS: Hymenoptera (Eulophidae), cyanellus species group of Entedon, Turkey.

The species group cyanellus was proposed by Graham (1963) for the association of Entedon cyanellus Dalman, 1820, E. pallicrus Erdős, 1944, E. metatarsalis Thomson, 1878, E. subovatus Thomson, 1878, and E. parvicalcar Thomson, 1878. Later Graham (1971) revised the species of the group, and include to the species group of cyanellus the following species: Entedon subimpressus Thomson, 1878, E. cyanellus, E. pallicrus Erdős, 1944, E. subovatus, E. parvicalcar, E. biroi Erdős, 1944 and E. astragali Erdős, 1944, and stated that the species sharing the characters as follow: missing frontal sulcus, oral fossa 2.5-4.5 times as long as malar space, anterior margin of clypeus produced forwards, fore tibia with two longitudinal white stripes, POL (post ocellar distance) nearly or quite twice OOL (ocello-ocular distance), hind ocelli separated by 1-1.75 times their own major diameter from eyes, fore wing speculum open below, basal vein normally bare, three segmented male funicle. Askew (1992) proposed some corrections to the species group structure, and to include E. sylvestris Szelenyi, 1981 in the species group cyanellus because of presence of two hardly discernible stripes on the fore tibia, while the rest have fore tibiae wholly darkened. Gumovsky (1999) studied the type series and numerous (about 1000) other specimens of E. sylvestris (HNHM), and placed it in the costalis species group of Entedon.

In Turkey, Doğanlar (1985) recorded *E. biroi*, *E. parvicalcar*, and *E. pallicrus* from the *cyanellus* species group and some other species of *Entedon* from the Eastern Anatolia. Gumovsky (1999) described *E. angorensis* from Ankara province, and Gumovsky & Boyadzhiev (2003) gave some species of the group from Bulgaria and Trace.

The morphology of hypopygia in the taxonomy of Pteromalidae (Hymenoptera: Chalcidoidea) has been studied for separating the species of *Mesopolobus* Westwood, 1833 by Graham (1969), for the species of *Pachyneuron* Walker, 1833 and *Euneura* Walker, 1844 by Doğanlar (1986) and for the species of *Dibrachys* Förster, 1856 by Doğanlar (1987). In the taxonomy of Eulophidae (Hymenoptera: Chalcidoidea) Graham (1987, 1991) used the morphology of hypopygia in the classification of species of some genera in Tetrastichinae, Doğanlar (1991a,b) for some species of Ormyridae, and Tarla et al. (2010) for species of genus *Oopristus* Steffan, 1968 in Monodontomerinae (Torymidae).

In this work the morphology of hypopygia and some other morphological characters of the species in the *cyanellus* species group of *Entedon* were treated as diagnostic characters for the systematic of the species from Turkey, and the new species were described. Aids of some morphological characters a new identification key was created for the species of the *cyanellus* species group of *Entedon* in Turkey.

**MATERIAL AND METHODS**

This study is based upon examination and identification of the specimens collected from several parts of Turkey. The examined specimens were deposited in Insect Museum of Plant Protection Department, Agriculture Faculty, Mustafa Kemal University, Antakya, Hatay, Turkey (MKUI). Specimens were collected by sweeping and putting the whole contents of the swept materials directly in 96 % ethanol. After sorting the material, individuals were mounted on cards for further morphological studies. The species were identified by following the keys of Graham (1971), Gumovsky (1999) and Gumovsky & Boyadzhiev (2003). The hypopygia were separated from metasoma by dissecting and slide mounted in Canada balsam, the other parts of the metasoma were replaced on its own card near its mesosoma. Wings and antennae of some para-types were slide-mounted in Canada balsam. Photographs of diagnostic characters of the genera were taken by using of Leica DM 5500 B microscope with a digital Leica DFC 295 camera attached to it.

**Terminology and abbreviations**

Morphological terminology follows Graham (1969) in hypopygia as in Fig. 1, Gibson (1997) and Gumovsky & Boyadzhiev (2003). Abbreviations used in the key and descriptions are: OOL= shorter distance between ocello-ocular line POL= distance between posterior ocelli, F1-4= funicular segments. The name of some parts of hypopygium given in Fig. 1.

**RESULTS AND DISCUSSION**

**Key to female of the species of the *cyanellus* species group of *Entedon***

1- Mid and hind tibiae wholly pale (mostly white) (Fig. 4b,c); eye height 4.2 times as long as malar space; antenna (Fig. 4a) with scape 5.6 times as long as broad; metasoma 1.3 times as long as broad; hypopygium (Fig. 4d,e) with median area circular, with median sclerotized line complete......................................................... *Entedon pallicrus* Erdős
- Mid and hind tibiae at least with narrow basal dark band; other characters variable........2
2- Mid and hind tibiae at least their distal third pale (Figs. 5b,c; 6b,c; 7b,c; 8b,c)............3
- Mid and hind tibiae at most their distal quarter or less pale (Figs. 9b,c; 10b,c; 11b,c)........6
3- Mid and hind tibiae with basal dark band almost margined at both ends, covering 1/4 of total length of tibiae (Fig. 5b,c); eye height 5.5 times as long as malar space. Antenna (Fig. 5a) with scape 3.5-3.75 times as long as broad. Metasoma ovate, slightly longer than broad; hypopygium (Fig. 5d,e) with median area quadrangular, median sclerotized line medially almost absent..........................................................Entedon biroi Erdős
- Mid and hind tibiae with basal dark band at least covering their basal 1/3, lower margin of this dark band washed out; other characters variable...............................................................4
4- Basal dark band of mid tibia longer than the band of hind tibia (Fig. 6b,c); eye height 4.8-5.67 times as long as malar space; antenna (Fig. 6a) with scape 3.14-3.43 times as long as broad. Metasoma 1.73 times as long as broad; hypopygium (Fig. 6d,e) with median area circular, median sclerotized line complete..........................................................Entedon arabanensis n. sp.
- Basal dark band of mid and hind tibiae almost equal in breadth (about 1/3-2/3 of length of the tibia), or hind tibia somewhat broader than mid one (Figs. 7b,c; 8b,c); other characters variable...............................................................5
5- Head in frontal view 1.4 times as broad as high; POL 2.1-2.4 OOL; breadth of oral fossa about 5.0 times as long as malar space; Antenna (Fig. 7a) with scape 6 times as long as broad; pedicel 2.0 times as long as broad, 0.6-0.8 times as long as F1; the latter 2.0-2.25 times as long as broad, and 1.14-1.3 times as long as F2; F2 almost twice as long as broad, F3 1.3 times as long as broad. Metasoma ovate, slightly shorter than broad; hypopygium as in Fig. 7d,e..........................................................Entedon parvicollar Thomson
- Head in frontal view 1.32 times as broad as high; POL 3.33 OOL; breadth of oral fossa about 8.0 times as long as malar space. Antenna (Fig. 8a) with scape 2.75 times as long as broad, pedicel 1.66 times as long as broad, almost as long as F1; the latter 1.5 times as long as broad, and 1.8 times as long as F2; F2 and F3 subquadrate. Metasoma long-ovate, about 1.5 times longer than broad; hypopygium as in Fig. 8e..........................................................
........................................................................................................................................Entedon sarkislaensis n. sp.
- Forewing with fumation below marginal vein (Fig. 9d); clypeus almost smooth; head in frontal view 1.4 times as broad as high. Breadth of oral fossa about 5.67 times as long as malar space. Eye height 3.57 times as long as malar space. Combined length of pedicel and flagellum 0.9 times as long as breadth of head. Antenna (Fig. 9a) with scape 5.7 times as long as broad, 0.76 times as long as eye height; pedicel 2.4 times as long as broad, 0.67 as long as F1; the latter twice as long as broad, and 1.38 times as long as F2; F2 1.85 times, and F3 1.3 times as long as broad; clava twice as long as broad. Metasoma long, about 1.9 times longer than broad..........................................................Entedon susuzensis n. sp.
- Forewing hyaline, without fumation below marginal vein; clypeus reticulate; other characters variable........................................................................................................................................7
7- Eye height 3.6-4.6 times as long as malar space. Antenna (Fig. 10a) with scape 5.0-6.25 times as long as broad; pedicel about 0.4-0.75 as long as F1; the latter 1.83-5.0 times as long as broad, clava 1.66-2.25 times as long as broad. Hypopygium (Figs. 11d,e) with anterior median incision broadly C-shaped, basally straight, antero-lateral angle with tip tapering, towards median incision slightly concaved; anterior lobe much narrower than posterior lobe which is distally circular, median area distinctly longer than broad, posterior median incision as in Fig. 10e..........................................................Entedon cyanellus Dalman
- Eye height 5.0 times as long as malar space. Antenna (Fig. 11a) with scape 3.14-3.27 times as long as broad; pedicel about 1.14-1.16 as long as F1; the latter about 1.3-1.55; clava about 1.25-1.4 times longer than broad. Hypopygium (Fig. 11d,e) with anterior median incision broadly U-shaped, anterior lobe circular, antero-lateral angle towards median incision almost straight; posterior lobe distally circular, but narrowing towards median incision; median area and posterior median incision as in Fig. 11e..........................................................Entedon gumushanensis n. sp.

Key to male of the species of the cyanellus species group of Entedon

1- Mid and hind tibiae wholly pale (mostly white); antennae (Fig. 2c) with scape 3.25 times as long as broad, F2 1.33 times as long as broad, F3 almost quadrate. Metasoma long-ovate, about 1.73 times longer than broad..............................Entedon pallicrurus Erdős
**Entedon pallicrus** Erdös

(Figs. 4a-e; 2c)

*Entedon pallicrus* Erdös, 1944: 52.♀♂, ɔɔ♂♂,


*Type material:* given by Gumovsky (1999).


**Diagnosis:** Both sexes: Mid and hind tibiae wholly pale (mostly white) (Fig. 4b,c); Female; head in dorsal view 2.26 times as broad as long, in frontal view 1.45 times as broad as high; POL 2.2 OOL; breadth of oral fossa 5.0 times as long as malar space; eye height 4.2 times as long as malar space; combined length of pedicel and flagellum 0.66 times as long as breadth of head; antenna (Fig. 4a) with scape 5.6 times as long as broad; pedicel 2.25, F1 1.66, F2 and F3 1.2-1.3, times as long as broad, clava 1.76 as long as broad; metasoma 1.3 times as long as broad; hypopygium (Fig. 4d,e) with anterior median incision broad; anterior lobe circular, anterior lateral angle distinct medially, median area circular, with median sclerotized line complete. Male: antennae (Fig. 2c) with scape 3.25 times as long as broad, pedicel 1.7 times as long as broad, 0.75 times as long as F1; the latter 2.2 times as long as broad, 1.37 times as long as F2; F2 1.33 times as long as broad, F3 almost quadrate, clava two-segmented including spicula 2.67 times as long as broad; Metasoma long-ovate, about 1.73 times longer than broad.

**Description:** given by Gumovsky (1999).


*Entedon biroi* Erdős
(Figs. 5a-e; 2a)


Type material: given by Gumovsky (1999).


Diagnosis: Both sexes: Mid and hind tibiae with basal dark band almost margined at both ends, covering 1/4 of total length of tibiae(Fig. 5b,c); Female: antennae (Fig. 5a) with scape 2.6 times as long as broad, pedicel 2.17times as long as broad, 0.8 times as long as asF1; the latter twice as long as broad, F2 and F3 almost quadrate; clava including spicula 2.3 times as long as broad; Metasoma long-ovate, about 1.7times longer than broad. Hypopygium (Fig. 5d,e) with anterior median incision broadly C-shaped; anterior and posterior lobes circular; median area quadrangular, median sclerotized line medially almost absent. Male: antennae (Fig. 2a) with scape 2.6 times as long as broad, pedicel 2.17times as long as broad, 0.8 times as long as asF1; the latter twice as long as broad, F2 and F3 almost quadrate; clava including spicula 2.3 times as long as broad; Metasoma long-ovate, about 1.7times longer than broad.

Description: given by Gumovsky (1999).

Biology: Host unknown, associated with fabaceous plants (Gumovsky, 1999).

Distribution: Czech Republic, Slovak Republic, Moldova, Hungary (Boucek & Askew, 1968), Erzurum, Turkey (Doğanlar, 1985). Ukraine, Russia, Iran, Uzbekistan (Gumovsky, 1999).

*Entedon arabanensis* n. sp.
(Figs. 6a-e)

Diagnosis. Hypopygium (Fig. 6d,e) with anterior median incision broadly U-shaped, antero-lateral angle straight; posterior lobe distally circular, but narrowing towards median incision, median sclerotized line reaching to anterior median incision of hypopygium, median sclerotized area almost circular; posterior median incision as in Fig. 7e. Metasoma almost as long as head plus mesosoma, about 1.73 times as long as broad; penultimate tergite of metasoma 0.44 times as long as broad, last tergite 0.44 times as long as broad; antenna (Fig. 6a) with scape of female 3.14-3.43 times as long as broad; pedicel about 2.02-2.4 times as long as broad; F1 about 1.14-1.6, F2 1.0-1.3, F3 1.0-1.2 times as long as broad; clava two-segmented, about 1.85-2.17 times longer than broad, twice longer than the preceding segment; eye height 5.5 times as long as malar space; breadth of breadth of oral fossa 4.8-5.67 times as long as malar space; fore wing
2.06 times as long as broad, apical margin with fringe; fore tibiae 1.36, mid tibiae about 1.45 and hind tibia about 1.9 times as long as their tarsi.

**Description:**

Female. Body length 1.5-2.1 mm. Color of body metallic dark blue, frons with weak greenish tint. Entire antennae dark. Legs (Figs. 6b,c) dark, except knees, 2/5 of distal ends of mid tibiae and ½ of hind tibiae, the first three tarsomeres of mid and hind legs, which are pale. Dorsal and ventral pale longitudinal stripes on fore tibia discernible along entire tibia.

Head in dorsal view 2.13 times as broad as long; POL 2.12 OOL. Occipital margin sharp. Eyes sparsely setose, with short setae, eye height 5.5 times as long as malar space. Head in front view 1.25-1.33 times as broad as long. Interocular distance 2.1 times as long as eye breadth. Malar sulcus indicated by a line. Breadth of breadth of oral fossa 5.67-6.67 times as long as malar space. Clypeus reticulate, its anterior margin produced forward. Antennae (Fig. 6a) inserted slightly above the level of ventral eye margin. Pedicel plus flagellum 0.71-0.78 times broad of head. Antennal scape of female 3.14-3.43 times as long as broad; pedicel about 2.02-2.4 times as long as broad, almost as long as F1; F1 about 1.14-1.6, F2 1.0-1.3, F3 1.0-1.2 times as long as broad; clava two-segmented, about 1.85-2.17 times longer than broad, twice longer than the preceding segment; Mesosoma 1.4 times as long as broad. Pronotal collar hardly traceable, postero-lateral corners of pronotum evenly rounded. Mesoscutum 1.9 times as broad as long, notaulli traceable anteriorly as very fine sutures, posteriorly as shallow depressions; scutellum as long as broad and 1.2 times as long as mesoscutum. Propodeal surface finely reticulate, median carina complete, lateral sulcus incomplete; paraspiracular sulcus deep, complete; supracoxal flange moderate; spiracular elevation with blunt projection below, propodeal callus with 2 long, 4 short setae. Hind coxa reticulate dorsally. Fore femur about 4.1 times as long as broad, fore tibia 5.0 times as long as broad, about 0.9 times as long as its femur; mid femur 3.5 times as long as broad; mid tibia 7.2 times as long as broad, spur of mid tibia 1.33 times as long as breadth of tibia, 1.14 as long as dorsal margin of mid basitarsus; hind femur about 2.6 times as long as broad, hind tibia about 6.7 times as long as broad, spur of hind tibia about 0.71 times as long as breadth of its tibia, and 0.83 times as long as dorsal margin of hind basitarsus. Fore tibiae 1.36, mid tibiae about 1.45 and hind tibia about 1.9 times as long as their tarsi.

Forewing 2.06 times as long as broad; costal cell bare, comparatively wide, 6.67 times as long as broad, 0.9 times as long as marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein slightly shorter than stigma vein; speculum open below; apical margin with fringe. Hind wing 4.23 times as long as broad. Petiole reduced, strongly transverse. Metasoma almost as long as head plus mesosoma, about 1.73 times as long as broad; penultimate tergite of metasoma 0.44 times as long as broad, last tergite 0.44 times as long as broad; Hypopygium (Fig. 6d,e) with anterior median incision broadly C-shaped, antero-lateral angle circular, towards median incision slightly concaved; posterior lobe distally circular, but narrowing towards median incision, median sclerotized line reaching almost middle of hypopygium, posterior median incision as in Fig. 6d,e.

**Type materials.** Holotype, ♀, Turkey: Gaziantep, 2.v. 2008, swept from lent field (M. Doğanlar). Paratypes: 10 ♀, 2♂, same data as Holotype; 2 ♀, 1♂, Diyarbakır, 3 km to Hilvan, 26. Iv. 2007, swept from Vicia sp. Field (M.& O. Doğanlar); 1♀, Gaziantep, 5 km from Nizip, side of Nizip-Karkamış road, 17.iv. 2010, (M. Doğanlar); 1♀, Şanlıurfa, 15 km to Suruç, side of Nizip-Suruç road, 17.iv. 2010, swept from lent field (M. Doğanlar); 1♂, Adıyaman, near Atatürk Barage,
24.iv. 2008, swept from pasture (M. Doğanlar); 1♀, Erzincan, Kemaliye, Yuva village, 18.vi.1982, swept from pasture (M. Doğanlar). All of the types were deposited in MKUI.

Discussion: Entedon arabanensis n. sp. is similar to E. angorensis Gumovsky and E. calvescentitus Szelenyi in having mid tibiae with their distal 2/5 and hind tibiae with their distal half pale (Figs. 3b,c); but it differs from the both species in having head in dorsal view 2.13 times as broad as long; POL 2.12 OOL, eye height 5.5 times as long as malar space; breadth of oral fossa 5 times as long as malar space; antennal scape of female 3.14-3.43 times as long as broad; F1 about 1.14-1.6, F2 1.0-1.3 (in the both species head in dorsal view 2.3-2.5 times as broad as long; POL at least 2.4 OOL; eye height at most 4.66 times as long as malar space; breadth of oral fossa 5 times as long as malar space in E. calvescentitus, and 4.6 times in E. angorensis; scape at least 5.5 times as long as broad; F1 1.77, F2 1.65 times as long as broad in E. calvescentitus, and F1 2.25, F2 1.77, F3 1.2 times as long as broad in E. angorensis).

Entedon palvicalcar Thomson
(Fig. 7a-e; 3a)

Entedon palvicalcar Thomson, 1878: 244.

Type material: given by Gumovsky (1999).

Material examined: Turkey: Erzurum, 1♀, 28.vi. 1976 (H. Özbek); 24 ♀♀, 13 ♂♂, 23. vi.-28. vii. 1978 (H. Özbek); 7 ♀♀, 3 ♂♂, 24. vii.-08.ix. 1979 (H. Özbek); Sivas,Centrum, Keçili vil., 1♀, 03.vii.2005 (O. Doğanlar); Taşlıdere, 1♀, 1♂, 03.vii. 2005 (O. Doğanlar); Kangal, Tahtalı vil., 1♀, 03. vii. 2005 (O. Doğanlar); Kayseri, Pınarbaşı, 1♀, 07. vii. 2005 (O. Doğanlar); Ukraine: Turu, nr. Kaniv, Pishaltinski, 08 ♀♀, 3 ♂♂, (M. Doğanlar).

Diagnosis: Both sexes: Basal dark band of mid and hind tibiae almost equal in breadth (about 1/3-2/3 of length of the tibia), or hind band somewhat broader than mid one (Figs. 7b,c). Female: Head in dorsal view 2.0-2.25 times as long as broad; POL 2.1-2.4 OOL; Head in frontal view 1.4 times as broad as high; breadth of oral fossa about 5.0 times as long as malar space; eye height 5.5 times as long as malar space. Combined length of pedicel and flagellum 0.72 times as long as breadth of head. Antenna (Fig. 7a) with scape 6 times as long as broad, 0.6-0.7 times as long as eye height; pedicel 2.0 times as long as broad, 0.6-0.8 times as long as F1; the latter 2.0-2.25 times as long as broad, and 1.14-1.3 times as long as F2; F2 almost twice as long as broad, F3 1.3 times as long as broad; clava 1.6-2.1 times as long as broad. Metasoma ovate, slightly shorter than broad; hypopygium (Figs. 7d,e) with anterior median incision broadly C-shaped, antero-lateral angle circular, towards median incision slightly concaved; posterior lobe distally circular, median sclerotized line reaching to anterior median incision of hypopygium, posterior median incision as in Fig. 8d,e. Male: Antennae (Fig. 3a) with scape 6 times as long as broad, 0.6-0.7 times as long as eye height; pedicel 2.0 times as long as broad, 0.66 times as long as F1; the latter 2.25 times as long as broad, and 1.2-1.3 times as long as F2; F2 twice as long as broad, F3 subquadrate; clava 1.6-1.9 times as long as broad. Metasoma almost ovate, 1.25 times as long as broad.

Description: given by Gumovsky (1999).

Biology: Host unknown. associated with fabaceous plant.
Distribution: Britain, Sweden, Czech Republic, Slovak Republic, Moldova, Hungary, former Yugoslavia (Boucek & Askew, 1968), Turkey (Doğanlar, 1985), Ukraine, Rusia (European part, the Caucasus, Siberia), Kazakhstan (Gumovsky, 1999).

*Entedon sarkislaensis* n.sp.

(Figs. 8a–e; 3b)

**Diagnosis.** Hypopygium (Fig. 8d,e) with anterior median incision broadly U-shaped, antero-lateral angle straight; posterior lobe distally circular, but narrowing towards median incision, median sclerotized line reaching to anterior median incision of hypopygium, median sclerotized area almost circular; posterior median incision as in Fig. 8e. Metasoma almost as long as head plus mesosoma, about 1.73 times as long as broad; penultimate tergite of metasoma 0.44 times as long as broad, last tergite 0.44 times as long as broad; antenna (Fig. 8a) with scape of female 3.14–3.43 times as long as broad; pedicel about 2.02–2.4 times as long as broad; F1 about 1.14–1.6, F2 1.0–1.3, F3 1.0–1.2 times as long as broad; clava two-segmented, about 1.85–2.17 times longer than broad, twice longer than the preceding segment; eye height 5.5 times as long as malar space; breadth of breadth of oral fossa 4.8–5.67 times as long as malar space; fore wing 2.06 times as long as broad, apical margin with fringe; fore tibiae 1.36, mid tibiae about 1.45 and hind tibia about 1.9 times as long as their tarsi.

**Description:**

Female. Body length 1.5–2.1 mm. Colour of body metallic dark blue, frons with weak greenish tint. Entire antennae dark. Legs (Figs. 8b, c) dark, except knees, 2/5 of distal ends of mid tibiae and ½ of hind tibiae, the first three tarsomeres of mid and hind legs, which are pale. Dorsal and ventral pale longitudinal stripes on fore tibia discernible along entire tibia.

Head in dorsal view 2.13 times as broad as long; POL 2.12 OOL. Occipital margin sharp. Eyes sparsely setose, with short setae, eye height 5.5 times as long as malar space. Head in front view 1.25–1.33 times as broad as long. Interocular distance 2.1 times as long as eye breadth. Malar sulcus indicated by a line. Breadth of breadth of oral fossa 5.67–6.67 times as long as malar space. Clypeus reticulate, its anterior margin produced forward. Antennae (Fig. 8a) inserted slightly above the level of ventral eye margin. Pedicel plus flagellum 0.71–0.78 times broad of head. Antennal scape of female 3.14–3.43 times as long as broad; pedicel about 2.02–2.4 times as long as broad, almost as long as F1; F1 about 1.14–1.6, F2 1.0–1.3, F3 1.0–1.2 times as long as broad; clava two-segmented, about 1.85–2.17 times longer than broad, twice longer than the preceding segment; Mesosoma 1.4 times as long as broad. Pronotal collar hardly traceable, postero-lateral corners of pronotum evenly rounded. Mesoscutum 1.9 times as broad as long, notauli traceable anteriorly as very fine sutures, posteriorly as shallow depressions; scutellum as long as broad and 1.2 times as long as mesoscutum. Propodeal surface finely reticulate, median carina complete, lateral sulcus incomplete; paraspiracular sulcus deep, complete; supracoxal flange moderate; spiracular elevation with blunt projection below, propodeal callus with 2 long, 4 short setae. Hind coxa reticulate dorsally. Fore femur about 4.1 times as long as broad, fore tibia 5.0 times as long as broad, about 0.9 times as long as its femur; mid femur 3.5 times as long as broad; mid tibia 7.2 times as long as broad, spur of mid tibia 1.33 times as long as breadth of tibia, 1.14 as long as dorsal margin of mid basitarsus; hind femur about 2.6 times as long as broad, hind tibia about 6.7 times as long as broad, spur of hind tibia about 0.71 times as long as breadth of its
tibia, and 0.83 times as long as dorsal margin of hind basitarsus. Fore tibiae 1.36, mid tibiae about 1.45 and hind tibia about 1.9 times as long as their tarsi.

Fore wing 2.06 times as long as broad; costal cell bare, comparatively wide, 6.67 times as long as broad, 0.9 times as long as marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein slightly shorter than stigmal; speculum open below; apical margin with fringe. Hind wing 4.23 times as long as broad.

Petiole reduced, strongly transverse. Metasoma almost as long as head plus mesosoma, about 1.73 times as long as broad; penultimate tergite of metasoma 0.44 times as long as broad, last tergite 0.44 times as long as broad; Hypopygium (Fig. 8d,e) with anterior median incision broadly C-shaped, antero-lateral angle circular, towards median incision slightly concaved; posterior lobe distally circular, but narrowing towards median incision, median sclerotized line reaching almost middle of hypopygium, posterior median incision as in Fig. 8d,e.

**Type material.** Holotype, ♀, Turkey: Sivas, Şarkışla, Tavladeresi vil. 19.vi. 2003, swept from pasture (O. Doğanlar). Paratypes: 2♀♀, 2♂♂, same data as Holotype; Sivas, Centrum, Gökçekent, Sökün vil. 1♀, 17.vi.2003, swept from pasture (O. Doğanlar); Kayseri, Pınarbaşı, Çukuryurt vil. 2♀, 2♂, 19.vi.2003, swept from pasture (O. Doğanlar); Erzurum, Kandilli, 2♀, 12.vi.1982, swept from pasture (M. Doğanlar); Horasan, Karaçuha, 2♀, 2♂, 30.v.-10.vi.1980, swept from pasture (M. Doğanlar); Hatay, Yayladağ, Ayışığı vil. 13.iv. 2008, swept from Vicia sativa field (M. Doğanlar); Adıyaman, Dut, 1♀, 11.v.2008, swept from Onobrycis sp. field (M. Doğanlar); Gaziantep, Nizip, Arat Mnt. 1♀, 04.v. 2006, swept from Lent field (M. Doğanlar); From Kahramanmaraş to Gölbaşı Road, Araban turn, 1♀, 02.v. 2008, swept from Lent field (M. Doğanlar). All of the types were deposited in MKUI.

**Discussion:** Entedon arabanensis n. sp. is similar to *E. angorensis* Gumovsky and *E. calvescentitus* Szelenyi in having mid tibiae with their distal 2/5 and hind tibiae with their distal half pale (Figs. 3b,c); but it differs from the both species in having head in dorsal view 2.13 times as broad as long; POL 2.12 OOL, eye height 5.5 times as long as malar space; breadth of breadth of oral fossa 5.67 - 6.67 times as long as malar space; antennal scape of female 3.14 - 3.43 times as long as broad; F1 about 1.14 - 1.6, F2 1.0 - 1.3 (in the both species head in dorsal view 2.3 - 2.5 times as long as broad; POL at least 2.4 OOL; eye height at most 4.66 times as long as malar space; breadth of oral fossa 5 times as long as malar space in *E. calvescentitus*, and 4.6 times in *E. angorensis*; scape at least 5.5 times as long as broad; F1 1.77, F2 1.65 times as long as broad in *E. calvescentitus*, and F1 2.25, F2 1.77, F3 1.2 times as long as broad in *E. angorensis*).

**Entedon susuzensis n. sp.**

(Figs. 9a-d)

**Diagnosis.** Forewing with fumation below marginal vein (Fig. 9d); clypeus almost smooth; POL 1.5 OOL. head in frontal view 1.4 times as broad as high. Breadth of oral fossa about 5.67 times as long as malar space. Eye height 3.57 times as long as malar space. Combined length of pedicel and flagellum 0.9 times as long as breadth of head. Antenna (Fig. 9a) with scape 5.7 times as long as broad, 0.76 times as long as eye height; pedicel 2.4 times as long as broad, 0.67 as long as F1; the latter twice as long as broad, and 1.38 times as long as F2; F2 1.85 times, and F3 1.3 times as long as broad; clava twice as long as broad, almost twice longer than the preceding segment; fore wing 2.22 times as long as broad, apical margin with fringe. Metasoma long, about 1.9 times as long as broad;
penultimate tergite of metasoma 0.45 times as long as broad, last tergite 0.63 times as long as broad.

**Description:**

Female. Body length 3.5 mm. Color: head, mesosoma and first tergite of metasoma metallic dark green, rest of metasoma dark blue. Entire antennae dark blue. Legs (Figs. 9b,c) dark, except knees, 1/5 of distal ends of mid and hind tibiae, the first two tarsomeres of mid and hind legs, which are pale. Dorsal and ventral pale longitudinal stripes on fore tibia discernible along entire tibia, fore tarsi dark, forewing (Fig. 9d) with fumation below marginal vein.

Head in dorsal view 2.3 times as broad as long; POL 1.5 OOL. Occipital margin sharp medially. Eyes sparsely setose, with short setae, eye height 3.7 times as long as malar space. Head in front view 1.4 times as broad as long. Interocular distance 3.5 times as long as eye breadth. Malar sulcus indicated by a line. Breadth of breadth of oral fossa 5.7 times as long as malar space. Area between antennal toruli and clypeus almost smooth, anterior margin of clypeus produced forward. Antennae inserted slightly above the level of ventral eye margin. Combined length of pedicel and flagellum 0.9 times as long as breadth of head. Antenna (Fig. 9a) with scape 5.7 times as long as broad, 0.76 times as long as eye height; pedicel 2.4 times as long as broad, 0.67 as long as F1; the latter twice as long as broad, and 1.38 times as long as F2; F2 1.85 times, and F3 1.3 times as long as broad; clava twice as long as broad, almost twice longer than the preceding segment.

Mesosoma 1.32 times as long as broad. Pronotal collar hardly traceable, postero-lateral corners of pronotum evenly rounded. Mesoscutum 2.2 times as broad as long, notauali traceable anteriorly as very fine sutures, posteriorly as shallow depressions; scutellum as long as broad and 1.32 times as long as mesoscutum. Propodeal surface almost smooth, median carina complete, lateral sulcus incomplete; paraspircacular sulcus deep, complete; supracoxal flange moderate; spiracular elevation with blunt projection below, propodeal callus with 2 long, setae. Hind coxae reticulate dorsally. Fore femur about 3.3 times as long as broad, fore tibia 8.5 times as long as broad, about as long as its femur, 1.26 times as long as its tarsi; mid femur 3.8 times as long as broad; mid tibia 9.6 times as long as broad, about 1.4 times as long as its tarsi, spur of mid tibia 1.16 times as long as breadth of tibia, as long as dorsal margin of mid basitarsus; hind femur about 3.0 times as long as broad, hind tibia about 6.3 times as long as broad, about 1.5 times as long as its tarsi, spur of hind tibia about 0.63 times as long as breadth of its tibia, and as long as dorsal margin of hind basitarsus.

Fore wing 2.22 times as long as broad; costal cell bare, comparatively wide, 8.0 times as long as broad, about as long as marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein slightly shorter than stigmal; speculum open below; apical margin with fringe. Hind wing 3.6 times as long as broad.

Petiole reduced, strongly transverse. Metasoma almost 1.3 times as long as head plus mesosoma, long, about 1.9 times as long as broad; penultimate tergite of metasoma 0.45 times as long as broad, last tergite 0.63 times as long as broad.

**Type material.** Holotype, ♀, Turkey: Kars, Susuz, 12. vii. 2012, swept from Onobrychis sativa field (M. Doğanlar). The type was deposited in MKUI.

**Discussion:** *Entedon susuzensis* n. sp. is similar to *E. cyanellus* Dalman and to *E. procioni* Erdös, 1944 of the hercynia group of *Entedon* in having mid and hind tibiae with their distal 1/5 pale (Figs. 9b,c), and to *E. procioni* in having forewing infumate, but it differs from *E. cyanellus* in having forewing with fumation below marginal vein (Fig. 9d); clypeus almost smooth; POL 1.5 OOL; pedicel 2.4 times as long as broad; metasoma long, about 1.9 times longer than broad (in *E.
Entedon cyanellus Dalman
(Figs. 10 a-e)

*Entedon cyanellus* Dalman, 1820: Table VIII.
*Entedon subimpressus* Thomson, 1878: 243 (Gumovsky, 1999)
*Entedon nubilatus* Erdös, 1944: 25 (Gumovsky, 1999)
*Entedon astragali* Erdös, 1951: 225 (Gumovsky, 1999)

**Type material:** given by (Gumovsky, 1999).

**Material examined:** Turkey: Sivas, Taşlıdere, 1♀, 1♂, 03.vii.2005, swept from pasture (O. Doğanlar); Kayseri, Erciyes Mnt. 1♀, 07.vii.2005, swept from pasture (O. Doğanlar); Ağrı, Tutak, 1♀, 04.vii.2010, swept from pasture (O. Doğanlar). Ukraine: Kaniv, U-turn to Pschalniy., 5♀♀, 1♂, 04.vii.2008, swept from pasture (M. Doğanlar).

**Description:** given by (Gumovsky, 1999).

**Biology:** Solitary parasite of larvae. emergence in early spring from earth cells of the host (Boucek & Askew, 1968). Host: *Tychius quinquepunctatus* L. (Col. Curculionidae) (Szelenyi, 1961; Boucek & Askew, 1968; Gumovsky, 1999), also probably *Apion* sp. (Col. Curculionidae) associated with *Astragalus austriacus*, *A. anobrychidis*, *A. cicer* and *Vicia silvestris* (Gumovsky, 1999).

**Distribution:** Holarctic: Sweden, Hungary (Dalman, 1820; Erdös, 1944, 1951; Boucek & Askew, 1968; Gumovsky, 1999), Mongolia (Szelenyi, 1977; Gumovsky, 1999); Lithuania, Ukraine, Moldova, Kazakhstan, Russia (Siberia), USA: Montana, Colorado (Gumovsky, 1999); Turkey (new record).

**Entedon gumushanensis** n. sp.
(Figs. 11a-e)

**Diagnosis.** Hypopygium (Fig. 12d,e) with anterior median incision broadly U-shaped, anterior lobe circular, antero-lateral angle towards median incision almost straight; posterior lobe distally circular, but narrowing towards median incision, median sclerotized line reaching at most middle of hypopygium; median area and posterior median incision as in Fig. 12 e. Metasoma almost as long as mesosoma, about 1.4 times as long as broad; penultimate tergite of metasoma 0.37 times as long as broad, last tergite 0.4 times as long as broad; antenna (Fig. 11a) scape of female 3.14–3.27 times as long as broad; pedicel about 1.75 times as long as broad; pedicel 1.14–1.16 as long as F1; F1 about 1.3–1.55, F2 and F3 almost quadrate; clava two-segmented, about 1.25–1.4 times longer than broad, twice longer than the preceding segment; eye height 5.0 times as long as malar space; breadth of mouth opening 4.86–5.4 times as long as malar space; fore wing twice as long as broad, apical margin with fringe; fore tibiae 1.34 and mid tibiae about 1.07 times as long as their tarsi.

**Description:**
Female. Body length 1.3–1.5 mm. Colour of body metallic dark blue, frons with weak greenish tint. Entire antennae dark. Legs (Figs. 11b,c) dark, except knees, 1/5 of distal ends of tibiae and first three tarsomeres of mid and hind legs, which are pale. Dorsal and ventral pale longitudinal stripes on fore tibia discernible along entire tibia.
Head in dorsal view 2.08-2.25 times as broad as long; POL 2.1 OOL. Eye height 5.0 times as long as malar space. Head in front view 1.4-1.57 times as broad as long. Interocular distance 2.9 times as long as eye breadth. Malar sulcus indicated by a line. Breadth of mouth opening 5.33 times as long as malar space. Clypeus reticulate, its anterior margin moderately produced forward. Antennae inserted slightly above the level of ventral eye margin. Pedicel plus flagellum as long as broad of head. Antenna (Fig. 1a) with scape of female 3.14-3.27 times as long as broad; pedicel about 1.75 times as long as broad; pedicel 1.14-1.16 as long as F1; F1 about 1.3-1.55, F2 and F3 almost quadrate; clava two-segmented, about 1.25-1.4 times longer than broad, twice longer than the preceding segment.

Mesosoma almost 1.24 times as long as broad. Pronotal collar broad, carinated, only postero-lateral corners of pronotum rounded. Mesoscutum twice as broad as long, notauli traceable anteriorly as very fine sutures, posteriorly as shallow depressions; scutellum slightly longer than broad and 1.32 times as long as mesoscutum. Propodeal surface finely reticulate, median carina complete, lateral sulcus incomplete; parapspiracular sulcus deep, complete; supracoxal flange moderate; spiracular elevation with blunt projection below, propodeal callus with 2 long short setae. Hind coxae reticulate dorsally. Fore femur about 3.4 times as long as broad, fore tibia 6.4 times as long as broad, about as long as its femur, 1.34 times as long as its tarsi; mid femur 4.3 times as long as broad; mid tibia 6.66 times as long as broad, about 1.25 times as long as its tarsi, spur of mid tibia as long as breadth of tibia, dorsal margin of mid basitarsus; hind femur about 3.33 times as long as broad, hind tibia about 5.4 times as long as broad, about 1.07 times as long as its tarsi, spur of hind tibia about 0.75 times as long as breadth of its tibia, and 1.5 times as long as dorsal margin of hind basitarsus.

Fore wing twice as long as broad; costal cell bare, comparatively wide, 8.4 times as long as broad, about as long as marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein slightly longer than stigmal; speculum open below; apical margin with fringe. Hind wing 3.1 times as long as broad.

Petiole reduced, strongly transverse. Metasoma almost as long as mesosoma, about 1.4 times as long as broad; penultimate tergite of metasoma 0.37 times as long as broad, last tergite 0.4 times as long as broad; Hypopygium (Fig. 1d,e) with anterior median incision broadly U-shaped, anterior lope circular, antero-lateral angle towards median incision almost straight; posterior lobe distally circular, but narrowing towards median incision, median sclerotized line reaching anterior median incision of hypopygium; median area and posterior median incision as in Fig. 1e.

**Type material.** Holotype, ♂, Turkey: Gümüşhane, 17.vi. 2003, swept from pasture (O. Doğanlar). Paratype: 1♀, same data as holotype. All of the types were deposited in MKUI.

**Discussion:** *Entedon gumushanensis* n. sp. is similar to *E. molyndaenus* Erdős and *E. cyanellus* and *E. susuzensis* n. sp. of the cyanellus group of *Entedon* in having mid and hind tibiae at most their distal quarter or less pale (Figs. 1b,c); but it differs from *E. susuzensis* in having forewing hyaline (in *susuzensis* forewing distinctly infumate). It differs from *E. cyanellus* in having head in dorsal view 2.08-2.25 times as broad as long, in frontal view 1.4-1.57 times as broad as high; antennae with scape 3.14-3.27 times as long as broad, pedicel 1.14-1.16 as long as F1; the latter 1.5-1.55 times as long as broad, F2 1.0-1.2 times, F3 1.0 times as long as broad; clava 1.25-1.4 times as long as broad; hypopygium with median sclerotized line reaching at most middle of hypopygium (in *E. cyanellus* head in dorsal view 2.4-2.44 times as broad as long, in frontal view 1.28-1.39 times as broad as high; antennae with scape 5.0-6.25 times as long as broad, pedicel 0.4-
0.75 as long as F1; the latter 1.83-5.0 times as long as broad, F2 1.6-3.6 times, and F3 1.2-1.8 times as long as broad; clava 1.66-3.25 times as long as broad; hypopygium with median sclerotized line almost reaching to anterior median incision of hypopygium.

LITERATURE CITED


Figure 1. Hypopygium of Entedon cyanellus Dalman.

Figure 2. Male antennae. a. Entedon biroi Erdős; b. E. arabanensis n. sp. c. E. pallicrus Erdős.

Figure 3. Male antennae. a. Entedon parvicalcar Thomson; b. E. sarkislanensis n. sp. c. E. cyanellus Dalman.
Figure 4. *Entedon pallicrus* Dalman. Female. a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median area of hypopygium.

Figure 5. *Entedon biroi* Erdős. Female. a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median area of hypopygium.

Figure 6. *Entedon arabanensis* n. sp. Female. a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median area of hypopygium.
Figure 7. *Entedon parvicalcar* Thomson. Female. a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median area of hypopygium.

Figure 8. *Entedon sarkisanensis* n.sp. Female. a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median area of hypopygium.

Figure 9. *Entedon susuzensis* n. sp. Female. a. antenna; b. mid leg; c. hind leg; d. forewing.
Figure 10. *Entedon cyanellus* Dalman. Female. a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median area of hypopygium.

Figure 11. *Entedon gumushanensis* n. sp. Female. a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median area of hypopygium.
THREE NEW SPECIES OF THE GENUS 
HOMOLOBUS FOERSTER FROM INDIA 
(HYMENOPTERA: BRACONIDAE: HOMOLOBINAE) 

Mohammad Shamim*

* Section of Entomology, Department of Zoology, Aligarh Muslim University, Aligarh-202002 U. P., INDIA. E-mail: drmshamim@gmail.com


ABSTRACT: Three new species of the genus Homolobus Foerster i.e. Homolobus (Apatia) etawawiana Shamim sp. nov., Homolobus (Apatia) kanpurensis Shamim, sp. nov. and Homolobus (Apatia) sharifi Shamim sp. nov. is described and illustrated with nineteen photographs from India. A key to the Indian species of subgenus Apatia Enderlein is also proposed for the first time. Both the species is running his nearest allies and compared with Indian species.

KEY WORDS: Hymenoptera, Braconidae, Homolobinae, Homolobus, Apatia, new species, India.

The family Braconidae contains species which are exclusively parasitoids of various pest species mainly belonging to the Lepidoptera and also of other insect orders. These parasitoids keep the pest populations under check in their natural habitats. However, due to hazardous nature of chemicals used in the control of pest species, alternative and safer and more eco-friendly methods of control have been investigated especially in the last century all over the world Bosen and De Bach (1991). One of the best alternative methods of control of insect pests has proved to be the use of other insects (called parasitoids) for the control of pest species. The family Braconidae is the second largest family of the order Hymenoptera containing with 17,605 valid species in the world (Yu et al., 2005) and more than 500 species from India.

Homolobines are solitary koinobiont endoparasitoids of Lepidoptera. Species of Homolobus are parasites of caterpillars with more or less exposed way of life, mainly belonging to the families Noctuidae and Geometridae. Achterberg (1979) and Shaw & Huddleston (1991) note that the Noctuidae and Geometridae are the most commonly recorded hosts of Homolobus. The comparatively high number of species of the subgenus Apatia seems to be typical for the Indian subcontinent. The biology of the new species is unknown, but other members of the genus are koinobiont endoparasitoids (with a final ectoparasitoid phase) of the Lepidoptera larvae, mainly in Geometridae and Noctuidae (Achterberg, 1979; Shaw, 2006).

For the identification of the genus Homolobus and subgenus Apatia see Achterberg (1979) a revision of the subfamily Zelinae auct. (Hymenoptera, Braconidae) page no. 276 and 277.

The genus Homolobus is cosmopolitan and speciose among the homolobines genera containing 55 described species from the world (Yu et al., 2005). The species of this genus have been revised by Achterberg (1979) from world. Subsequently, Achterberg (1992), Chou & Hsu (1995), Ahmad & Shujauddin (2001) and Achterberg & Shaw (2009) have done excellent work on genus Homolobus. The genus Homolobus containing five subgenera Homolobus Foerster, 1862, Apatia Enderlein, 1920, Chartolobus Achterberg, 1979 and Phylacter Reinhard, 1863. Out of which four subgenera are reported from India. The genus is represented by 10 species from from India spread over four
subgenera, four species from *Apatia* i.e. *elagabalus* (Nixon, 1938), *indicus* Ahmad & Shujauddin, 2001, *truncatoides* Achterberg, 1979 and *truncator* (Say, 1829); two species from *Chartolobus* i.e. *infumator* (Lyle, 1914), *undulatus* Achterberg, 1979; three species from *oulophus* i.e. *annulatus* Achterberg, 1979, *bohemani* (Bengtsson, 1918) and *flagitator* (Curtis, 1837) and one species from *Phylacter* Reinhard, 1863 i.e. *bifurcates* Achterberg, 1979. In this work three new species of *Homolobus* (*Apatia*) *etawawiana* Shamim sp. nov., *Homolobus* (*Apatia*) *kanpurensis* Shamim, sp. nov. and *Homolobus* (*Apatia*) *sharifi* Shamim sp. nov. are described and illustrated under the subgenus *Apatia* Enderlein from India. A key to the *Homolobus* species of subgenus *Apatia* Enderlein is proposed for the first time from India.

**MATERIAL AND METHODS**

The specimens were collected from Uttar Pradesh (India) by using sweeping nets. Photographs of various parts on slide and card mounted of specimens were taken with the help of a camera attached to a Trinocular Research Microscope (NIKON SMZ-1500). Measurements of slide-mounted structures and carded species were taken with the help of an ocular micrometer (linear side of 100 divisions) fitted in one of the two eyepieces of the Stereozoom Microscope (NIKON SMZ1500). The divisions of the ocular micrometer were converted to millimeters.

The terminology for the various parts and wing venation is that of van Achterberg (1993). Eady (1968) is followed for surface sculpture. Abbreviations used in the text are: POL: Posterior ocellar line (distance between the posterior ocelli); OOL: Ocello-ocular line (distance between posterior ocellus and eye); OD: Ocellar diameter; F: Flagellomere.

The types and other specimens are housed in the Insect Collection, Department of Zoology, Aligarh Muslim University, Aligarh (ZDAMU).

**Key to Indian species of the genus Homolobus subgenus Apatia Enderlein**

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<table>
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<tbody>
<tr>
<td>1.</td>
<td>Vein r of hind wing present; length of eye in dorsal view 3.7 times temple; surface of first metasomal tergite smooth, dorsal carinae absent...<em>H. (A.) elagabalus</em> (Nixon)</td>
</tr>
<tr>
<td></td>
<td>- Vein r of hind wing absent; length of eye in dorsal view 1.6-2.6 times temple; surface of first metasomal tergite variable</td>
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<tr>
<td>2.</td>
<td>Length of 4th segment of labial palp 4-5.5 times the 3rd segment...<em>H. (A.) truncator</em> (Say)</td>
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<td>- Length of 4th segment of labial palp 1.4-1.8 times the 3rd segment</td>
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<tr>
<td>3.</td>
<td>Length of first metasomal tergite 3.2 times its apical width, length of mesosoma 1.4 times its height; length of malar space 0.9 times basal width of mandible...</td>
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<tr>
<td></td>
<td>- Length of first metasomal tergite 2.1-2.75 times its apical width, length of mesosoma 1.5-2.1 times its height; length of malar space 1.15-1.27 times basal width of mandible</td>
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<td>4.</td>
<td>Antennal segments 40-42...</td>
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<tr>
<td></td>
<td>- Antennal segments 43-44</td>
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</table>
| 5. | Length of eye in dorsal view 1.6 times temple; frons flat and somewhat coriaceous; vein SR of hind wing weakly sinuate; length of hind femur 6.5 times its width; length of first metasomal tergite 2.5 times its apical width, its surface...
Homolobus (Apatia) etawawiana Shamim, sp. nov. (Figures 1-9)

Description:

**Body length:** 13.3 mm, Forewing: 12.5 mm, Antenna 17.5 mm

**Head:** width of head in dorsal view 1.76 times its length; antennal segments 43, length of F1 1.2 times F2, length of F3, F4-F5, F6-F7, F8, F9-F10, F11-F14, F15-F16, F17-F18, F19-F20, and F21-F22 2.9 times, 3.57 times, 3.33 times, 3 times, 2.4 times, 2.35 times their width respectively, apical flagellomere pointed; length of outer aspect of 4th segment of labial palp 1.6 times 3rd segment; length of eye in dorsal view 2.6 times temple, and 1.62 times its width; eyes indistinctly emarginated; OOL: POL: AOL: OD = 15: 8: 7: 13; vertex 2.25 times as wide as long, smooth, sparsely setose; frons 2 times as wide as long, smooth, near eye margin setose, depressed medially; between antennal sockets median carina visible up to 1/4 length of face; face flat, 1.37 times as wide as long, medially smooth, remaining somewhat strigose; clypeus 1.6 times as wide as long, smooth, sparsely setose, strongly convex; ocelli somewhat oval shaped and large; lateral side of stemmaticum 1.14 times posterior side, occipital carina complete; intertentorial line 1.76 times tentorio-ocular line, tentorial pit deep and round; length of malar space 1.27 times basal width of mandible.

**Mesosoma:** Length of mesosoma 1.6 times its height and 2 times its width; pronotal sides anteriorly smooth, remaining largely crenulate; precocital sulcus wide and large, reticulate coriaceous, setose; mesopleuron antero-dorsally reticulate rugose, remaining smooth, setose; metapleuron dorsally smooth, densely setose, ventrally reticulate rugose; epicenmial area sparsely punctate; notaui broad, deep, anteriorly crenulate, posteriorly reticulate rugose with strong median longitudinal carina; middle lobe smooth, setose; lateral lobes sparsely setose; scutellar sulcus wide, deep with one median longitudinal carina; scutellum convetimes, smooth; side of scutellum crenulate; medio-posterior depression somewhat oval shaped, wide, deep with one median carina; metanotum crenulate; surface of propodeum densely and rather finely reticulate rugose except for a narrow anterior part smooth with carinae anteriorly.

**Forewing:** Length of forewing 3.12 times its width; length of pterostigma 4 times its width; SR1 slightly curved; r arising at middle of pterostigma; r 0.8 times as long as width of pterostigma; length of vein 1R1 1.35 times length of pterostigma; cu-a inclivous, postfurcal; 1-CU1: 2-CU1: 3-CU1 = 10: 55: 25; vein 2A shortly developed, area basally of 2A mainly bare; r: 3-SR: SR1= 20: 26: 120; 2-SR: 3-SR: r-m= 15: 26: ; Hindwing: Length of hind wing 4.1 times its width; vein
SC+R1 slightly curved; 2SC+R thick, vertical; SR basal third sclerotized and weakly curved, vein r absent; 1-M: 1-r-m: 2-SC+R = 50: 24: 14.

**Hind leg:** Hind coxa rugose, densely setose; length of hind femur, tibia and basitarsus 6.8 times, 10 times and 9.5 times their width respectively; length of hind tibial spurs 0.42 and 0.55 times hind basitarsus; tarsal claws simple, distinctly pectinate brown; spurs originates from each segments of tarsus.

**Metasoma:** Length of metasoma 3.98 times width and 2.67 times its height; length of first metasomal tergite 2.12 times its apical width, apical width 1.33 times its basal width, its surface apically smooth, basally carinate, remaining densely rugose; first metasomal tergite slightly medially depressed apically and basally impressed; length of ovipositor sheath 0.08 times forewing; ovipositor sheath thick, slender; ovipositor apically pointed.

**Colour:** Yellow except stemmaticum black; telotarsus, F1-F41 brown; scape pedicel, first and second metasomal tergite, femur, tibia, tarsus, pronotum, mesoscutum, metanotum and ovipositor sheath yellowish brown; eyes grayish black; ocelli transparent yellow and wing veins brownish yellow.

**Male:** Same as holotype except antennal segments 40; hind coxa indistinctly rugose; lateral lobes densely setose; mesopleuron largely reticulate rugose, medially smooth; scutellum smooth, setose; first metasomal tergite uniformly rugose.


**Host:** Unknown

**Etymology:** The species name refers to its type locality.

**Discussion:**

The new species Homolobus (Apatia) etawawiana Shamim, sp. nov. resembles with Homolobus (Apatia) indicus Ahmad & Shujauddin. However, it differs in having (1) Antennal segments 43 (Antennal segments 40-42 in indicus) (2) Length of eye in dorsal view 2.6 times temple (Length of eye in dorsal view 1.6 times temple in indicus) (3) Vein 2A of forewing basally bare distinctly (Vein 2A of forewing basally sclerotized distinctly in indicus) (4) Hind coxa rugose, densely setose (Hind coxa mainly somewhat punctulate in indicus).

The new species Homolobus (Apatia) etawawiana Shamim, sp. nov. also resembles with Homolobus (Apatia) ophioninus (Vachal). However, it differs in having (1) Antennal segments 43 (Antennal segments 46 in ophioninus (Vachal) (2) Length of malar space 1.27 times basal width of mandible (Length of malar space 0.5 times basal width of mandible in ophioninus (Vachal) (3) Length of hind tibial spurs 0.42 and 0.55 times hind basitarsus (Length of hind tibial spurs 0.7 and 0.5 times hind basitarsus in ophioninus (Vachal) (4) Clypeus, smooth, strongly convex; (Clypeus, punctulate, convex in ophioninus (Vachal) (5) Notauli broad, deep, anteriorly crenulate, posteriorly reticulate rugose with strong median longitudinal carina (Notauli closely crenulate, anteriorly and almost smooth in ophioninus (Vachal)).

**Homolobus (Apatia) kanpurensis Shamim, sp. nov.**

(Figures 10-19)

**Description:**

**Body length:** 12.5 mm, Forewing: 11 mm, Antenna: 14.7 mm
Head: Width of head in dorsal view 1.35 times its length; antennal segments 42, length of F₁ 1.1 times F₂, length of F₁–F₂, F₃–F₈, F₅–F₁₂, F₁₃–F₁₄, F₁₅–F₁₈, F₁₉–F₃₉, and F₄₀ 3.1 times, 2.75 times, 2.85 times, 2.5 times, 2.1 times, 1.7 times and 2.5 times their width respectively, apical flagellomere pointed; length of outer aspect of 4th segment of labial palp 1.4 times 3rd segment; length of eye in dorsal view 2.5 times temple and 1.57 times its width; eyes indistinctly emarginated; OOL: POL: AOL: OD = 13: 8:8: 15; vertex 2.36 times as wide as long, smooth, sparsely setose; frons 1.77 times as wide as long, smooth; near eye margin sparsely setose; depressed medially; between antennal sockets median carina visible; face 1.65 times as wide as long, punctate, setose; clypeus 1.8 times as wide as long, smooth, sparsely setose, slightly convex; ocelli oval shaped and large; lateral side of stemmaticum 1.8 times its posterior side; occipital carina complete; intertentorial line 2.5 times tentorio-ocular line, tentorial pit deep and round; length of malar space 1.2 times basal width of mandible.

Mesosoma: Length of mesosoma 2.1 times its height and 1.8 times its width; pronotal sides anteriorly reticulate rugose, posteriorly smooth, largely setose; precoxal sulcus wide, reticulate rugose, setose; mesopleuron dorsally reticulate rugose, remaining sparsely punctate, setose; metapleuron dorsally smooth, sparsely setose, ventrally reticulate, densely setose; epicnemial area smooth sparsely setose; notauli complete broad, deep, anteriorly crenulate, posteriorly reticulate rugose with strong median longitudinal carina; middle lobe smooth, sparsely setose; lateral lobes, sparsely punctate setose; scutellar sulcus wide, deep with one median longitudinal carina; scutellum convex, smooth, side of scutellum crenulate; medio-posterior depression oval shaped, wide, deep with one median carina; metanotum crenulate; propodeum apically and mediately reticulate rugose, basally carinate with three areola.

Forewing: Length of forewing 3.4 times its width; length of pterostigma 4.5 times its width; SR₁ slightly curved; r arising at middle of pterostigma; r 1.2 times as long as width of pterostigma; length of vein 1R₁ 1.5 times length of pterostigma; 1-CU₁: 2-CU₁: 3-CU₁ = 12: 48: 20; cu-a incliniovous postfurcal; vein 2A well developed, shortly sclerotized, basally; r: 3-SR: SR₁ = 15: 26: 115; 2-SR: 3-SR: r-m = 20: 26: 12; Hind wing: Length of hind wing 4.1 times its width; vein SC+R₁ slightly curved; 2SC+R thick, comparatively short, vertical; SR strongly curved, vein r absent; 1-M: 1-r-m: 2-SC+R = 40: 25: 15.

Hind leg: Hind coxa punctate, densely setose; length of hind femur, tibia and basitarsus 5.8 times 10 times and 8 times their widths respectively; length of hind tibial spurs 0.46 times and 0.65 times hind basitarsus; tarsal claws simple, distinctly pectinate brown; spurs originates from each segments of tarsus except last segment.

Metasoma: Length of metasoma 3.7 times its width and 2.7 times its height; length of first metasomal tergite 2.75 times its apical width, apical width 1.6 times its basal width, its surface apically smooth, remaining rugose, first metasomal tergite medially depressed, apically and basally impressed; apically more impressed than basally; length of ovipositor sheath 0.07 times forewing; ovipositor sheath thick, slender, densely setose; ovipositor apically pointed.

Colour: Yellowish brown except stemmaticum black; telotarsus, mandibles apically ovipositor sheath brown; hypopygium, malar space, wing veins, first and second metasomal tergite, brownish yellow; vertex, frons, labial and maxillary palp yellow; eyes grayish black; ocelli transparent yellow.

Male: Same as holotype except antennal segments 42; hind coxa rugose, sparsely setose; vein SR sclerotized, slightly curved; vein 2SC+R short; between antennal sockets median carina hardly visible.

Host: Unknown

Etymology: The species name refers to its type locality.

Discussion:
The new species *H. (A.) kanpurensis* Shamim, sp. nov. closely resembles with *H. (A.) indicus*. However, it differs in having (1) Length of eye in dorsal view 2.5 times temple (length of eye in dorsal view 1.6 times temple in *indicus*) (2) Frons depressed medially, smooth (Frons flat and somewhat coriaceous in *indicus*) (3) Vein SR of hind wing strongly curved (Vein SR of hind wing weakly sinuate in *indicus*) (4) Length of hind femur 5.8 times its width (Length of hind femur 6.5 times its width in *indicus*) (5) Length of first metasomal tergite 2.75 times its apical width, its surface apically smooth, remainder rugose (Length of first metasomal tergite 2.5 times its apical width, its surface longitudinally rugose in *indicus*) (6) Length of ovipositor sheath about 0.07 times of fore wing (Length of ovipositor sheath about 0.9 times of fore wing in *indicus*).

*Homolobus (Apatia) sharifi* Shamim, sp. nov. (Figures 20-28)

Description:

Body length: 12.05 mm, Forewing: 11.87 mm, Antenna: 16.2 mm

Head: Width of head in dorsal view 1.69 times its length; antennal segments 44, length of F1 as long as F2, length of F1-F2, F3-F10, F11-F18, F19-F22, F23-F24, F25-F39, F40-F41 and F42 3.12 times, 3.33 times, 3.6 times, 3 times, 2.4 times, 2 times, 1.75 times and 3.33 times their width respectively, apical flagellomere pointed; length of outer aspect of 4th segment of labial palp 1.9 times 3rd segment; length of eye in dorsal view 2.5 times temple and 1.42 times its width; eyes weakly emarginated; OOL: POL: AOL: OD = 15: 7: 5: 15; vertex 2.42 times as wide as long, smooth, sparsely setose; frons almost 2 times as wide as long (55:27), smooth; near eye margin sparsely setose; slightly depressed medially; between antennal sockets median carina visible; face 1.48 times as wide as long, medially sparsely punctate, remaining strigose, sparsely setose; clypeus 1.75 times as wide as long, smooth, sparsely setose, convex; ocelli somewhat oval shaped and large; lateral side of stigmaticum 1.4times its posterior side; occipital carina complete; intertentorial line 1.83 times tentorium-ocular line, tentorial pit deep; length of malar space 1.2 times basal width of mandible.

Mesosoma: Length of mesosoma 1.8times its height and 2times its width; pronotal sides posteriorly and antero-dorsally crenulate, remaining smooth; precoxal sulcus wide, rugose- punctate, sparsely setose; mesopleuron antero-dorsally somewhat reticulate rugose, remaining smooth, setose; metapleuron dorsally smooth, sparsely setose, ventrally with some rugae; epicnemial area sparsely smooth; notauli broad, deep, anteriorly crenulate, posteriorly reticulate rugose with strong median longitudinal carina; middle lobe smooth, densely setose; lateral lobes smooth, sparsely setose; scutellar sulcus wide, deep with one median longitudinal carina and two weak lateral carinae; scutellum convex, smooth, side of scutellum crenulate; medio-posterior depression somewhat oval shaped, wide, deep with one median carina; metanotum crenulate; propodeum apically densely rugose, basally carinate with three areola.
Forewing: Length of forewing 2.79 times its width; length of pterostigma 3.6 times its width; SR1 slightly curved; r arising at middle of pterostigma; r 0.8 times as long as width of pterostigma; length of vein 1R1 1.44 times length of pterostigma; 1-CU1: 2-CU1: 3-CU1 = 10: 50: 22; cu-a postfurcal; vein 2A well developed, shortly sclerotized, area basally of 2A remotely setose; r: 3-SR: SR1= 20: 30: 120; 2-SR: 3-SR: r-m= 28: 30: 15; Hind wing: Length of hind wing 4.21 times its width; vein SC+R1 straight; 2SC+R thick, comparatively long, vertical; SR basal third sclerotized and strongly curved, vein r absent; 1-M: 1-r-m: 2-SC+R = 45: 24: 15.

Hind leg: Hind coxa densely setose, dorsally rugose, ventrally punctate; length of hind femur, tibia and basitarsus 6.25, 10.55 and 13.55 times their widths respectively; length of hind tibial spurs 0.45 times and 0.57 times hind basitarsus; tarsal claws simple, distinctly pectinate brown; spurs originates from each segments of tarsus.

Metasoma: Length of metasoma 3.33 times its width and 4 times its height; length of first metasomal tergite 2.28 times its apical width, apical width 1.66 times its basal width, its surface densely rugose, first metasomal tergite medially depressed, apically and basally impreesed; apically more impressed than basally; length of ovipositor sheath 0.04 times forewing; ovipositor sheath thick, slender, densely setose; ovipositor apically pointed.

Colour: Yellow except stemmaticum black; telotarsus, F1-F4, ovipositor sheath brown; first and second metasomal tergite, femur, tibia, tarsus, trochantellus and telotarsus yellowish brown; eyes grayish black; ocelli transparent yellow and wing veins brownish yellow.

Male: Same as holotype except antennal segments 42; hind coxa rugose, sparsely setose; vein SR sclerotized, slightly curved; vein 2SC+R short; between antennal sockets median carina hardly visible.


Host: Unknown

Etymology: The species is named in memory of my late father, Mohammad Sharif, who collected these parasitoids.

Discussion:

The new species H. (A.) sharifi Shamim, sp. nov. also closely resembles with H. (A.) truncator. However, it differs in having (1) Length of malar space 1.2 times basal width of mandible (Length of malar space 0.5 times basal width of mandible in truncator) (2) Antennal segments 44 Antennal segments 50 in truncator) (3) Frons smooth, near eye margin sparsely setose; depressed medially (Frons almost flat, with some superficial striae near antennal socket in truncator) (4) Length of first metasomal tergite 2.28 times its apical width (Length of first metasomal tergite 3.2 times its apical width in truncator) (5) Propodeum apically densely rugose, basally carinate with three areola (Propodeum narrowly smooth anteriorly and with a short median carina medially and posteriorly reticulate rugose in truncator).

The new species H. (A.) sharifi Shamim, sp. nov. resembles with H. (Apatia) etawawiana Shamim, sp. nov. However it differs in having (1) Antennal segments 44 (Antennal segments 43 in etawawiana) (2) Length of vein 1-R1 1.44 times length of pterostigma (length of vein 1-R1 1.35 times length of pterostigma in etawawiana) (3) Vein SC+R1 of hind wing straight (Vein SC+R1 of hind wing
slightly curved in *etawawiana*) (4) Vein 2A of forewing well developed, area basally of 2A remotely setose (Vein 2A of forewing shortly developed, area basally of 2A mainly bare in *etawawiana*) (5) F₁ as long as F₂ (F₁ 1.2 times F₂ in *etawawiana*).

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**LITERATURE CITED**


POPULATION DYNAMICS OF SPIDERS IN SELECTED COTTON FIELDS OF VIRUDHUNAGAR DISTRICT, TAMIL NADU, INDIA

S. Jeyaparvathi*, S. Baskaran and Ga. Bakavathiappan

* Post Graduate & Research Dept. of Zoology, Ayya Nadar Janaki Ammal College, Sivakasi – 626 124, INDIA. E-mail: sjpwomenscientist@gmail.com


ABSTRACT: The mean populations of spiders in three different places like Thayilpatti, Madathuppatti and Vembakkottai, Virudhunagar district, Tamil Nadu, India were studied. In these areas, twenty common species of spiders belonging to six families from these three selected areas were collected and identified. The collected spiders belonging to the family, Salticidae, Oxyopidae, Araneidae, Lycosidae, Gnaphosidae and Sparassidae. In this study, two species of spiders were observed, one is web weaver and another one is non – web weaver. The web weaving spiders belonging to the family Araneidae and Lycosidae. The non-web weaving spiders belonging to the family Salticidae, Oxyopidae, Gnaphosidae, Lycosidae and Sparassidae. P. viridana, O. birmanicus, O. hindostanicus, P. latikae and A. anasuja a dominant predator recorded in these three selected areas. The population dynamics of the individual spider species in different months showed that the population of spider species mainly P. viridana, O. birmanicus, O. hindostanicus, A. anasuja, N. lugubris, P. latikae, C. cicatrosa and L. pseudoannulata were very high throughout the study period. The increase in the spiders density suggested that the spider density is influenced by the increase in prey density.

KEY WORDS: Spider, population, oxyopidae, web.

Spiders have often been confused with insects, but in truth they belong to the class Arachnida, with major differences being that spiders have two body divisions and eight legs and insects have three body divisions and six legs. Orders within the arachnids include daddy longlegs, scorpions, mites, and ticks. About 39,000 species of spiders have been named so far (Platnick, 2005) representing what is believed to be only about one-fifth of the total spider species (Levi, 1981). Some 3,000 species have been thoroughly examined and named from Europe, and approximately 3,500 have been identified from North America (Levi, 1954). Spiders are one of the more diverse arthropod taxa, ranking seventh in global diversity (Coddington, 1986), which makes them a fascinating group to study. Biodiversity is not only an issue of curiosity but stands firm on the political agenda as a resource for humanity (Kamal et al., 1992). Spiders are predaceous arthropods which largely feed on insects, their larvae and arthropod eggs (Barnes & Barnes, 1954; Riechert & Bishop, 1990; Mansour et al., 1980; Bartos, 2005; Nyffeler et al., 1987a). Being generalist predators spiders feed on a variety of small sized prey relative to their own size (Nyffeler & Benz, 1987; Riechert & Lockley, 1984; Wise, 1993). In most of the spiders, consumption is not only limited to the adults but larvae and nymphs are preyed upon as well (Whitcomb & Eason, 1967; Sunderland, 1999). On account of these attributes spiders are rated as important biological agents for controlling insect pests in the cotton and farmlands. Before attempting to assess the role of spiders in suppressing pest populations in a given agricultural situation, there must be available sufficient information on their taxonomic diversity and abundance habitat preferences in space and time, hunting strategy, body size of species, predators and prey items and the rate of
their consumption, and reproduction. Information on these aspects is essential for the formulations of ecological concepts and conclusions (Berry, 1970; Horner & Starks, 1972).

**MATERIALS AND METHODS**

**Study Area**

Thayilpatti, Madathuppatti and Vembakkottai are located in Sivakasi taluk, Virudhunagar district, Tamil Nadu, India. Sivakasi is located at 9.5' longitude and 7.8' altitude. This city is located 157 meter above sea level. Sivakasi belongs to Virudhunagar District of Tamil Nadu State of India. This is a warm, humid region and the seasonal variation in the temperature ranges from 30°C – 38°C. Humidity is also showing seasonal fluctuation.

**Study Period**

The investigation was carried out for a period of three months from November 2011 to March 2012. Sampling was conducted in five months at the randomly selected 5 sites of three places.

**Sampling**

Sampling was done every month from quadrates. Spiders were collected from 5 quadrates (1 sq. m x 1 sq. m) placed at four corners and one centre of 10 sq. m x 10 sq. m area by visual search method between 9.00 – 11.30 hours. A sufficient core area was left to avoid edge effects. All five quadrates were searched. Spiders were collected from the ground stratum and from the terminals of plants.

Sampling time was restricted to 15 minutes in each transect, depending on the density of under storey weeds and shrubs to be walked through, and this included time spent on field to identify unfamiliar taxa encountered. The time taken to describe web characteristics (useful in identifying the family, and in some instances, up to the genus level) was excluded from the calculation of sampling time for each transect. Attempts were made to carefully scan the leaf litter surface, tree bark, foliage (including the under – surface of leaves when traces of webs were found) twigs, and branches of the vegetation (Up to 1.5m height) along the transect. Specimens from each quadrate were preserved in 75% alcohol in the field and counted under a microscope in the laboratory.

**Spider collection methods**

Following methods were used to collect the spiders.

**Sweep net**

This is particularly simple way to catch spiders. A sweep net is made of relatively heavy fabric like sailcloth or canvas. It was rugged enough not to be torn by the leaves and tightly woven to catch spiders of relatively small size.

**Hand Picking**

Slowly moving spiders, especially the soft-bodied spiders were collected by using fine camel hairbrush or fine forceps.

**Aerial netting**

Grasshoppers and wasps were collected by using aerial net methods described by George et al. (1986). The net has strong, light weight and easily maneuverable handle with 15-18” diameter ring and strong, durable, nylon bags with twice the diameter of the ring.

**Beating method**

Vegetation beating was carried out with a stick at the beginning and end of each transect by sharply tapping ten times a clump of vegetation about 1m in diameter at a height of about 1m. The spiders dislodged from the vegetation were
pooled as a single sample for analysis. The dislodged spiders were collected in a tray handheld beneath the plants and transferred in to vials for identification.

**Leaf litter Method**

Spiders were extracted from leaf litter using a modified Tullgren funnel (Kitching et al., 2000) consisting of ten 40cm funnels in an insect – proof box, each with a 60W bulb over it and tight fitting collection vials beneath. A 3-mm wire mesh was used in each funnel to prevent excessive amounts of litter fragments contaminating the samples of extracted spiders. About two metres away from each transect, a 25 x 25cm Metal frame was placed on the ground and the leaf litter within the frame was quickly scooped up and placed in a plastic cover, labelled, and tied tightly. In the field station, the leaf litter was placed in a tray and quickly sifted, to look for larger spiders and other arthropods too large to pass through the funnel mesh.

**Identification of Spiders**

The adult spiders were identified on species level and others on genus or family level using available literature (Tikader, 1987). Monthly data were prepared with detailed information on the occurrence of mature male, female and juvenile spiders. Voucher specimens were preserved in 75% alcohol and deposited in a reference collection housed with the Department of Zoology, Ayya Nadar Janaki Ammal College, Sivakasi, Virudhunagar district, Tamil Nadu, India.

**RESULTS**

**Taxonomical Characters**

The collection yielded twenty nine species belonging to twenty three genera and nine families. Among the nine sub-families, Salticidae (33.84 %) and Araneidae (21.05 %) and Oxyopidae (21.05 %) represented maximum number of species followed by Lycosidae (10.53 %). The sub-family, Gnaphosidae, Sparrasidae yielded the least number of species (05.26 % each) (Table 1).


All the analysed spiders have hairs throughout the body. The colour of the body is varied from black to white. Moreover combination of body colour was also observed in the study. The number of eyes varied from 6 to 8. Though many ethological features present in the spiders, in my study, I recorded only the camouflaging behaviour. Diversified cocoon colour was also observed in the present study. Among the web spinners, the webs are higher spherical shape or irregular shape.

Spiders considered as biological predators in nature. Many studies have been carried out to evaluate spiders as biological control agents and present an effective method of using spiders to reduction of pest population. Most of the studies were limited to the identification of spiders, and to investigate the dominant spider species, their regional distribution and seasonal fluctuations.
Hence, the present investigation is an attempt to study the biodiversity and the relative abundance of spiders in Thayilpatti, Madathuppatti and Vembakkottai for a period of five months from November 2011 to March 2012. This study clearly indicated that the Salticidae, Oxyopidae and Araneidae fauna of this area is rich and diversified.

The major component of the spider population found in this ecosystem was the family Salticidae mainly of P. petersi and P. paykullii, Araneidae composed mainly of A. anasuja, C. cicastrosa and Oxyopidae mainly composed of P. viridana, O. hindostanicus, O. birmanicus and P. latikae. The population of C. cicastrosa and the Oxyopidae spiders like P. viridana, O. hindostanicus, O. birmanicus and P. latikae were higher during November and December and lowered during March. The Satlicidae spider, P. paykullii population was stable throughout the study period. C. cicastrosa, O. birmanicus and A. anasuja were the predominant species of spider followed by P. indicus, G. poonaensis and P. latikae during November. The population of these spiders gradually decreased from November to March. N. lugubris, O. millet and G. unquifera were the least number of spiders. During December, the population of C. cicastrosa and O. birmanicus were higher. The population of T. dimidiatta and N. lugubris were lowered during March. The population of Gnaphosidae spider, G. poonaensis and Salticidae spider, M. thakuriensis was stable throughout the study period. During December the population of N. lugubris were higher. P. paykullii, H. olivacea, P. viridana, T. dimidiatta, P. latikae, L. pseudoannulata, P. indicus were higher during November and lowered during March. The population of O. millet were absent throughout the study period. Most of the species are lowered from December to March during the study period. G. unquifera available during December and totally there was no population of G. unquifera during March. The population of P. viridana was higher during January than November.

P. viridana, O. hindostanicus, P. indicus, M. decorata, M. thakuriensis, P. paykulli were the predominant species of spiders in Vembakkottai. These spider populations were higher during November and lowered during March. The spider G. unquifera was not available in the area. The population of L. pseudoannulata was higher from November to February and lower during March. The spider M. thakuriensis is available during November and absent during March. The population of A. anasuja was higher during January and the population of O. millet was higher during February and lowered during March. During March all the spider population was decreased except H. olivacea.

**Behaviours of the spiders**

The spiders belonging to the family Araneidae are orb web weaver, Gnaphosidae and Lycosidae are ground runners, Salticidae and Oxyopidae are stalkers and Sparassidae are foliage runners.

**DISCUSSION**

In the present study, twenty species of spiders belonging to six families in Thayilpatti, Madathuppatti and Vembakkottai were collected and identified. These spiders belonging to the family Salticidae, Oxyopidae, Araneidae, Lycosidae, Gnaphosidae, and Sparassidae. In this study two species of spiders were observed, one is web weaver and another one is non – web weaver. The web weaving spiders belonging to the family Araneidae and Lycosidae. The non web weaving spiders belonging to the family Salticidae, Oxyopidae, Thomisidae, Gnaphosidae, Tetragnathidae and Sparassidae. The reasons for the fluctuation in
different months may be due to seasonal variation and harvesting in the nearby fields to search the new niche. The reasons for the fluctuation in different months may be due to drought, flood, natural calamities, and disturbance by other animals, and manmade disturbance. The population dynamics of the individual spider species in different months showed that the population of spider species mainly *P. vridana*, *O. birmanicus*, *O. hindostanicus*, *P. latikae*, *A. anasuja*, *C. cicatrosa*, *L. pseudoannulata*, *P. petersi* and *P. paykullii* was very high throughout the study period. The increase in the spiders density suggests that spider density in influenced by the increase in prey density.

The webbing sites of web builders are easily affected by environmental factors in addition, when the web spaces over lap, there is competition with and between species of web builders. Therefore, hunters probably are more effective predators than web builders. In particular, the interaction of prey and predator shows a constant numerical interaction about these relationships which is fundamental to biological control. Spiders are considered as the favorable biological control agents in the forest eco system. The spiders are abundant throughout and all parts of country. They are an integrated part of all ecosystems and contribute to the balanced ecosystem evidently due to their predatory potential. They are found from hedges, shrubs, bushes and trees. They have also been found in fields of paddy, wheat, rice, and other crops etc. (Perfecto et al., 1996) Apart from this, spiders are observed in other ecologically different places viz., forest floors, under stone and logs, in dead leaves and detritus.

The present work includes the taxonomic position, morphological characters, and list of diversified species. The seasonal variation of spider population from this site has also been observed in the cotton field, maximum web – weaving individual had been found in November while less number of individual, were recorded during summer season (March). The study was resulted to identification of twenty species belonging to twenty three genera and nine families. The major families were Salticidae, Araneidae, oxyopidae and Lycosidae. Spiders are ubiquitous predators that are abundant and diverse in agricultural ecosystems. Spider assemblages have the ability to limit population growth of arthropod pests alone or in combination with other natural enemies (Mansour et al., 1980; Oraze & Grigarick, 1989; Riechert & Bishop, 1990; Carter & Rypstra, 1995). Different studies have shown that spiders’ influence on prey populations depends on spider density or biomass. Therefore, relatively high spider abundance has been considered a requirement for pest control in agricultural systems (Greenstone, 1999; Riechert, 1999; Sunderland & Samu, 2000), but the role of spider diversity in prey regulation is less understood. The same result observed in my study also. A diverse assemblage of spiders may occupy a variety of biotopes in agroecosystems and, as a whole, are likely to be active throughout the day. Therefore, a diverse spider assemblage will leave fewer refuges for potential prey in time and space. Due to variation in spider size and/or prey capture strategies, spiders should be able to capture prey that varies in size and/or developmental stages (Sunderland, 1999; Henaut et al., 2001; Riechert et al., 1999) found that there seemed to be no single spider species that regulates pests or maintains temporal consistency, as well as a diverse assemblage of spider species. The complexity of vegetation structure has been suggested to be an important habitat component that affects spider density and diversity in both natural ecosystems (Lowrie, 1948; Barnes, 1953; Barnes & Barnes, 1955; Greenstone, 1984) and agroecosystems (Hatley & MacMahon, 1980; Alderweireldt, 1994; Rypstra & Carter, 1995; Downie et al., 1999). Vegetation structure could influence spiders through a variety of biotic and abiotic factors, namely structures for webs,
temperature, humidity, level of shade cover, abundance and type of prey, refuges from natural enemies and intraguild predation (Wise, 1993; Samu et al., 1999; Rypstra et al., 1999).

Most studies regarding the role of shade tree density and diversity in coffee plantations have found a higher species diversity in more diverse coffee agroecosystems (Perfecto et al., 1996; Greenberg et al., 1997). Perfecto and Snelling (1995) found that species diversity of ground-foraging ants decreased with shade reduction whereas coffee-foliage-foraging ant diversity did not change along the same shade gradient. In our study, there was no apparent trend between management and spider diversity. Most cases (11 out of 18), according to species richness, Shannon and Simpson indices, showed no relation between management and spider diversity. In only two cases did we find that spider diversity decreased with management intensification. Surprisingly, in five cases, we found an increase in spider diversity as land management increased. These results are contrary to what has previously been reported (Perfecto et al., 1996; Greenberg et al., 1997), and there are several possible explanations. An uncontrolled factor that could affect spider diversity was the presence and density of insectivorous birds, which are known to predate spiders intensely (Gunnarsson, 1998). The different predation level could affect spiders’ abundance and composition, by selectively reducing numbers of those spiders species more exposed to bird predation. Another explanation is the possibility that relative diversity levels change between years, as we only made a one-year study, and therefore results should be interpreted with caution. The organic management site had the lowest species richness and diversity, and the highest dominance in the dry season (according to all alpha indices used) with the exception of hunting spiders. In both seasons, web-building spiders were more abundant and had higher species richness than hunting spiders. Among the web-building spiders, *Leucauge argyra* and *Leucauge* sp. were found disproportionately abundant in all sites, but most notably in organic management. The extreme dominance of the *Leucauge* spp. in organic management was the cause for the high values estimated by Simpson index (which is more sensitive to dominant species). The Shannon index values are most affected by species richness and secondarily by evenness. The organic management with low species richness and extreme dominance (reduced evenness) therefore had low Shannon index values. Several authors consider that dominant species tend to exploit resources more efficiently than non-dominant species (Agnew & Smith, 1989; Mason et al., 1997). Extreme dominance of *Leucauge* spp. in organic management compared to control and conventional management in the dry season may be because the optimum, in shade and humidity conditions, for these species are those of the organic management (intermediate between the control and the conventional sites). *Leucauge mariana* has been reported as a very abundant species in disturbed habitats in Central America (Eberhard, 1988; Eberhard & Hube, 1998). For these reasons, these species could be more abundant in the coffee systems than in the control site, but the dominance of this species should be subject of a particular study. Spider diversity under the organic management significantly increased in the rainy season due to an increase in species richness and a decrease in the dominant species abundance. In contrast, in conventional management and control, there were no significant differences between the seasons. Theoretically, when populations of competitive dominant species decrease or disappear, species diversity might increase (Putman, 1994). In the study period, the population of *O. milleti* and *G. unquifera* were less common. These results support the existence of a gradient in species composition, from control site to conventional management,
with organic as intermediate, although in the rainy season the difference between organic and conventional management was reduced. This might be explained because in the rainy season the interference of clouds and rain with solar irradiation reduces the differences in temperature and humidity, making the coffee farms more similar in these variables. Additionally, the exclusive presence of a spider species at one site may be related to the existence of a favourable microclimate and/or an adequate web support for these species. For example, *T. albosinctus* were high during November and lowered February and no population was observed during March in Madathuppatti. *Spintharus flavidus*, had been poorly studied taxonomically and is common under the leaves of bushes (Levi, 1954), so it is possible that it could prefer the non disturbed control site, in opposition to the periodically perturbed coffee plantations. On the other hand, *E. brevipes* was found only on control habitat, and is known that the spiders of this family live almost exclusively in wet or humid, shaded forest habitats (Coddington, 1986). Some species collected were singletons, as in the case of *Dolichognatha* sp. and *Tetragnatha* sp., and could reflect a demographic rarity (Hafner & Ezcurra, 1992). In the summer season, a few species like *P. viridana* and *A. anasuja* of Oxyopidae and Araneidae were among the dominant and subdominant species at all sites, showing that they were not affected by the management gradient. However, with a seasonal change from dry to rainy season, *G. anguifera* became considerably less abundant in all sites. In contrast the population of Salticidae were higher throughout the study period.

**ACKNOWLEDGEMENTS**

The author’s express profound thanks to the Management, Principal and Head of the Department of Zoology, Ayya Nadar Janaki Ammal College (Autonomous), Sivakasi for providing facilities to carry out this work. One of us (Dr. S. Jeyaparvathi), grateful to the Department of Science and Technology (DST), New Delhi for providing financial assistance under Women Scientist Scheme (WOS-A).

**LITERATURE CITED**


Table 1. Taxonomical diversity of spiders collected from the selected areas of Virudhunagar district.

<table>
<thead>
<tr>
<th>Sub-family</th>
<th>No. of genera</th>
<th>No. of species</th>
<th>% of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxyopidae</td>
<td>2</td>
<td>4</td>
<td>21.05</td>
</tr>
<tr>
<td>Lycosidae</td>
<td>2</td>
<td>2</td>
<td>10.53</td>
</tr>
<tr>
<td>Araneidae</td>
<td>4</td>
<td>4</td>
<td>21.05</td>
</tr>
<tr>
<td>Salticidae</td>
<td>5</td>
<td>7</td>
<td>36.84</td>
</tr>
<tr>
<td>Gnaphosidae</td>
<td>1</td>
<td>1</td>
<td>5.26</td>
</tr>
<tr>
<td>Sparassidae</td>
<td>1</td>
<td>1</td>
<td>5.26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>19</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

Figure 1. Population dynamics of spiders from the cotton field of Thayilpatti.
Figure 2. Population dynamics of spiders from the cotton field of Madathuppatti.

Figure 3. Population dynamics of spiders from the cotton field of Vembakkottai.
A CONTRIBUTION TO THE KNOWLEDGE OF TURKISH LONGICORN BEETLES FAUNA
(COLEOPTERA: CERAMBYCIDAE)

Yakup Şenyüz* and Hüseyin Özdikmen**

* Dumlupınar University, Faculty of Arts and Science, Department of Biology, Kütahya, TURKEY.
** Gazi Üniversitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü, 06500 Ankara / TÜRKİYE.
E-mail: ozdikmen@gazi.edu.tr

ABSTRACT: In the present paper were studied specimens of the family Cerambycidae (Coleoptera) collection in personal collection of Dr. Yakup Şenyüz (Kütahya / Turkey) from Turkey. New faunistic data is presented on Cerambycidae of Turkey. The faunistic data in the present paper on almost all species add to knowledge on their distribution in Turkey. As a result of identification of these specimens, thirty three species of twenty genera of five subfamilies were determined for Turkey. So, the present paper contributes to the knowledge of the longhorn beetles fauna of Asian Turkey and European Turkey.

KEY WORDS: Prioninae, Lepturinae, Cerambycinae, Dorcadioninae, Lamiinae, Cerambycidae, Coleoptera, faunistic data, Turkey.

The specimens for this study were collected by the author, Dr. Yakup Şenyüz over various years (2003, 2004, 2005, 2007, 2008, 2009, 2011) from different localities in Turkey and deposited in the Dumlupınar University (Kütahya prov.). In this paper classification and nomenclature of the longhorn beetles suggested by Özdikmen (2012) are followed. Within the subfamilies all genera are listed in the same order as in Özdikmen (2012). Within the genera the species are listed alphabetically. Each name of a species or subspecies is accompanied by the author's name and description date.

The data, Material and Remarks under the title for each species is given in present text.

With the present work, thirty four species of twenty genera of five subfamilies were determined for Turkey. Among them, 1 species as *Rhagium* (s. str.) *inquisitor* (Linnaeus, 1758) is new to Aegean Region of Turkey; 1 species as *Agapanthia (Epoptes) dahlī* (Richter, 1820) is new to Marmara Region of Turkey; 2 species as *Vadonia moesiaca* (Daniel & Daniel, 1891) and *Dorcadion (Cribrodorcadion) infernale* Mulsant & Rey, 1863 are new to European Turkey in Marmara Region of Turkey; 13 species as *Prionus coriarius* (Linnaeus, 1758), *Rhagium* (s. str.) *inquisitor* (Linnaeus, 1758), *Stictoleptura* (s. str.) *cordigera* (Fuessly, 1775), *Stenurella bifasciata* (Müller, 1776), *Stenurella melanura* (Linnaeus, 1758), *Cerambyx* (s. str.) *carinatus* (Küster, 1845), *Chlorophorus (Perderomaculatus) sartor* (Müller, 1766), *Dorcadion (Cribrodorcadion) infernale* Mulsant & Rey, 1863, *Dorcadion (Cribrodorcadion) scabricolle* (Dalman, 1817), *Morimus finereus* Mulsant, 1862, *Phytoecia (Helladia) humeralis* (Waltl, 1838), *Phytoecia (Opsilia) coerulescens* (Scopoli, 1763) and *Agapanthia (Epoptes) lateralis* Ganglbauer, 1884 are new to Kütahya province; 6 species as *Vadonia unipunctata* (Fabricius, 1775), *Stictoleptura (s. str.) fulva* (DeGeer, 1775), *Anastrangalia dubia* (Scopoli, 1763), *Rutpela maculata* (Poda, 1761), *Stenurella melanura* (Linnaeus, 1758) and *Morimus
funereus Mulsant, 1862 are new to Eskişehir province; 5 species as Vadonia moesiaca (Daniel & Daniel, 1891), Pseudovadonia livida (Fabricius, 1777), Chlorophorus (Humeronaculatus) figuratus (Scopoli, 1763), Dorcadion (Cribrodorecdion) infernale Mulsant & Rey, 1863 and Neodorecdion bilineatum (Germain, 1824) are new to Kirkareli province; 4 species as Plagionotus (Echinocerus) floralis (Pallas, 1773), Phytoecia (s. str.) pustulata (Schrank, 1776), Agapanthia (Eopotes) dahli (Richter, 1820) and Agapanthia (Eopotes) lateralis Ganglbauer, 1884 are new to Edirne province; 4 species as Vadonia unipunctata (Fabricius, 1787), Stenurella bifasciata (Müller, 1776), Plagionotus (Echinocerus) floralis (Pallas, 1773) and Agapanthia (Eopotes) dahli (Richter, 1820) are new to Istanbul province; 1 species as Chlorophorus varius (Müller, 1766) is new to Bursa province; 1 species as Cerambyx cerdo Linnaeus, 1758 is new to Bilecik province; and 1 species as Anastrangalia montana (Mulsant & Rey, 1863) is new to Kahramanmaras province.

SUPERFAMILY CERAMBYCOIDEA Latreille, 1802

FAMILY CERAMBYCIDAE Latreille, 1802: 211

SUBFAMILY PRIONINAE Latreille, 1802: 212
TRIBE PRIONINI Latreille, 1802: 212
GENUS PRIONUS Geoffroy, 1762: 198
SPECIES P. coriarius (Linnaeus, 1758: 389)

Remarks: The species is probably more or less widely distributed in Turkey. It is new to Kütahya province (Özdikmen, 2007, 2008b).

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)

Material examined: Kütahya: Murat Mt., Kaplıcalar district, 17.VII.2011, 1 specimen.
Remarks: The species is widely distributed in N Turkey mostly. It is new to Kütahya province and thereby to Aegean Region of Turkey (Özdikmen, 2007, 2008b).

TRIBE LEPTURINI Latreille, 1802: 218
GENUS VADONIA Mulsant, 1863: 559
SPECIES V. moesiaca (Daniel & Daniel, 1891: 6)

Material examined: Kirkareli: Between Dereköy and Iğneada, 31.V.2007, 1 specimen.
Remarks: The rare species is probably distributed only in western half of Turkey. It is new to Kirkareli province and thereby to European Turkey in Marmara Region of Turkey (Özdikmen, 2007, 2008a).

SPECIES V. unipunctata (Fabricius, 1787: 157)
SUBSPECIES V. u. unipunctata (Fabricius, 1787: 157)

Material examined: Eskişehir: Türkmen Mt., Sehitgazi district, 18.V.2007, 1 specimen; İstanbul: Başakşehir, underside the first stage, 03.VI.2007, 4 specimens; Valley in back side of Oyak, 10.VI.2007, 1 specimen; Göçmen houses, 11.VI.2008, 6 specimens.
Remarks: The species is widely distributed in Turkey. But it is new to Eskişehir and İstanbul provinces (Özdikmen, 2007, 2008a).
GENUS PSEUDOVADONIA Lobanov et al., 1981: 787
SPECIES P. livida (Fabricius, 1777: 233)
SUBSPECIES P. l. livida (Fabricius, 1777: 233)

Remarks: The species is widely distributed in Turkey. But it is new to Kirklareli province (Özdikmen, 2007, 2008a).

GENUS STICTOLEPTURA Casey, 1924: 280
SUBGENUS STICTOLEPTURA Casey, 1924: 280
SPECIES S. cordigera (Fuessly, 1775: 14)
SUBSPECIES S. c. cordigera (Fuessly, 1775: 14)

Material examined: Kütahya: Old Gediz, Ali Ağá district, 12.VII.2011, 1 specimen.
Remarks: The species is widely distributed in Turkey. But it is new to Kütahya province (Özdikmen, 2007, 2008b).

SPECIES S. fulva (DeGeer, 1775: 137)

Material examined: Eskişehir: Türkmen Mt., between Uluçayır and Çobanlar plateau, 10.VII.2007, 2 specimens.
Remarks: The species is probably more or less widely distributed in Turkey. It is new to Eskişehir province (Özdikmen, 2007).

GENUS ANASTRANGALIA Casey, 1924: 280
SPECIES A. dubia (Scopoli, 1763: 47)
SUBSPECIES A. d. dubia (Scopoli, 1763: 47)

Material examined: Eskişehir: Türkmen Mt., between Uluçayır and Çobanlar plateau, 10.VII.2007, 1 specimen.
Remarks: The species is probably more or less widely distributed in Turkey. It is new to Eskişehir province (Özdikmen, 2007).

SPECIES A. montana (Mulsant & Rey, 1863: 179)
SUBSPECIES A. m. montana (Mulsant & Rey, 1863: 179)

Material examined: Kahramanmaraş: Andız road, 27.VI.2011, 1 specimen
Remarks: The species is probably widely distributed in W and S Turkey. It is new to Kahramanmaraş province (Özdikmen, 2011).

GENUS JUDOLIA Mulsant, 1863: 496
SPECIES J. erratica (Dalman, 1817: 490)
SUBSPECIES J. e. erratica (Dalman, 1817: 490)

Material examined: Kirklareli: Madra stream bridge env., 31.05.2007, 1 specimen.

GENUS RUTPELA Nakani & Ohbayashi, 1957: 242
SPECIES R. maculata (Poda, 1761: 37)
SUBSPECIES R. m. maculata (Poda, 1761: 37)

Remarks: The species is widely distributed in Turkey. But it is new to Eskişehir province (Özdikmen, 2007, 2008a).
GENUS STENURELLA Villiers, 1974: 217
SPECIES S. bifasciata (Müller, 1776: 93)
SUBSPECIES S. b. bifasciata (Müller, 1776: 93)

Remarks: The species is widely distributed in Turkey. But it is new to İstanbul and Kütahya provinces (Özdikmen, 2007, 2008a,b).

SPECIES S. melanura (Linnaeus, 1758: 397)

Material examined: Eskişehir: Türkmen Mt., between Uluçayır and Çobanlar plateau, 10.VII.2007, 4 specimens; Kütahya: Türkmen Mt., between Gullüdere and Türkmen Baba district, 11.VII.2007, 1 specimen; İstanbul: Başakşehir, valley in back side of Oyak, 10.VI.2007, 3 specimens.
Remarks: The species is probably more or less widely distributed in Turkey. It is new to Eskişehir and Kütahya provinces (Özdikmen, 2007, 2008a,b).

SPECIES S. septempunctata (Fabricius, 1792: 346)
SUBSPECIES S. s. latenigra (Pic, 1915: 5)

SUBFAMILY CERAMBYCINAE Latreille, 1802: 211
TRIBE CERAMBYCINAE Latreille, 1802: 211
SUBTRIBE CERAMBYCINAE Latreille, 1802: 211
GENUS CERAMBYX Linnaeus, 1758: 388
SUBGENUS CERAMBYX Linnaeus, 1758: 388
SPECIES C. carinatus (Küster, 1845: 46)

Material examined: Kütahya: Muhat pass, 06.V.2007, 1 specimen; Yenimahalle, 23.VI.2009, 1 specimen.
Remarks: The species is probably more or less widely distributed in western half of Turkey. It is new to Kütahya province (Özdikmen, 2008b).

SPECIES C. cerdo Linnaeus, 1758: 392
SUBSPECIES C. c. cerdo Linnaeus, 1758: 392

Material examined: Bilecik: Central, 31.VIII.2011, 1 specimen.
Remarks: The species is more or less widely distributed in Turkey. It is new to Bilecik province (Özdikmen, 2007, 2008b).

TRIBE CALLIDIINI Kirby, 1837: 170
GENUS ROPALOPUS Mulsant, 1839: 40
SUBGENUS ROPALOPUS Mulsant, 1839: 40
SPECIES R. clavipes (Fabricius, 1775: 188)


TRIBE CLYTINI Mulsant, 1839: 70
GENUS PLAGIONOTUS Mulsant, 1842: 1
SUBGENUS ECHINOCERUS Mulsant, 1862: 143
SPECIES P. floralis (Pallas, 1773: 724)
Material examined: **Edirne**: İskender village, 01.VI.2007, 8 specimens; **İstanbul**: Başakşehir, valley in back side of Oyak, 10.VI.2007, 1 specimen; Göçmen houses, 20.VI.2008, 2 specimens.

**Remarks:** The species is more or less widely distributed in Turkey. It is new to Edirne and İstanbul provinces (Özdikmen, 2007, 2008a).

**GENUS CHLOROPHORUS** Chevrolat, 186: 290  
**SUBGENUS CHLOROPHORUS** Chevrolat, 186: 290  
**SPECIES** *C. varius* (Müller, 1766: 188)  
**SUBSPECIES** *C. varius varius* (Müller, 1766: 188)

Material examined: **Bursa**: Mezitler valley, Mezit village, 13.VII.2007, 1 specimen.

**Remarks:** The species is widely distributed in Turkey. But it is new to Bursa province (Özdikmen, 2007, 2008a, 2011).

**SUBGENUS PERDEROMACULATUS** Özdikmen, 2011: 537  
**SPECIES** *C. sartor* (Müller, 1766: 188)

Material examined: **Kütahya**: İlca district, 05.VIII.2003, 1 specimen.

**Remarks:** The species is widely distributed in Turkey. But it is new to Kütahya province (Özdikmen, 2007, 2008b).

**GENUS HUMEROMACULATUS** Özdikmen, 2011: 537  
**SPECIES** *C. figuratus* (Scopoli, 1763: 55)

Material examined: **Kırklareli**: Bridge of Madra stream env., 31.V.2007, 1 specimen.

**Remarks:** The species is probably more or less widely distributed in Turkey. It is new to Kırklareli province (Özdikmen, 2007, 2008a).

**SUBFAMILY DORCADIONINAE** Swainson, 1840: 290  
**TRIBE** DORCADIONINI Swainson, 1840: 290  
**GENUS DORCADION** Dalman, 1817: 397  
**SUBGENUS CRIBRIDORCADION** Pic, 1901: 12  
**SPECIES** *D. divisum* Germar, 1839: 15  
**SUBSPECIES** *D. d. divisum* Germar, 1839: 15

Material examined: **Kütahya**: Türkmen Mt., Göknebi village, 12.IV.2008, 12 specimens.

**Remarks:** The subspecies is endemic to Turkey. The species is probably more or less widely distributed in Turkey (Özdikmen, 2008b, 2010).

**SPECIES** *D. infernale* Mulsant & Rey, 1863: 158  
**SUBSPECIES** *D. i. infernale* Mulsant & Rey, 1863: 158


**Remarks:** The species is endemic to Turkey and more or less widely distributed in Turkey. It is new to Kütahya province and Kırklareli province and thereby European Turkey in Marmara Region of Turkey (Özdikmen, 2007, 2008a,b, 2010).

**SPECIES** *D. scabricolle* (Dalman, 1817: 174)  
**SUBSPECIES** *D. s. scabricolle* (Dalman, 1817: 174)

Material examined: **Kütahya**: Türkmen Mt., Gölcük district, 15.IV.2008, 4 specimens; Aydoğdu village, 10.III.2011, 1 specimen.

**Remarks:** The species is widely distributed in Turkey. But it is new to Kütahya province (Özdikmen, 2007, 2008b, 2010).
SPECIES D. septemlineatum Waltl, 1838: 469
SUBSPECIES D. s. novemlineatum Kraatz, 1873: 61

Material examined: Kütahya: Ahmetoğlu village, 900 m, 24.IV.2004, 2 specimens; Central, Dumlupınar village, 920 m, 15.V.2004, 5 specimens; Dumlupınar University, 23.IV.2008, 4 specimens.

Remarks: The species is more or less widely distributed in western half of Turkey (Özdikmen, 2007, 2008b, 2010).

GENUS NEODORCADION Ganglbauer, 1884: 437
SPECIES N. bilineatum (Germar, 1824: 485)


Remarks: The species is more or less widely distributed only in NW Turkey. But it is new to Kırklareli province (Özdikmen, 2008a, 2010).

SUBFAMILY LAMIINAE Latreille, 1825: 401
TRIBE LAMIINI Latreille, 1825: 401
GENUS MORIMUS Brullé, 1832: 258
SPECIES M. funereus Mulsant, 1862: 279


Remarks: The species is probably more or less widely distributed in western half of Turkey. It is new to Eskişehir and Kütahya provinces (Özdikmen, 2007, 2008b).

TRIBE ACANTHOCININI Blanchard, 1845: 154
GENUS ACANTHOCINUS Dejean, 1821: 106
SPECIES A. aedilis (Linnaeus, 1758: 392)

Material examined: Kütahya: Central, Kütahya castle, 10.VII.2007, 1 specimen; Murat Mt. thermal waters, 12.VII.2011, 17.VII.2011, 2 specimens.

Remarks: The species is more or less widely distributed in Turkey (Özdikmen, 2007, 2008b).

GENUS LEIOPUS Audinet-Serville, 1835: 86
SPECIES L. nebulosus (Linnaeus, 1758: 391)
SUBSPECIES L. n. nebulosus (Linnaeus, 1758: 391)

Material examined: İstanbul: Büyükada, 26.VII.2007, 5 specimens.

Remarks: The species is probably more or less widely distributed in Turkey (Özdikmen, 2007, 2008a).

TRIBE PHYTOECIINI Mulsant, 1839: 191
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: Kütahya: 11.04.2011, 1 specimen.

Remarks: The species is more or less widely distributed in Turkey. It is new to Kütahya province (Özdikmen, 2007, 2008b).

SUBGENUS PHYTOECIA Dejean, 1835: 351
SPECIES P. icterica (Schaller, 1783: 292)

Material examined: Kütahya: Central, Cumhuriyet primary school, 21.V.2007, 2 specimens.
**Remarks:** The species is more or less widely distributed in Turkey (Özdikmen, 2007, 2008b).

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

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

**Material examined:** Edirne: İskender village, 01.VI.2007, 1 specimen.

**Remarks:** The species is probably more or less widely distributed in Turkey. It is new to Edirne province (Özdikmen, 2007, 2008a).

**SUBGENUS** *OPSILIA* Mulsant, 1862: 387

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

**Material examined:** Kütahya: Porsuk stream basin, 13.VII.2007, 1 specimen; Simav, Nadar Çam district, 12.VII.2011, 1 specimen; **Kirklareli:** Demirköy, 31.V.2007, 2 specimens.

**Remarks:** The species is widely distributed in Turkey. But it is new to Kütahya province (Özdikmen, 2007, 2008a,b).

**TRIBE** AGAPANTHIINI Mulsant, 1839: 172

**GENUS** AGAPANTHIA Audinet-Serville, 1835: 35

**SUBGENUS** EPOPTES Gistel, 1857: 93

**SPECIES** *A. dahli* (Richter, 1820: 12)

**Material examined:** İstanbul: Back side of Oyak site, 10.VI.2007, 1 specimen; Edirne: Havsa village, 01.VI.2007, 1 specimen.

**Remarks:** The species is probably more or less widely distributed in Turkey. It is new to Edirne and İstanbul provinces thereby Marmara Region of Turkey (Özdikmen, 2007, 2008a).

**SPECIES** *A. lateralis* Ganglbauer, 1884: 541

**Material examined:** Kütahya: Felent basin, Felent source, 20.VII.2007, 1 specimen; Edirne: Havsa village, 01.VI.2007, 1 specimen; between Akköprü and Perli, 19.VI.2007, 1 specimen.

**Remarks:** The species is endemic to Turkey and widely distributed in Turkey. But it is new to Edirne and Kütahya provinces (Özdikmen, 2007, 2008a,b).

**LITERATURE CITED**


SELECTION OF POLYVOLTINE BREEDS
AND POLYVOLTINE × BIVOLTINE HYBRIDS
OF THE SILKWORM, BOMBYX MORI L.

Ravindra Singh* and D. Gangopadhyay**

*Silkworm Seed Technology Laboratory, Kodathi, Bangalore - 560 035, Karnataka, INDIA.
**National Institute of Science Technology & Development Studies, New Delhi - 110012, INDIA.

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bivoltine hybrids of the Silkworm, Bombyx mori L.. Munis Entomology & Zoology, 8 (2):
578-581]

ABSTRACT: Identification of promising silkworm breeds and polyvoltine × bivoltine
hybrids was carried out utilizing three statistical tools viz., multiple traits evaluation indices,
combining ability and hybrid vigour. Out of four polyvoltine silkworm breeds, DNP, was
found promising based on its performance and multiple traits evaluation indices exhibiting
maximum values for seven characters viz., pupation rate, cocoon yield/10,000 larvae by
weight, cocoon shell weight, cocoon shell %, filament length, raw silk percentage and
neatness followed by DNP which exhibited higher values for three characters viz.,
fecundity, cocoon weight and retrailability. DNP exhibited maximum general combining
ability (GCA) effects for five characters viz., pupation rate, cocoon shell weight, cocoon shell
%, raw silk % and neatness. Out of sixteen polyvoltine × bivoltine hybrids, DNP × CSR, recorded maximum values for four characters viz., cocoon shell weight, cocoon shell %, raw
silk % and neatness analyzed through their rearing performance and evaluation indices
followed by DNP × CSR which exhibited maximum values for three characters namely,
cocoon yield/10,000 larvae by weight, cocoon weight and retrailability. DNP × CSR, expressed maximum specific combining ability (SCA) effects for three characters namely,
cocoon yield/10,000 larvae by weight, retrailability and raw silk % whereas DNP × CSR manifested higher hybrid vigour for three characters viz., pupation rate, reailability and
neatness.

KEY WORDS: Bombyx mori, hybrid vigour, combining ability, multiple traits evaluation
indices, rearing performance, polyvoltine silkworm breeds / hybrids.

Cumulative effects of several characters have been employed in silkworm
breeding for the identification of promising silkworm breeds as well as hybrids
(Narayanaswamy et al., 2002). Several attempts have been made to select
silkworm breeds / hybrids on the basis of multiple traits evaluation indices
(Vidyunnala et al., 1998; Ramesh Babu et al., 2002; Kariappa & Rajan, 2005;
Gangopadhyay et al., 2006; Choudhary & Singh, 2006a; Rao et al., 2006;
Nirupama et al., 2008a,b) and through analysis of combining ability and hybrid
vigour (Datta et al., 2001; Choudhary & Singh, 2006b; Ravindra Singh et al.,
2000, 2001, 2010). Of late, polyvoltine silkworm breeds and polyvoltine ×
bivoltine hybrids (Singh & Nirupama, 2012) and bivoltine silkworm breeds and
hybrids (Singh & Gangopadhyay, 2013) have been short listed through various
statistical tools. The present study has been undertaken to identify promising
polyvoltine breeds and polyvoltine × bivoltine hybrids based on their rearing
performance as well as through different statistical methods.

MATERIALS AND METHODS

Four polyvoltine silkworm breeds namely, DNP, DNP, DNP and DNP and
sixteen polyvoltine × bivoltine hybrids were utilized in the present study. Rearing
of both silkworm breeds along with hybrids was conducted with three replications and 300 larvae were retained in each replication after III moult. Data were collected for eleven economic characters namely, fecundity, hatching %, pupation rate, yield/10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length, reelability, raw silk percentage and neatness and analyzed through different statistical methods like multiple traits evaluation indices method of Mano et al. (1993), analysis of combining ability method of Kempthorne (1957) and hybrid vigour.

RESULTS AND DISCUSSION

Maximum rearing performance, evaluation index, GCA of parents, SCA of polyvoltine × bivoltine hybrids and hybrid vigour values pertaining to 11 economic characters have been given in Table 1. Among the parental silkworm breeds, DNP\textsubscript{1} was adjudicated as the best parent showing maximum values for seven economic characters namely, pupation rate, cocoon yield/10,000 larvae by weight, cocoon shell weight, cocoon shell percentage, filament length, raw silk and neatness followed by DNP\textsubscript{3} which revealed maximum values for three characters namely; fecundity, cocoon weight and reelability based on average performance and evaluation index values. Maximum general combining ability (GCA) effects were found in DNP\textsubscript{1} for five characters \textit{viz.}, pupation rate, cocoon shell weight, cocoon shell %, filament length, and raw silk and neatness.

Among sixteen polyvoltine × bivoltine hybrids, DNP\textsubscript{1} × CSR\textsubscript{2} was found promising by exhibiting maximum values and evaluation indices for four characters namely, cocoon shell weight (0.402g and 63.30), cocoon shell percentage (20.62 and 65.52), raw silk (15.99 % and 72.43) and neatness (91 p and 65.18) followed by DNP\textsubscript{3} × CSR\textsubscript{17} which exhibited maximum values and evaluation indices for three characters \textit{viz.}, cocoon yield/10,000 larvae by weight (19.920 kg and 69.50), cocoon weight (2.135 g and 71.40) and reelability (85.5 % and 63.04). Maximum specific combining ability (SCA) effects were expressed in DNP\textsubscript{4} × CSR\textsubscript{4} for three characters \textit{viz.}, cocoon yield/10,000 larvae by weight, reelability and raw silk followed by DNP\textsubscript{2} × NB\textsubscript{4}D\textsubscript{2} and DNP\textsubscript{3} × CSR\textsubscript{17} exhibiting SCA effects for two characters each. DNP\textsubscript{2} × CSR\textsubscript{4} manifested maximum hybrid vigour for three characters \textit{viz.}, pupation rate (14.16), reelability (9.64) and neatness (2.46) followed by DNP\textsubscript{4} × CSR\textsubscript{4} for two characters cocoon yield/10,000 larvae by weight (51.78) and cocoon shell percentage (17.39).

Efforts have been made to select silkworm breeds and hybrids through multiple traits evaluation index method (Ramesh Babu et al., 2002; Gangopadhyay et al., 2006; Choudhary & Singh, 2006a; Rao et al., 2006; Lakshmi & Chandrashekarahia, 2007; Nirupama et al., 2008a,b) and through analysis of combining ability and hybrid vigour (Datta et al., 2001; Choudhary & Singh, 2006b; Singh et al., 2000, 2001, 2010). Singh & Nirupama (2012) have selected promising polyvoltine breeds and polyvoltine × bivoltine hybrids on the basis of rearing performance, combining ability and hybrid vigour. Further, Singh & Gangopadhyay (2013) have identified bivoltine breeds and bivoltine hybrids based on rearing performance, combining ability and hybrid vigour. Results of the present study revealed that the identified polyvoltine breed DNP\textsubscript{1} may be further utilized in future breeding programmes for the development of outstanding polyvoltine silkworm breeds. The identified polyvoltine × bivoltine hybrid DNP\textsubscript{1} × CSR\textsubscript{2} may be exploited on large scale for commercial exploitation.
LITERATURE CITED


Plate I. 1- Larvae of DNP₁, 2- Cocoons of DNP₁, 3- Larvae of DNP₁ × CSR₂ and 4- Cocoons of DNP₁ × CSR₂.

Table 1. Short-listing of polyvoltine breeds and polyvoltine × bivoltine hybrids based on various statistical measures.

<table>
<thead>
<tr>
<th>Character</th>
<th>Polyvoltine breeds</th>
<th>Polyvoltine × bivoltine hybrids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Based on average performance</td>
<td>Based on Breeding Ability (BBA)</td>
</tr>
<tr>
<td>Face index (mm)</td>
<td>DNP₁ (94.4)</td>
<td>DNP₁ (55.39)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (55.13)</td>
<td>DNP₁ × CSR₂ (50.29)</td>
</tr>
<tr>
<td>Hatching (%)</td>
<td>DNP₁ (91.65)</td>
<td>DNP₁ (7.77)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (55.15)</td>
<td>DNP₁ × CSR₂ (70.73)</td>
</tr>
<tr>
<td>Pupal index</td>
<td>DNP₁ (55.15)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (55.15)</td>
<td>DNP₁ × CSR₂ (50.72)</td>
</tr>
<tr>
<td>Cycling yield/1000 larvae by wet wt (kg)</td>
<td>DNP₁ (12.12)</td>
<td>DNP₁ (55.07)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (1.12)</td>
<td>DNP₂ (73.69)</td>
</tr>
<tr>
<td>Cocoons weight (g)</td>
<td>DNP₁ (1.12)</td>
<td>DNP₂ (73.69)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (55.07)</td>
<td>DNP₂ × CSR₂ (71.40)</td>
</tr>
<tr>
<td>Cocoons shell weight (g)</td>
<td>DNP₁ (0.225)</td>
<td>DNP₂ × CSR₂ (70.98)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (55.07)</td>
<td>DNP₂ × CSR₂ (61.33)</td>
</tr>
<tr>
<td>Cocoons shell %</td>
<td>DNP₁ (16.11)</td>
<td>DNP₂ × CSR₂ (60.44)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (64.67)</td>
<td>DNP₂ × CSR₂ (60.44)</td>
</tr>
<tr>
<td>Filmament length (mm)</td>
<td>DNP₁ (57.2)</td>
<td>DNP₁ × CSR₂ (58.84)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (55.07)</td>
<td>DNP₂ × CSR₂ (58.84)</td>
</tr>
<tr>
<td>Readiability (%)</td>
<td>DNP₁ (71.7)</td>
<td>DNP₂ × CSR₂ (58.84)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (55.07)</td>
<td>DNP₂ × CSR₂ (58.84)</td>
</tr>
<tr>
<td>Reel silk %</td>
<td>DNP₁ (12.12)</td>
<td>DNP₂ × CSR₂ (58.84)</td>
</tr>
<tr>
<td></td>
<td>DNP₂ (55.07)</td>
<td>DNP₂ × CSR₂ (58.84)</td>
</tr>
<tr>
<td>Nutrient</td>
<td>DNP₁ (55.07)</td>
<td>DNP₂ × CSR₂ (58.84)</td>
</tr>
</tbody>
</table>
TWO NEW AGAPANTHIA AUDINET-SERVILLE, 1835
SPECIES FROM GREECE (COLEOPTERA: CERAMBYCIDAE)

Pierpaolo Rapuzzi*, Gianfranco Sama** and Attila Kotán***

* via Cialla, 48, 33040 Prepotto (UD), ITALY. E-mail: info@ronchidicialla.it
** via Raffaello 84, 47023 Cesena (FC), ITALY. E-mail: francosama@gmail.com
*** Komáromi út 5/a, 1142 Budapest, HUNGARY. E-mail: helladia@gmail.com

ABSTRACT: Two new Agapanthia Audinet-Serville, 1835 species from Greece are described and figured. Comparative notes are proposed as well. Agapanthia izzilloi n. sp. from Peloponnese belongs to A. amitina Holzschuh, 1989 species group. Agapanthia markusi n. sp. is close to A. villosoviridescens DeGeer, 1775 and it comes from Pindos Mountains.

KEY WORDS: Cerambycidae, Agapanthia, new species, Greece.

Studying large series of Agapanthia collected in Greece, we found two species that evidently belong to new taxon. Agapanthia (s. str.) izzilloi n. sp. belongs to A. amitina Holzschuh, 1989 species group. It is very interesting because the new species is the first record of this group from Europe and it is the most Western species known. Agapanthia (Epoptes) markusi n. sp. is close related with A. villosoviridescens DeGeer, 1775 and it is known only from Pindos Mountains.

Agapanthia (s. str.) izzilloi n. sp.
(Fig. 1)


Description of the Holotype.
Length 11 mm, width 3 mm. Body green metallic with blue reflex. Head deep punctured, frons with dense long erect black hairs and dense short recumbent white hairs, denser in the middle, at eyes side and on cheeks. Pronotum a little longer than wide, dense punctured with denser punctures on the middle of the disk, in this area the punctures are smaller than the rest of pronotum. Pubescence made by long black erect hairs. These hairs are denser at sides then on the disk. Scutellum rounded, with dense and very short recumbent white pubescence, denser at the apex. Elytra parallel sides, with dense and deep punctures. The points merge to form wrinkles along the suture. Shoulders with deep carina. Pubescence made by long black erect hairs, longer and denser on the first half and shorter towards the apex. Along the apical side there are very short and dense...
white hairs. Legs long, metallic green covered with dense short erect white hairs; there are few longer black erect hairs on tibiae and femora. Antennae long, exceeding elytral apex with the last 6 joints. Scape long, metallic green, near reaching the base of pronotum, covered with dense dark erect hairs, from the 3\textsuperscript{rd} to the 12\textsuperscript{th} covered with short recumbent white pubescence, denser on the first two thirds to give a ringed aspect to antennae. Third Joint and half of the fourth with metallic reflections, the others are black.

**Variability of the Paratypes**
The specimens of the type series show a range of color from the green with some golden reflection (the largest number of specimens), to the blue (rarely), few specimens are double colored: head and pronotum golden-green and elytra more or less blue. One specimen is bronze-green. The range of size is between 7 to 13 mm. among males and from 8 to 12.5 mm. among females.

**Biology**
All the specimens was collected on the leaves or flying around the plants of *Psoralea bituminosa* (Linnaeus, 1753) (*Fabaceae*). It is very probably that this plant is the host of the new species.

**Discussion**
*Agapanthia* (s. str.) *izzoiloi* n. sp. belongs to the homogeneous group of metallic *Agapanthia* where we find: *Agapanthia* (s. str.) *amitina* Holzschuh, 1989 from North Iran, *Agapanthia* (s. str.) *pesarini* Sama & Rapuzzi, 2010 from Southern Turkey, *Agapanthia* (s. str.) *psoraleae* Sama & Rapuzzi, 2010 from Lebanon and *Agapanthia* (s. str.) *gemella* Holzschuh, 1989 from Cyprus. The new species for the large size of body is closer with *A. gemella* but is immediately separable from it by the longer antennae. The antennae ringed in both sex permit to separate the new species from all other species of this group. It is very interesting to note that the new Taxon is the western most species of a species group widespread from the North-East part of the Mediterranean Sea till the mountains up to the Caspian Sea.

**Etymology**
We dedicate the new species with gratitude to Francesco Izzillo from Naples who collected the largest number of specimens of this interesting new species as thanksgiving for the opportunity to study his specimens.

*Agapanthia* (*Epoptes*) *markusi* n. sp.

(Fig. 2)

Description of the Holotype.
Length 16 mm, width 4 mm. Body black with leaden reflections. Head with deep and dense punctures. Pubescence made by long black erect hairs and dense but not homogeneous short pubescence made by short white recumbent hairs, denser between antennae and around eyes. Pronotum as long as width, dense punctured with deep punctures. Pubescence made by long black erect hairs, little denser at sides than on the disk. In the middle only few short recumbent white hairs, denser near the apex and the base but invisible without loop. Scutellum rounded, larger than long and covered with dense and very short recumbent white hairs. Elytra parallel, shortly acuminate towards the apex, dense punctured and covered with long black erect hairs. These hairs are longer and denser on the first two thirds and shorter and rarer towards apex but reaching the apex. Elytra are complete black, only few evanescent white small spots made by short and recumbent ashen hairs, denser near the apex. Legs long, black. Median and hind tibiae with scattered white recumbent hairs, denser on tibiae than on the femora. Antennae long, exceeding elytral apex with the last five joints. Antennae black, with evanescent ring of ash pubescence on the first half from 3rd to the 12th joint. Scape with medium dense erect black hairs; rarer on the next joints from the third to the fifth and absent on the subsequent joints.

Variability of the Paratypes
The paratypes show sometimes a denser scattered ashy pubescence, only two specimens show this pubescence till the first half. Sometimes the white median strips on pronotum is more or less evident. The range of size is between 12 to 18 mm. among males and from 14 to 18 mm. among females.

Discussion
The species known of Agapanthia (Epoptes) villosoviridescens widespread in all the West Palearctic region very probably represents a complex of different species diffuse in all the West Palearctic region. In fact several population from the southern part of its area are quite different from the population from Middle and North Europa. A. villosoviridescens was described by DeGeer on the base of specimens without locality, most likely Sweden or Northern Europe. The specimens from Central Italy show a larger body and a dense yellow pubescence, the specimens from Thracian (Greece and Turkey) are bigger with longer antennae and a different color on elytra. We believe that a study of the whole group is necessary to clear this situation.

Agapanthia (Epoptes) markusi n. sp. is close related with A. villosoviridescens DeGeer, 1775 but it is easy to distinguish by the lead black color
of the body. Pronotum is with a very thin and incomplete median strip, sometimes this stripe is complete missing. The light pubescence is ashy colored in the new specie and yellowish in *villosoviridescens*. Antennae are shorter and only small ringed with ashy pubescence, evidently whitish ringed in *villosoviridescens*. The body is bigger and larger than in *villosoviridescens* and elytral apex is less acuminate. Erect hairs on elytra are denser in the new species than in *villosoviridescens* (Figs. 3 and 4) Apex of parameters are shorter and stouter and show denser pubescence than in *villosoviridescens* (Figs. 5 and 6). Aedeagus and endophallus are similar to *villosoviridescens*.

**Etymology**

We dedicate the new species to the late dr. András Márikus, who was the father of dr. András Márikus, who collected the largest number of this interesting species.

**ACKNOWLEDGEMENTS**

We wish to thank our friends and colleagues TAMÁS NÉMETH (Hungarian Natural History Museum, Budapest, Hungary) for producing photos for this paper, PETRA NEMES, ANDRÁS MÁRKUS and TAMÁS NÉMETH for collecting the paratypes of the new species, and G. Handrinos (GREEK MINISTRY OF ENVIRONMENT, Directorate of Aesthetic Forests, National Parks and Game Management) for providing collecting permission and to Apostolos Trichas (Natural History Museum of Crete, University of Crete, Iráklion, Greece) for helping get that permission and advice.

**LITERATURE CITED**


Figure 1. *Agapanthia* (s. str.) *izzilloi* n. sp. (Holotypus male).

Figure 2. *Agapanthia* (*Epoptes*) *markusi* n. sp. (Paratypus male and female).
Figure 3. *Agapanthia (Epoptes) markusi* n. sp. (Paratypus male – Lateral view).

Figure 4. *Agapanthia (Epoptes) villosoviridescens* (DeGeer, 1775) (Lateral view).

Figure 5. Paramers of *Agapanthia (Epoptes) markusi* n. sp.

Figure 6. Paramers of *Agapanthia (Epoptes) villosoviridescens* (DeGeer, 1775).
TWO NEW GENUS RECORDS FOR SPIDER FAUNA OF TURKEY (ARANEAE: LINYPHIIDAE)

Tarık Danışman*, Halil Koç**, İlhan Coşar***, Kübra Ceren Karanfil*** and Meryem Arslan***

* Kırıkkale University, Sciences and Arts Faculty, Department of Biology, 71450 Yahşihan, Kırıkkale, TURKEY. E-mail: tarikdanisman@hotmail.com
** Sinop University, Faculty of Science and Arts, Department of Biology, Sinop, TURKEY.
*** Kırıkkale University, Graduate School of Natural and Applied Sciences, Department of Biology, Kırıkkale, TURKEY.


ABSTRACT: This study reports two linyphiid genera as new genus record for the Turkish araneo-fauna. The characteristic features and photographs of Piniphantes pinicola (Simon, 1884) and Trichoncoides piscator (Simon, 1884) are presented. The total number of linyphiid species recorded from Turkey is now 107.

KEY WORDS: Piniphantes, Trichoncoides, Linyphiidae, Araneae, Turkey, New records.

A total of 4419 species in 589 genera have been identified in the family Linyphiidae all over the world (Platnick, 2012). A total of 105 species in 60 genera are known in Turkey (Bayram et al., 2012) from Linyphiidae. With this paper, we add two genera to the spider fauna of Turkey. These taxa are Piniphantes pinicola (Simon, 1884) and Trichoncoides piscator (Simon, 1884).

MATERIAL AND METHODS

The main materials in this study were collected from Ağrı and Çankırı province. Specimens were preserved in 70% ethanol. The identification of spiders and photography were made with Lieca S8APO Stereo microscope and Leica DC 160 camera. Photographs have been taken in dishes of different size with paraffin on the bottom. Different size holes were made in the bottom to keep specimens in the right position. Images have been montaged using “CombineZM” image stacking software and “Photoshop CS5” image editing software. SEM photographs were taken with JEOL JSM-5600. The specimens were deposited in the collection of the Arachnological Museum of Kırıkkale University (KUAM). All measurements are in millimeters.

RESULTS

Piniphantes pinicola (Simon, 1884)

Material examined: 2♀, 2♂ from Ağrı province, Diyadin district (39°54′06″ N, 43°68′06″ E), 14.12.2011 (leg. İ. Coşar), 4♀, 4♂ from Çankırı province, Ilgaz district (40°52′30″ N, 33°39′19″ E), 09.09.2011 (leg. T. Danışman).

Description: Male. Total length 1.9 mm, carapace length 0.925 mm, width 0.825 mm; abdomen length 0.975 mm, width 0.8 mm. Anterior eye row recurved, posterior eye row slightly recurved. Cephalothorax brownish yellow, without marginal bands, dots and stripes. Abdomen dirty yellow (Fig. 1). Leg formula I, II, IV, III. Paracymbium large, with 2 teeth. Males recognized by having an elongated
projection with numerous finger-like protrusions at the proximal part of the embolus (Fig. 2). **Female.** Total length 2.0 mm, carapace length 0.975 mm, width 0.85 mm; abdomen length 1.025 mm, width 0.85 mm. Anterior eye row recurved, posterior eye row slightly recurved. Cephalothorax yellow, without marginal bands. Abdomen brownish yellow (Fig. 1). Leg formula I, II, IV, III. Epigyne with a strongly protruding epigyneal area and markedly hypertrophied posterior median plate (Fig. 2).

**Trichoncoides piscator** (Simon, 1884)

**Material examined:** 1♀, 1♂ from Çankırı Province, Ilgaz district (40°52’30” N, 33°39’19” E), 09.09.2011 (leg. T. Danışman).

**Description:** **Male.** Total length 1.5 mm, carapace length 0.625 mm, width 0.52 mm; abdomen length 0.875 mm, width 0.5 mm. Anterior eye row recurved, posterior eye row straight. Cephalothorax fawn coloured, anteriorly with hairs. Abdomen straw-colored (Fig. 3). Leg formula IV, I, II, III. Male palpal paracymbium sickle-shaped. Palpal tibia with three prominent, the first piece in the form of a binary hook. Distal part of the embolus hook shaped (Fig. 4). **Female.** Total length 1.8 mm, carapace length 0.66 mm, width 0.44 mm; abdomen length 1.14 mm, width 0.74 mm. Anterior eye row recurved, posterior eye row straight. Cephalothorax brownish yellow coloured, without hairs. Abdomen straw-colored (Fig. 3). Leg formula IV, I, II, III. Epigyne with trapezoid medial structure, characteristic, with septum, interiorly bears two rounded spermatechaes (Fig. 5).

**DISCUSSION**

With this study, the number of linyphiid spiders in Turkey has increased from 105 species belonging to 60 genera to 107 species belonging to 62 genera. The morphometric measurements of this species are not different from European specimens. As a result of our study, two new genera record were given for the araneofauna of Turkey. Therefore, we expect that more new Turkish records will be found in the future for this families.

**ACKNOWLEDGEMENTS**

We are very grateful to Robert Bosmans (Belgium) for his valuable contributions. We wish to thank Kirikkale University Scientific and Technological Research Laboratories (KUBTAL) for SEM.

**LITERATURE CITED**


Figure 1. *Piniphantes pinicola* A: female dorsal view, B: male dorsal view (scale 1 mm).

Figure 2. *Piniphantes pinicola*, SEM micrographs, A: male pedipalp median view, B: male pedipalp retrolateral view C: proximal part of the embolus, D: epigyne, ventral view.
Figure 3. *Trichoncoides piscator* A: female dorsal view, B: male dorsal view (scale 0.5 mm).

Figure 4. *Trichoncoides piscator*, SEM micrographs, A: male pedipalp retrolateral view, B: male pedipalp ventral view.
Figure 5. *Trichoncoides piscator*, epigyne, ventral view (scale 0.1 mm).
AN OVERVIEW ON THE DEVELOPMENT AND EVALUATION OF BREEDS/HYBRIDS OF THE MULBERRY SILKWORM, BOMBYX MORI L.

Ravindra Singh*, D. Gangopadhyay** and R. Nirupama*

* Silkworm Seed Technology Laboratory, Kodathi, Bangalore - 560 035, Karnataka, INDIA.
** National Institute of Science Technology & Development Studies, New Delhi - 110012, INDIA.


ABSTRACT: Response of different silkworm breeds towards parthenogenetic development has been studied in newly developed bivoltine and polyvoltine silkworm breeds. Japanese type bivoltine silkworm breeds showed pronounced parthenogenetic developments as compared to Chinese ones. An increased tendency towards parthenogenetic development was observed in hybrids obtained from a mother moth having a high tendency of parthenogenesis. Three bivoltine breeds viz., DNB1, DNB6 and DNB7 were developed and evaluated. Evaluation was carried out through various statistical tools like analysis of combining ability, hybrid vigour and cocoon size uniformity. Androgenetic development was also induced in different silkworm breeds/hybrids. Polyvoltine hybrids exhibited higher androgenic development as compared to bivoltine hybrids. A breed with dominant cocoon colour gene was utilized as genetic marker to identify androgenic male individuals. Induction of androgenesis was performed by exposing the oviposited eggs to hot air (38 ºC) for 200 min. Repeated backcrosses were adopted utilizing androgenic males to introgress homozygosity in the breeding lines. Among six polyvoltine silkworm breeds developed through androgenesis, two breeds AGL3 and AGL5 were found promising. Two bivoltine hybrids viz., DNB1 × CSR2 and DNB6 × CSR2 and 2 polyvoltine × bivoltine hybrids viz., AGL3 × CSR2 and AGL5 × CSR2 were found promising.

KEY WORDS: Androgenesis, Bombyx mori, evaluation, hybrid vigour, combining ability, parthenogenesis, performance, silkworm breed and hybrids.

Continuous domestication and selection of the mulberry silkworm, Bombyx mori L has made a diversified genotype (Tazima, 1964). Though, conventional breeding approaches have remarkably increased the silk production, continuous selection showed a decline of targeted characters (Seidel & Brackett, 1981). Selection of desirable individuals based on phenotypic observation is not always accurate. Breeders often opt to preserve the exact genotypic copy of the parent in the descendants (Strunnikov, 1983). Parthenogenesis and androgenesis would be useful in the development of superior silkworm breeds and hybrids with more viability, hybrid vigour, combining ability and less phenotypic variability (Dznealaidze & Tabliashvili, 1990; Takei et al., 1990; Plugaru et al., 1993; Strunnikov, 1995). Androgenic development in silkworm has been induced through several activating agents like X-ray and gamma irradiation of mated female moths, hot air, hot water, CO2 and super cooling of oviposited eggs at low temperature (Whiting, 1955; Tazima & Onuma, 1967; Ye et al., 1989; Nagoya et al., 1996). Attempts have been made to isolate bisexual lines of the mulberry silkworm through application of dispermic androgenesis (Xu et al., 1997; Nacheva et al., 1999). Information on the role of artificial parthenogenesis and androgenesis in the development of silkworm breeds / hybrids is lacking. In the present study, an attempt was made to explore the possibility of using breeding strategies like artificial parthenogenesis and androgenesis in the development and
evaluation of outstanding hybrids of high viability, more hybrid vigour, combining ability and phenotypically uniform population.

Astaurov (1940) method was followed to induce ameiotic parthenogenesis in the unfertilized eggs. Eggs were extracted by rubbing through a muslin sieve, washed in running tap water, dried and kept in a cotton bag for 12 h at room temperature. Then they were dipped in a hot water bath at 46 °C for 18 min and abruptly cooled at 20 °C water bath for 10 min. After drying, eggs batches were put in a Petri dish and incubated at 15 °C and 80 % RH for 3 - 5 days. Egg were soaked in hot HCl (Sp. Gr. 1.075) for 5 min to terminate the egg diapause and rinsed in tap water (20 °C) to eliminate acid traces before being dried. Care was taken to incubate the eggs at normal temperature (25 ± 0.5 °C) and relatively high humidity of 90-95% till larval hatching. Appearance of reddish-brown to dark-brown pigmentation in the serosa was considered as parthenogenetic development. The rate of parthenogenesis was estimated by counting pigmented eggs about 7 - 8 days after transfer from 15 to 25 °C. The ratio of reddish-brown / dark pigmented eggs and total number of eggs treated was expressed as percentage of parthenogenesis whereas the ratio of hatched larvae and pigmented eggs was considered as percentage of hatching. Data were recorded for number of pigmented eggs, number of non-pigmented eggs, number of larvae hatched, percentage parthenogenesis and hatching.

Induction of androgenesis: Diagramatic representation of androgenetic development in silkworm has been depicted in Fig.1 (Singh et al., 2009a). Twenty six polyvoltine silkworm breeds viz., BL23, BL24, BL61, BL62, BL65, BL67, BL68, BL69, 96A, 96C, 96B, ND9, ND7, NP4, PM, P2D1, MY1, D1, GNP, Sarupat, Moria, Nistari, Kollegal Jawan, Kolar Gold, DNP3 and DNP5 were screened to shortlist superior breeds based on average evaluation indices as per Mano et al. (1993). Five polyvoltine silkworm breeds viz., NP1, ND7, BL68, DNP3 and DNP5 exhibiting higher evaluation index values were utilized as breeding resource materials (Nirupama & Singh, 2007).

Induction of androgenesis in the oviposited eggs was carried out in three different hot air treatments I) at 38 °C for 200 min, II) 40 °C for 135 min and III) 42 °C for 210 min to standardize the procedure(Nirupama & Singh, 2007). Soon after treatment, the eggs were transferred to 15 °C till the appearance of pigmentation in the serosa. Bivoltine and bivoltine × polyvoltine hybrid eggs were treated with hot hydrochloric acid to terminate the egg diapause. Incubation of eggs was done at 25 °C till hatching. The ratio of dark bluish pigmented eggs and total number of eggs treated was expressed as percentage of androgenetic eggs. Nistari, a polyvoltine race possessing dominant gene for golden yellow cocoon colour with marked larvae was utilized as genetic marker to identify androgenetic male individuals. Repeated backcrosses were adopted utilizing the androgenic males. Astaurov (1957) method was followed for the induction of androgenetic development. In order to increase the rate of androgenetic development in the eggs of the polyvoltine hybrid [Nistari × (BL68 × BL69)], the method of Astaurov was modified (Singh et al., 2009b).

Artificial parthenogenesis and silkworm breeding: Five breeding plans were initiated during the course of breeding for the development of homozygous breeds of the silkworm utilizing Chinese and Japanese type bivoltine silkworm breeds as breeding resource materials. Breeds with sex-limited characteristics were kept as genetic marker to identify the parthenogenetic female individuals. Six parthenogenetic lines namely, DNB1 and DNB2 of Chinese type (plain larvae;
oval cocoons) and DNB3, DNB4, DNB6 and DNB7 having Japanese racial characteristics (marked larvae; dumbbell cocoons) were evolved.

**Evaluation of silkworm hybrids:** Six newly developed bivoltine breeding lines viz., DNB1, DNB2, DNB3, DNB4, DNB5 and DNB6 were evaluated with 4 bivoltine breeds namely, CSR3, CSR4, CSR7 and NB4D2. Selection of the silkworm breeds / hybrids was carried out through multiple traits evaluation index method of Mano et al. (1993). The breeds / hybrids showing greater average evaluation index value and evaluation index value for a particular character higher than 50 for more characters were identified as promising. Newly developed 6 breeding lines and 4 popular bivoltine breeds were utilized as lines and testers, respectively. General combining ability of lines and testers and specific combining of bivoltine and polyvoltine × bivoltine hybrids were determined as per Kempthorne (1957).

**Identification of silkworm breeds with high parthenogenetic ability:** Initially, response towards artificial parthenogenesis in bivoltine silkworm breeds was studied (Gangopadhyay & Singh, 2004, 2006a). Among Japanese type bivoltine breeds, CSR19 expressed maximum parthenogenetic development (58.55 %) followed by NB4D2 (51.09 %) and CSR4 (50.85 %). Among Chinese type bivoltine breeds, CSR12 exhibited maximum parthenogenetic development (39.85%) followed by CSR3 (39.25 %) and CSR18 (37.17 %). In order to establish parthenogenetic characters, crosses were made between the breeds possessing higher parthenogenetic ability. Among Japanese type bivoltine hybrid, maximum parthenogenetic development was observed in CSR19 × CSR6 (91.20 %) followed by CSR19 × CSR4 (88.56 %). Hatching % was recorded maximum in CSR19 × CSR4 (78.13 %) followed by CSR19 × CSR6 (51.05 %). Among Chinese type hybrids, maximum parthenogenetic development was observed in CSR18 × CSR12 (81.65 %) followed by CSR3 × CSR17 (60.34 %) Hatching % was maximum in CSR18 × CSR12 (10.57 %) followed by CSR2 × CSR27 (6.78 %). Though, the rate of parthenogenetic development was higher in F1 hybrids; there was no further improvement in the subsequent generations. A new improved method (Gangopadhyay and Singh, 2006b;c) was devised to improve the rate of parthenogenetic development and results were compared with the routine one.

**Development of homozygous silkworm breeds with parthenogenetic origin:** Five breeding plans were initiated for the development of homozygous breeds utilizing Chinese and Japanese type bivoltine breeds as breeding resource materials. Astaurov (1940) method was followed for the induction of artificial parthenogenesis. Breeds with sex-limited characteristics were used as genetic marker to identify the parthenogenetic individuals. Eggs extracted from 30 virgin female moths were individually tested and the egg batch of each female was kept separately. The egg batch showing maximum parthenogenetic development and hatchability was continued further. To achieve a balance between viability and productivity characters in the parthenoclones, two backcrosses were adopted in the earlier generations. Six parthenogenetic lines namely, DNB1 and DNB2 of Chinese type (plain larvae; oval cocoons) and DNB3, DNB4, DNB6 and DNB7 having Japanese racial characteristics (marked larvae; dumbbell cocoons) were developed. Improvement in parthenogeneic development in parthenogenetic lines were observed (Gangopadhyay and Singh, 2006b). Promising lines were evaluated in limited scale (Gangopadhyay & Singh, 2007) Mean performance of two promising lines DNB1 and DNB7 has been given in Table 1.
Assessment of advantages of parthenogenesis: Two bivoltine breeds viz., DNB₁ and DNB₇ and two bivoltine hybrids viz., DNB₁ × CSR₄ and DNB₇ × CSR₂ were found promising based on average evaluation indices. Estimation of GCA revealed superiority of DNB₁ for 8 characters. Less GCA effects in DNB₇ may be due to existence of only females. Two hybrids DNB₁ × CSR₄ and DNB₇ × CSR₂ showed significant SCA effects for 5 - 6 characters. Significant hybrid vigour for pupation rate, yield / 10,000 larvae by weight, cocoon weight, cocoon shell weight, filament length and filament size was observed. The hybrids have shown standard deviation less than 8 and their CV % ranged from 4.04 to 4.96 % (Table 2). DNB₇ × CSR₂ was identified as promising and evaluated along with control CSR₂ × CSR₄ in the Technology Validation and Demonstration Centre, CSRTI, Mysore (Table 3). The hybrid was characterized with high viability, quantitative characters and each kg of cocoons fetched 15 - 20 rupees more than the control.

Genotypic variability of the silkworm breeds developed through DNA fingerprinting: For the assessment of homozygosity, 8 random decamer primers from Operon Technologies Inc., Alameda, USA (OPAA2, OPAA5, OPAH1, OPA5, OPA11, OPA20, OPC4, and OPD2) were tested on 8 individuals each taken from the bisexual line DNB₁, female parthenoclonal lines DNB₆ and DNB₇. No polymorphism in DNA was detected among the individuals randomly selected indicating the attainment of homozygosity in their genetic make-up (Singh et al., 2009c). Further, shared (common) RAPD fragments found in all individuals of DNB lines with fixed frequencies (monomorphic) observed in all investigated primers, imply their close genetic relationships. The RAPD DNA pattern of all the randomly selected individuals belonging to parthenogenetic bisexual line DNB₁ (both male and female) and entirely female parthenoclonal line DNB₇ have shown identical banding pattern clearly suggesting the attainment of homozygosity (Fig. 2). The amplification product with decamer OPA20 revealed 1 band of 1700 base pairs (bp) specific to DNB₇. Thousand two fifty bp bands specific to DNB₆ and DNB₇ appeared in the DNA profile indicate their close genetic relationship. DNB₁ males and females shared 2 bands (1100 and 1000 bp).

Preliminary field trail of promising bivoltine hybrids: Two selected bivoltine hybrids viz., DNB₁ × CSR₄ and DNB₇ × CSR₂ along with control CSR₂ × CSR₄ were further evaluated both in the laboratory and with a few farmers located in Karnataka. Rearing results of 400 dfls each of the selected bivoltine hybrids tested with the farmers recorded an average cocoon yield of 65.450, 69.770 and 60.350 kg / 100 dfls, cocoon weight of 1.789, 1.827 and 1.741 g, cocoon shell weight of 0.371, 0.399 and 0.354 g and cocoon shell percentage of 20.74, 21.85 and 20.35 % in DNB₁ × CSR₄, DNB₇ × CSR₂ and CSR₂ × CSR₄ respectively Gangopadyay et al., 2009; Singh et al., 2009d). Results showed superiority of DNB₇ × CSR₂ over other hybrids both in the laboratory as well as in the field.

Development of homozygous silkworm breeds with androgenetic origin: Twenty six polyvoltine silkworm breeds were screened based on higher average evaluation indices and 5 breeds viz., DNP₅ (59.95), DNP₃ (58.25), NP₁ (55.52), ND₇ (54.42) and BL₆₈ (53.68) possessing higher average evaluation indices were selected for breeding resource materials (Nirupama and Singh, 2007). Treatment of eggs at 38 °C for 200 min, maximum hatching percentage (12.78 %) was observed in the modified method as compared to the (6.36 %) in the routine method. Nistari, a polyvoltine silkworm race possessing marked larvae and golden yellow spindle shaped cocoons was kept as a genetic marker to
identify the androgenetic individuals. Androgenetic individuals were utilized as donors to transmit homozygosity into bisexual lines by a series of backcrosses. Five breeding plans were initiated and five lines \textit{viz.}, AGL1, AGL2, AGL3, AGL4 and AGL5 were developed. Mean performance of selected polyvoltine androgenetic lines namely, AGL3 and AGL5 has been given in Table 4.

**Assessment of advantages of androgenesis:** Five polyvoltine androgenetic lines were evaluated following different statistical analyses like multiple traits evaluation index method (Mano et al., 1993), combining ability and hybrid vigour analysis (Kempthorne, 1957) and cocoon size uniformity test etc. Polyvoltine androgenetic lines \textit{viz.}, AGL1, AGL2, AGL3, AGL4 and AGL5 were evaluated utilizing popular bivoltine breeds namely, CSR2, CSR3, CSR4, CSR12 and NB3D2. Two polyvoltine × bivoltine hybrids AGL3 × CSR2 and AGL5 × CSR2 were found promising based on subordinate function index method, average evaluation indices and cocoon size variability (Nirupama et al., 2008a;b). AGL3 and AGL5 exhibiting significant GCA effects for majority of the characters were good general combiners. Among 30 polyvoltine × bivoltine hybrids, AGL3 × CSR2 and AGL5 × CSR2 expressed highly significant (SCA) effects for fecundity, cocoon yield/10,000 larvae by weight, cocoon weight, cocoon shell weight and cocoon shell percentage (Singh et al., 2010). AGL3 × CSR2 and AGL5 × CSR2 were found promising and manifested highly significant hybrid vigour over MPV and BPV for cocoon yield/10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length and raw silk percentage over the control PM × CSR2. Cocoons of AGL3 × CSR2 and AGL5 × CSR2 were found relatively uniform with their SD < 8 and CV % of 4.23 and 4.09 %, respectively (Table 5). AGL3 × CSR2 and AGL5 × CSR2 were evaluated in the Technology Validation and Demonstration Centre, CSRTI, Mysore along with control PM × CSR2. Data showed that the new hybrids performed better in terms of cocoon yield, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length and raw silk percentage over the control (Table 6).

**Genotypic variability of the silkworm breeds developed through DNA fingerprinting:** For the assessment of homozygosity, 8 random decamer primers from Operon Technologies Inc., Alameda, USA (OPAA2, OPAA5, OPAH1, OPA5, OPA11, OPA20, OPC4, and OPD2) were tested on 8 individuals each taken from androgenetic lines AGL1, AGL2, AGL3, AGL4 and AGL5. No polymorphism in DNA was detected among the individuals randomly selected indicating the attainment of homozygosity in their genetic make-up (Singh et al., 2009c). A total of 28 scorable, discrete amplicons were generated when the template DNA of AGL series (AGL1 to AGL5) were amplified with 7 random primers at an average of 4 bands per primer. The analysis has shown identical RAPD profiles within the inbred lines of AGL series when amplified with OPA11, and OPD2 (Fig. 3) indicating the accomplishment of homozygosity of the lines at the molecular level. The two bands with 1870 and 1650 bp are seen common in all the AGL series analyzed.

Development of silkworm breeds by conventional breeding has played a vital role in upgrading both quality and quantity of silk produced (Datta, 1984). Since most of the quantitative characters in silkworm are governed by polygenes, their inheritance shows variation and therefore, more emphasis is being paid for selection of silkworm breeds based on their phenotypic expression (Nagaraju, 1998). Sometimes, a suitable phenotype may not exhibit a suitable genotype and due to low heritability, the subsequent progeny may lose its unique genotype.
Artificial parthenogenesis enables one to produce from one outstanding
individual hundreds of parthenoclonies each of which is an exact genotypical
copy of its parent (Astaurov, 1957; Strunnikov, 1975). In sexual reproduction,
the offsprings receive only a random half of alleles from each parent and the results
are not predictable accurately (Seidel and Brackett, 1981). Application of new
breeding strategies like parthenogenesis and androgenesis would be beneficial to
the silk industry in the development and cloning of homozygous silkworm breeds
with either entirely females (completely heterozygous) via ameiotic
parthenogenesis or predominantly males (homozygous) via androgenesis to
improve the selection efficiency (Strunnikov, 1983, 1986; Retnakaran & Percy,
1985; Takei et al., 1990). Though, the practical significance of artificial
parthenogenesis and androgenesis has been realized, less attention has been
given to explore the possibility of utilizing these strategies for the development of
silkworm breeds / hybrids found in India. Attempts have been made to develop
superior breeds / hybrids of the silkworm through the application of artificial
parthenogenesis and androgenesis (Singh et al., 2004; Gangopadhyay & Singh,

Response of different silkworm breeds towards parthenogenetic development
has been studied. Among the different bivoltine and polyvoltine breeds, Japanese
type bivoltine silkworm breeds showed pronounced parthenogenetic development
(Gangopadhyay & Singh, 2006a). An increased tendency towards parthenogenesis
was observed in hybrids obtained from a mother moth having a high tendency of
parthenogenesis. Breeds with higher parthenogenetic ability were crossed to
establish parthenogenetic character in the lines. Three bivoltine breeds viz., DNB1,
DNB6 and DNB7 were developed. The bisexual line DNB1 was characterized by
sex-limited characteristics with white oval cocoons while DNB6 and DNB7 were
characterized by entirely female parthenoclonies possessing white dumbbell
cocoons. Hybrids were prepared by crossing the developed silkworm breeds and
productive bivoltine breeds. Evaluation of the developed breeds / hybrids was
carried out through various statistical measures like analysis of combining ability,
hybrid vigour and cocoon size uniformity. Studies showed more combining
ability, hybrid vigour and cocoon size uniformity in the new hybrids.

Induction of androgenesis was performed in different silkworms to select
potential breeds. Polyvoltine hybrids showed higher androgenic development as
compared to bivoltine hybrids. Nistari, a polyvoltine breed possessing dominant
gene for golden yellow cocoon colour with marked larvae was utilized as genetic
marker to identify the androgenic male individual. Females of Nistari were
crossed with the males of the hybrid BL68 × BL69 possessing plain larvae and oval
shaped greenish yellow cocoons. Induction of androgenesis was performed by
exposing the oviposited eggs at hot air of 38 ºC for 200 min. Both marked and
plain larvae were observed. Plain larvae were identified as androgenic individuals.
Sex of the plain larvae at pupal stage was further determined. All the pupae
derived from plain larvae were exclusively males. Backcrossing was adopted
utilizing androgenic males to introgress homozygosity in the breeding lines (Singh
et al., 2009c, 2011). By utilizing dispermic androgenesis, bisexual silkworm lines
have been isolated (Xu et al., 1997). Some bisexual lines of the mulberry
silkworm, B. mori with androgenetic origin have been developed (Nacheva et al.,
1999). Level of homozygosity was assessed in the breeds developed via
parthenogenesis and androgenesis through DNA fingerprinting (Singh et al.,
2009c). Promising polyvoltine breeds and hybrids were short-listed utilizing
different statistical tools (Singh & Nirupama, 2012).
Three bivoltine parthenogenetic lines viz., DNB1, DNB6 and DNB7 along with two polyvoltine androgenetic lines viz., AGL3 and AGL5 were developed. One bivoltine hybrid DNB7 × CSR2 and two polyvoltine × bivoltine hybrids AGL3 × CSR2 and AGL5 × CSR2 were found promising exhibiting significant improvement for various quantitative characters like higher survivability, combining ability, hybrid vigour and more cocoon size uniformity and may be recommended for commercial exploitation to obtain stabilized cocoon crops and better silk quality. The developed bivoltine parthenogenetic and polyvoltine androgenetic breeds can be utilized as breeding resource materials for future breeding programmes. Besides, studies on combining ability, hybrid vigour and phenotypic uniformity would be of immense use to the silkworm breeders to assess the practical significance of artificial parthenogenesis and androgenesis in the development of superior silkworm breeds / hybrids.

LITERATURE CITED


Figure 1. Diagramatic representation of normal zygotic and androgenic development in the silkworm, *B. mori* L. (Singh et al., 2009a).
Figure 2. Identical RAPD profiles of DNB parthenogenetic lines amplified with OPA20 decamer. Arrows indicate 1700 bp product specific to DNB7 line, 1250 bp band specific to DNB6 and DNB7, 1100 & 1000 bp amplified products found in DNB1 males and females (Singh et al., 2009c).

Figure 3. Identical RAPD profiles of AGL androgenetic lines amplified with OPD2 decamer. Arrows indicate 1870 and 1650 bp products common to all the AGL lines (Singh et al., 2009c).

Table 1. Performance of bivoltine parthenogenetic lines.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Fecundity</th>
<th>Fertilization</th>
<th>Pupation rate</th>
<th>Yield 10,000 larvae by wt.</th>
<th>Cocoon wt (g)</th>
<th>Cocoon shell (g)</th>
<th>Filament length (m)</th>
<th>Reliability (%)</th>
<th>Raw silk (%)</th>
<th>Neatness (%)</th>
<th>Ave. evaluation indices</th>
<th>Cocoon size uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNB1</td>
<td>-2.50</td>
<td>-0.64</td>
<td>3.06**</td>
<td>1.19***</td>
<td>0.03</td>
<td>0.02***</td>
<td>44.54***</td>
<td>-2.27</td>
<td>1.34***</td>
<td>0.25**</td>
<td>58.16</td>
<td>166.35±8.22</td>
</tr>
<tr>
<td>DNB2</td>
<td>-5.07</td>
<td>-0.48</td>
<td>3.55</td>
<td>-0.59</td>
<td>0.41</td>
<td>-0.01</td>
<td>0.22</td>
<td>-0.77</td>
<td>-0.90</td>
<td>45.38</td>
<td>171.6±12.11</td>
<td></td>
</tr>
</tbody>
</table>

Data are Mean ± SD of F_2 = F_12.

Table 2. GCA, SCA, Hybrid vigour, average evaluation indices and cocoon size uniformity in promising bivoltine silkworm breeds / hybrids.

<table>
<thead>
<tr>
<th>Breed/ Hybrid</th>
<th>Fecundity</th>
<th>Fertilization</th>
<th>Pupation rate</th>
<th>Yield 10,000 larvae by wt.</th>
<th>Cocoon wt (g)</th>
<th>Cocoon shell (g)</th>
<th>Filament length (m)</th>
<th>Reliability (%)</th>
<th>Raw silk (%)</th>
<th>Neatness (%)</th>
<th>Ave. evaluation indices</th>
<th>Cocoon size uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNB1 × CSR</td>
<td>-13.17</td>
<td>0.02</td>
<td>2.02</td>
<td>0.76**</td>
<td>0.06</td>
<td>0.01**</td>
<td>23.88**</td>
<td>1.11</td>
<td>0.69**</td>
<td>0.76</td>
<td>56.92</td>
<td>167.9±6.68</td>
</tr>
<tr>
<td>DNB2 × CSR</td>
<td>-8.82</td>
<td>-0.24</td>
<td>7.32**</td>
<td>16.93**</td>
<td>0.99**</td>
<td>13.92**</td>
<td>(2.03**)</td>
<td>-1.97</td>
<td>1.62**</td>
<td>1.24**</td>
<td>59.99</td>
<td>163.36±7.96</td>
</tr>
<tr>
<td>DNB1 × CSR</td>
<td>-2.68</td>
<td>(36.62**)</td>
<td>(31.92**)</td>
<td>(2.59)</td>
<td>(1.54)</td>
<td>(5.84)</td>
<td>(20.78**)</td>
<td>(2.97)</td>
<td>(7.10)</td>
<td>(1.47)</td>
<td>(58.99)</td>
<td>(163.36±7.96)</td>
</tr>
</tbody>
</table>

Data in parentheses are hybrid vigour over and parent values; ** and *** denote significant difference at 5%, 1% and 0.1% level respectively.
Table 3. Performance of promising bivoltine hybrids at TVDC (Mean of 3 trials).

<table>
<thead>
<tr>
<th>Hybrids</th>
<th>Coconu wt (g)</th>
<th>Coconu shell wt (g)</th>
<th>Coconu yield/100dfls (kg)</th>
<th>Coconu price/lkg</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNBJ×CSR₂</td>
<td>1.834</td>
<td>0.399</td>
<td>21.75</td>
<td>71.033</td>
</tr>
<tr>
<td>(0.49)</td>
<td>(2.31)</td>
<td>(2.31)</td>
<td>(10.34)</td>
<td>(7.65)</td>
</tr>
<tr>
<td>CSR₂×CSR₄ (Control)</td>
<td>1.825</td>
<td>0.390</td>
<td>21.36</td>
<td>63.690</td>
</tr>
<tr>
<td>(0.49)</td>
<td>(2.31)</td>
<td>(2.31)</td>
<td>(10.34)</td>
<td>(7.65)</td>
</tr>
</tbody>
</table>

Values in parentheses indicate per cent improvement over control.

Table 4. Performance of short listed multivoltine androgenetic lines Data are Mean ± SD of F₀ – F₁₂.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Fecundity (%)</th>
<th>Hatching (%)</th>
<th>Feculation rate (%)</th>
<th>Yield/10000 larvae by wt</th>
<th>Coconu wt (g)</th>
<th>Coconu shell wt (g)</th>
<th>Coconu shell yield (kg)</th>
<th>Filament length (m)</th>
<th>Reelability (%)</th>
<th>Raw silk (%)</th>
<th>Neatness (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGL₂</td>
<td>50.6±3.51</td>
<td>95.4±0.51</td>
<td>92.1±1.35</td>
<td>11.37±0.34</td>
<td>1.23±0.06</td>
<td>0.21±0.00</td>
<td>17.53±0.40</td>
<td>62.3±11.35</td>
<td>77±2.08</td>
<td>12.6±0.17</td>
<td>90±0.00</td>
</tr>
<tr>
<td>AGL₃</td>
<td>49±0±0.07</td>
<td>94.5±0.54</td>
<td>93.3±1.69</td>
<td>11.71±0.47</td>
<td>1.23±0.11</td>
<td>0.22±0.02</td>
<td>17.69±2.43</td>
<td>63±5.03</td>
<td>78±5.53</td>
<td>13.3±0.67</td>
<td>90±0.58</td>
</tr>
</tbody>
</table>

Table 5. GCA, SCA, Hybrid vigour, average evaluation indices and cocoon size uniformity in promising multivoltine silkworm breeds / hybrids.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Fecundity</th>
<th>Hatching</th>
<th>Feculation rate</th>
<th>Yield/10000 larvae by wt</th>
<th>Coconu wt</th>
<th>Coconu shell wt</th>
<th>Coconu shell yield</th>
<th>Filament length</th>
<th>Reelability</th>
<th>Raw silk</th>
<th>Neatness</th>
<th>Average evaluation indices</th>
<th>Cocoon size uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGL₂</td>
<td>46.4***</td>
<td>0.051</td>
<td>0.233</td>
<td>0.423***</td>
<td>0.031**</td>
<td>0.015***</td>
<td>0.505***</td>
<td>9.600</td>
<td>-0.111</td>
<td>0.650**</td>
<td>-0.544</td>
<td>52.90</td>
<td>185.9±0.59</td>
</tr>
<tr>
<td>AGL₃</td>
<td>42.23</td>
<td>0.254</td>
<td>0.227</td>
<td>0.594***</td>
<td>0.046**</td>
<td>0.037***</td>
<td>0.419**</td>
<td>10.033</td>
<td>1.358**</td>
<td>0.460**</td>
<td>1.130***</td>
<td>61.80</td>
<td>183.46±0.64</td>
</tr>
</tbody>
</table>

Specific combining ability effects of lines

<table>
<thead>
<tr>
<th>Breed</th>
<th>Fecundity</th>
<th>Hatching</th>
<th>Feculation rate</th>
<th>Yield/10000 larvae by wt</th>
<th>Coconu wt</th>
<th>Coconu shell wt</th>
<th>Coconu shell yield</th>
<th>Filament length</th>
<th>Reelability</th>
<th>Raw silk</th>
<th>Neatness</th>
<th>Average evaluation indices</th>
<th>Cocoon size uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGL₂×CSR₂</td>
<td>-25.57</td>
<td>0.664</td>
<td>0.722</td>
<td>0.170</td>
<td>0.036**</td>
<td>0.014**</td>
<td>0.382</td>
<td>38.257</td>
<td>1.467</td>
<td>0.593</td>
<td>1.659**</td>
<td>65.25</td>
<td>167.4±7.08</td>
</tr>
<tr>
<td></td>
<td>(-7.50)</td>
<td>(1.02)</td>
<td>(-3.22)</td>
<td>(46.62**)</td>
<td>(37.67**)</td>
<td>(50.12**</td>
<td>(11.43**)</td>
<td>(30.68**)</td>
<td>(-0.20)</td>
<td>(9.69**)</td>
<td>(-0.18)</td>
<td>(5.3±0.29)</td>
<td>161.7±6.62</td>
</tr>
<tr>
<td>AGL₃×CSR₂</td>
<td>31.12**</td>
<td>0.154</td>
<td>0.016</td>
<td>1.370***</td>
<td>0.114***</td>
<td>0.030***</td>
<td>0.518</td>
<td>32.457</td>
<td>2.100</td>
<td>0.253</td>
<td>-0.076</td>
<td>68.52</td>
<td>161.7±6.62</td>
</tr>
<tr>
<td></td>
<td>(8.21)</td>
<td>(0.35)</td>
<td>(3.12)</td>
<td>(53.90**)</td>
<td>(39.31**)</td>
<td>(50.57**)</td>
<td>(9.46**)</td>
<td>(29.97**)</td>
<td>(1.00)</td>
<td>(8.42**)</td>
<td>(-0.18)</td>
<td>(4.2±0.88)</td>
<td>161.7±6.62</td>
</tr>
</tbody>
</table>

Data in parentheses are hybrid vigour over mid parent value; *, ** and *** denote significant difference at 5%, 1% and 0.1% level respectively.

Table 6. Performance of promising multivoltine × bivoltine hybrids in TVDC (Mean of 3 trials).

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Coconu wt (g)</th>
<th>Coconu shell wt (g)</th>
<th>Coconu shell yield (%)</th>
<th>Yield/100dfls (kg)</th>
<th>Coconu rate / (Rt.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGL₂×CSR₂</td>
<td>1.806 (5.92)</td>
<td>0.364</td>
<td>20.15</td>
<td>71.945</td>
<td>13.76</td>
</tr>
<tr>
<td>AGL₃×CSR₂</td>
<td>1.879 (10.21)</td>
<td>0.383</td>
<td>20.38</td>
<td>76.359</td>
<td>13.07</td>
</tr>
<tr>
<td>PM×CSR₂</td>
<td>1.705 (11.34)</td>
<td>0.318</td>
<td>18.85</td>
<td>60.643</td>
<td>11.43</td>
</tr>
</tbody>
</table>

Values in parentheses indicate per cent improvement over control.
CHECKLIST OF THE GENUS *LEPTOMIAS* FAUST (COLEOPTERA: CURCULIONIDAE: ENTIMINAE) OF THE WORLD

G. Mahendiran* and V. V. Ramamurthy*

*National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, Pusa Campus, New Delhi-110012, INDIA. E-mails: mahi.iari@gmail.com and vvr3@vsnl.com


ABSTRACT: The paper to be published is based on an annotated checklist of *Leptomias* Faust (Entiminae: Curculionidae: Coleoptera) comprising 131 species with their updated nomenclature, synonyms and distribution. The analysis indicates that the genus is predominantly distributed in Oriental region. China (including Tibet) and India are the areas where the genus is well known, particularly the Himalayan and Sub-Himalayan regions. Currently, China is the single largest country with 81 species, followed by India with 35 species of *Leptomias*.

KEY WORDS: *Leptomias*, checklist, synonyms, distribution.

Weevils are among the most important insect herbivores and their species diversity is well documented worldwide, particularly in the tropics (Anderson, 1993, 1995; Farrell, 1998). The family Curculionidae comprises about 4600 genera and 51000 described species. It is larger than any other in weevils and comprises more than 80% of all weevil species (Oberprieler et al., 2007). The broad nosed weevils of the subfamily Entiminae, with more than 12000 described species form the largest group of weevils and they are distributed world-wide, mostly in tropical regions. The Entiminae includes many serious agriculturally important pests (Yunakov & Nadein, 2006). *Leptomias* Faust is one of the important genera within the tribe Tanymecini (Entiminae: Curculionidae). *Leptomias* Faust was first described by Faust (1886) with *Pachynotus angustatus* Redtenbacher as the type species. Marshall (1916) studied the genus and provided a key to species from the Oriental region. He referred the generic names *Heteromias* Faust and *Parisomias* Faust as synonyms of *Leptomias* Faust. Gunther & Zumpt (1933) added *Cneorrhinus* Redtenbacher also in the list of synonyms of *Leptomias* Faust. The genus was redefined by Aslam (1961) and Chen (1991) based on their finding from Indo-Pakistan region and China, respectively. Apart from the work of Gandhi & Pajni (1988a,b, 1989), who described four species from India no notable work has come out from India and adjacent countries. As far as its economic importance is concerned, the species *Leptomias nigroguttatus* Gandhi & Pajni has been reported as a pest of beans in Jammu and Kashmir (Gandhi & Pajni, 1988a). Moreover, no comprehensive studies have been undertaken during recent times.

MATERIAL AND METHODS

This checklist is mainly based on available literature rather than on extensive taxonomic studies. It has been compiled mainly with the aid of Zoological Record (Insecta), Coleopteran Catalogues and original descriptions, whenever available.
RESULTS AND DISCUSSION

Annotated checklist of *Leptomias* of the world

(Table 1)

Genus *Leptomias* Faust

*Leptomias* Faust, 1886: 132

*Heteromias* Faust, 1897: 344; Marshall, 1916: 172

*Parisomias* Faust, 1897: 342; Marshall, 1916: 172

*Cneorrhinus* Redtenbacher, 1844: 543 (nec *Cneorhinus* Schoenherr, 1823); Gunther & Zumpt, 1933

*Neoleptomias* Voss, 1961: 183

Type: *Pachynotus angustatus* Redtenbacher, 1844

An analysis of the fauna described by the different coleopterists indicates that Chao & Chen (1980–1992) contributed by far the most extensive work on *Leptomias*. They have described 66 species including a few subspecies from China (including Tibet). Faust (16 species), Aslam (15 species) Marshall (14 species) and Voss (11 species) were the other important contributors on the genus. Gandhi & Pajni (1988–89) described four new species with genitalia description from India. Hoffman (1963), Bajfenov (1980), Zumpt (1937), Redtenbacher (1944) and Hustache (1928) (one species each) were the other contributors in the field.

The zoogeographical distribution of the genus indicates that it predominantly exists in Oriental region. China (including Tibet) and India are the areas, where the genus is well known, particularly the Himalayan and Sub-Himalayan regions. China is the largest single region contributing with 81 species. From India, 35 species have been recorded, mainly in the states of Jammu and Kashmir, Uttarakhand, Himachal Pradesh and Sikkim.

While a great deal of taxonomic work is needed, a review of existing literature is necessary to facilitate future studies on the genus. Hence, in the present study an attempt has been made on preparation of checklist of world species of the genus *Leptomias* Faust. It includes 131 species with current updated valid names including synonyms and distribution. Synonyms are listed under their respective alphabetical order too. The names of the subgenera, if any, are given in parentheses after species name. Species previously included in the genus but now placed in the other genera are also included in the alphabetical order but neither numbered nor given distribution.

LITERATURE CITED


Chen, Y. Q. 1991. A Revision of *Leptomias* Faust and description of New Genera and New Species from Xizang, China (Coleoptera: Curculionidae). Sinozoologia, 8: 257-262 (Chinese); 263-266 (English).


Voss, E. 1940. Einige Russlerarten aus Turkestanz und Mandschukuo (Coleoptera: Curculionidae). Entomologische Blatter, 36: 49-52.


Table 1. Annotated checklist of *Leptomias* of the world.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Species</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>acuminatus</em> Aslam, 1961: 333</td>
<td>Tibet, China</td>
</tr>
<tr>
<td>2.</td>
<td><em>acutus</em> Aslam, 1961: 328</td>
<td>Tibet, China</td>
</tr>
<tr>
<td>2a.</td>
<td><em>acutus zayuensis</em> Chao in Chao and Chen, 1981: 538</td>
<td>Tibet, China</td>
</tr>
<tr>
<td>4.</td>
<td><em>alternans</em> Chao in Chao and Chen, 1980: 100</td>
<td>China</td>
</tr>
<tr>
<td></td>
<td><em>amplicollis</em> Chao in Chao and Chen, 1981: 534 see <em>schoenherri</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>amplifrons</em> Chao in Chao and Chen, 1981: 541 transferred to <em>Xizanomias magnus</em> Chao, 1980; Chen, 1991: 266</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td><em>argenteus</em> Hoffmann, 1963: 80</td>
<td>Iraq</td>
</tr>
<tr>
<td>9.</td>
<td><em>audax</em> Faust, 1886: 134</td>
<td>India</td>
</tr>
<tr>
<td>12.</td>
<td><em>bipustulatus</em> Faust, 1897: 342</td>
<td>India</td>
</tr>
<tr>
<td>15.</td>
<td><em>brevicornutus</em> Chao in Chao and Chen, 1981: 540</td>
<td>Tibet, China</td>
</tr>
<tr>
<td>16.</td>
<td><em>chagyabensis</em> Chao and Chen, 1981: 542</td>
<td>Tibet, China</td>
</tr>
<tr>
<td>17.</td>
<td><em>chaoi</em> Chen, 1983: 401</td>
<td>China</td>
</tr>
<tr>
<td>18.</td>
<td><em>clarus</em> Chao in Chao and Chen, 1980: 98</td>
<td>China</td>
</tr>
<tr>
<td>19.</td>
<td><em>clavellatus</em> Chen, 1992: 850</td>
<td>China</td>
</tr>
<tr>
<td>20.</td>
<td><em>clavicus</em> Marshall, 1955: 147</td>
<td>India</td>
</tr>
<tr>
<td>21.</td>
<td><em>clavipes</em> (Faust, 1897) <em>Heteromias clavipes</em> Faust, 1897: 345; Gunther and Zumpt, 1933</td>
<td>Mongolia, China</td>
</tr>
<tr>
<td>No.</td>
<td>Species</td>
<td>Location</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------</td>
<td>---------------------------------</td>
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<tr>
<td>22.</td>
<td><em>costatus</em> (Faust, 1897)</td>
<td>India</td>
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<td>23.</td>
<td><em>crinitarsus</em> Aslam, 1961: 326</td>
<td>Tibet, China</td>
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<td>25.</td>
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<td>Tibet, China</td>
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<td>27.</td>
<td><em>discaris</em> Chao in Chao and Chen, 1980: 98 transferred to <em>Triangulomias</em>: Chen, 1991: 264</td>
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<tr>
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<td><em>elongatoides</em> Chen, 1987: 411</td>
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<td>30.</td>
<td><em>elongitus</em> Chao in Chao and Chen, 1981: 543</td>
<td>Tibet, China</td>
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<td><em>errans</em> Faust, 1887: 158</td>
<td>Central Asia</td>
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<td>32.</td>
<td><em>errectus</em> Chao in Chao and Chen, 1981: 539</td>
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<td>33.</td>
<td><em>ferganensis</em> Bajtenov, 1980: 127</td>
<td>Kyrgyzstan</td>
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<td>35.</td>
<td><em>foveolatus</em> Chao in Chao and Chen, 1981: 536</td>
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<td><em>globicollis</em> Aslam, 1961: 332</td>
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<td>38.</td>
<td><em>globosus</em> Chen, 1987: 412</td>
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<td>39.</td>
<td><em>granulatus</em> Chao, 1980: 30</td>
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<td><em>griseus</em> Chao, 1980: 30</td>
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<td>Tibet, China</td>
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<td>Tibet, China</td>
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<tr>
<td>45.</td>
<td><em>includens</em> Voss, 1970: 448</td>
<td>Nepal</td>
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<tr>
<td>46.</td>
<td><em>indicus</em> Gandhi and Pajni, 1988b: 235</td>
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<td>47.</td>
<td><em>inquinatus</em> Voss, 1959: 87</td>
<td>Afghanistan</td>
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<td>invidus Faust, 1886</td>
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<td>48</td>
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<td>Eutinopus irrisus Faust, 1890: 434; Zumpt, 1931: 124</td>
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<td>jekeli Faust, 1886</td>
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<td>50</td>
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<td>kangmarenensis Chao in Chao and Chen, 1981</td>
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<td>52</td>
<td>kashmirensis Aslam, 1961</td>
<td>337</td>
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<td>53</td>
<td>kingdomwardi Marshall, 1955</td>
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<td>54</td>
<td>korbi Pic, 1905</td>
<td>98 see humalis</td>
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<td>laoshanensis Chao, 1980</td>
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<td>lineatus Aslam, 1961</td>
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<td>lineostriatus Gandhi and Pajni, 1988b</td>
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<td>79</td>
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<td>parvilatus Chen, 1983</td>
<td>401 transferred to type species of</td>
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<td>Authorities</td>
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<td>-------------</td>
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<td><em>Leptomias pilosus</em></td>
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<td><em>pinnatus</em> Chen in Chao and Chen, 1981: 530</td>
<td><em>Leptomias pilosus</em></td>
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<td><em>Leptomias qomolangmaensis</em></td>
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<td>91.</td>
<td><em>ramosus</em> Chen in Chao and Chen, 1981: 531</td>
<td><em>Leptomias ramosus</em></td>
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<td>92.</td>
<td><em>rubiginosus</em> Chen, 1983: 402</td>
<td><em>Leptomias rubiginosus</em></td>
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<td>93.</td>
<td><em>sabulosus</em> Faust, 1897</td>
<td><em>Leptomias sabulosus</em> Faust, 1897: 341; <em>Parisomias sabulosus</em> Aslam, 1961: 321; <em>Leptomias sabulosus</em> Chao and Chen, 1980: 105 (implicit combination, as they synonymised <em>Parisomias</em> back into <em>Leptomias</em>)</td>
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<td>94.</td>
<td><em>sagaensis</em> Chen, 1981: 531</td>
<td><em>Leptomias sagaensis</em></td>
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<td>97.</td>
<td><em>semicircularis</em> Chao in Chao and Chen, 1981: 538</td>
<td><em>Leptomias semicircularis</em></td>
</tr>
<tr>
<td>98.</td>
<td><em>seriatosetulus</em> Voss, 1940: 50</td>
<td><em>Leptomias seriatosetulus</em></td>
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<tr>
<td>101.</td>
<td><em>simulans</em> Chao in Chao and Chen, 1981: 541 see <em>tsanghoensis</em></td>
<td><em>Parisomias simulans</em></td>
</tr>
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<td>No.</td>
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<td>102</td>
<td>squamosetosus</td>
<td>Chao and Chen, 1981: 539</td>
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<td>103</td>
<td>stoliczkae</td>
<td>Faust, 1886: 137</td>
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<td>104</td>
<td>strictus</td>
<td>Chen in Chao and Chen, 1981: 533</td>
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<td>105</td>
<td>stultus</td>
<td>Faust, 1897: 340</td>
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<td>106</td>
<td>subaeues</td>
<td>Chen in Chao and Chen, 1981: 527</td>
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<td>107</td>
<td>sublongicollis</td>
<td>Chen, 1987: 411</td>
</tr>
<tr>
<td>108</td>
<td>submidlineatus</td>
<td>Chen, 1988: 367</td>
</tr>
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<td>109</td>
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<td>Chen, 1988: 367</td>
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<td>110</td>
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<td>Marshall, 1916</td>
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<td>111</td>
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<td>Chen, 1992: 851</td>
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<td>112</td>
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<td>Chen, 1992: 850</td>
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<td>113</td>
<td>thibetanus</td>
<td>Faust, 1888 Heteromias thibetanus Faust, 1888: 285; 1890: 437</td>
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<td>114</td>
<td>transversicollis</td>
<td>Voss, 1940: 49</td>
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<td>115</td>
<td>trianguloplatas</td>
<td>Chao in Chao and Chen, 1980: 98 transferred to type species of Triangulomias Chen, 1991: 264</td>
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<td>116</td>
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<td>Chao and Chen, 1981: 527</td>
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<td>117</td>
<td>trilineatus</td>
<td>Chao and Chen, 1980: 99</td>
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<tr>
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<td>Chao in Chao and Chen, 1980: 99</td>
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<td>Chen, 1984: 105</td>
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<td>Marshall, 1955: 147</td>
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<td>Chen, 1983: 402</td>
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<td>122</td>
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<td>Chen, 1987: 411</td>
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<td>123</td>
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<td>Faust, 1886: 138</td>
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<td>124</td>
<td>viridicantis</td>
<td>Chen, 1988: 367</td>
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<td>125</td>
<td>viridilinearis</td>
<td>Chen, 1984: 105</td>
</tr>
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<td>126</td>
<td>viridirostris</td>
<td>Voss, 1961: 185 (Leptomias)</td>
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<td>127</td>
<td>waltersi</td>
<td>Aslam, 1961: 333</td>
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<td>128</td>
<td>wenchuanensis</td>
<td>Chen, 1992: 851</td>
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<tr>
<td>129</td>
<td>yuhuensis</td>
<td>Chen, 1992: 850</td>
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<td>130</td>
<td>yulogshanensis</td>
<td>Chen, 1992: 850</td>
</tr>
<tr>
<td>131</td>
<td>zheduoshanensis</td>
<td>Chen, 1992: 851</td>
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EFFECT OF DIFFERENT NUTRITIONAL CONDITIONS OF SILKWORM BOMBYX MORI (LEPIDOPTERA: BOMBYCIDAE) ON ITS SUSCEPTIBILITY TO BEAUVERIA BASSIANA (HYPHOMYCETES: MONILIALES)

Kuniyil Chandrasekharan* and Byrappa Nataraju

* Silkworm Pathology Section, Central Sericultural Research and Training Institute, Mysore, Karnataka, INDIA. E-mail: kchandrasekharan@rediffmail.com


ABSTRACT: Effect of nutritional conditions of silkworm Bombyx mori on the susceptibility to Beauveria bassiana was studied and discussed in this paper. There was significant difference in the susceptibility of silkworm to B. bassiana when the nutritional conditions of silkworm were changed. Feeding with V1 variety mulberry leaves increased the susceptibility of silkworm to the fungus. Feeding silkworm with tender leaves also increased the susceptibility of silkworm to B. bassiana. The LT50 value was 6.18 days when tender leaves were provided and it was 6.34, 6.62 and 6.59 days with medium, matured and normal leaves, respectively. Feeding with tree mulberry leaves resulted in less mortality when compared to the others.

KEY WORDS: Beauveria bassiana, Bombyx mori, nutritional condition, susceptibility.

Muscardines caused by fungal pathogens are the most virulent and contagious diseases which occur throughout the sericultural areas of the world (Steinhaus, 1949). White muscardine caused by Beauveria bassiana (Bals.) Vuill. is one of the most common silkworm diseases which are predominant during rainy and winter seasons in India. The loss due to white muscardine varies from 5 to 50 % in different countries (Jayaramaiah & Kuberappa, 1987). Selvakumar et al. (2002) reported that incidence of muscardine was high during rainy (17.96 %) and winter (17.36 %) seasons. A variety of factors may determine or influence the susceptibility of a host to infection by B. bassiana. These include the fungal strain, the host’s physiological state, age, nutrition, genetics, exposure to injuries, defense mechanisms and a number of other diverse factors such as the environment. The susceptibility of silkworm to most of the pathogens is controlled by poly genes. Due to this, this character is prone to modification by external factors such as food, temperature and chemicals.

The susceptibility of silkworm to most of the pathogens is controlled by poly genes. Due to this, this character is prone to modification by external factors such as food, temperature and chemicals. There is some evidence indicating that the food quality influences the susceptibility of silkworm to viral infections. Silkworm reared on the artificial diet with mulberry leaf powder was more resistant to infection than the one without mulberry leaf powder (Matsubara & Hayashiya, 1969). They also indicated that silkworms reared on the artificial diet containing mulberry leaf powder from the spring season were more tolerant to infection than that containing leaf powder of autumn. Silkworms fed with artificial diet containing low protein; sucrose and high cellulose tend to have increased...
susceptibility to viral infections (Watanabe & Imanishi, 1980). The diet with low protein lowered the protease level in the gut juice of silkworm resulting in low anti-viral activity (Watanabe et al., 1989).

Mulberry (Morus spp.) leaves constitute the only food source to the silkworm Bombyx mori. There are different varieties of mulberry cultivated in India for rearing mulberry silkworm. The quality of mulberry leaf varies according to the variety, season, age of the plant and height of the plant. When poor quality leaves are provided to silkworm they become undernourished and such silkworms will be more susceptible to the pathogens. Nutritional effect on the disease development and cocoon traits in silkworm was studied by Mareppa et al. (1999) with respect to BmNPV and Bhaskar et al. (1999) with respect to BmCPV and found significant influence. Selvakumar et al. (2005) also studied on the influence of environmental and nutritional factors on the development of flacherie disease in silkworm.

In the present paper influence of mulberry leaf quality on the susceptibility of silkworm to the fungal pathogen B. bassiana is discussed.

**MATERIALS AND METHODS**

Influence of mulberry leaf quality on the susceptibility of silkworm to B. bassiana, was studied in three experiments. Larvae of a popular bivoltine silkworm hybrid (CSR2 × CSR4) were used for the experiments. B. bassiana was cultured in Petri plates using Sabouraud’s dextrose agar. Conidia were harvested by brushing the surface of three week-old culture into a 500 ml glass beaker containing 50 ml sterile distilled water using a sterile camel hair brush. A drop of tween-20 was added to the beaker containing distilled water and conidia to keep the conidia dispersed. The conidial suspension was prepared by mixing the solution using a magnetic stirrer for 5 minutes and its concentration was determined based on counts made with an improved Neubauer haemocytometer. The required concentration of B. bassiana inoculum (1 × 10^5 conidia/ml) was prepared by suitably diluting the stock inoculum with sterilised distilled water.

In the first experiment, the effect of feeding mulberry leaves from three different mulberry varieties was studied. Mulberry varieties V1, S36 and K2 were used for the study. Newly ecdysed fourth instar larvae (out of third moult) were counted (100 each) and topically inoculated by dipping them in B. bassiana inoculum suspension of 1 × 10^5 conidia/ml concentration. The inoculated larvae were then reared separately by providing mulberry leaves of the three varieties in plastic rearing trays (90 cm × 60 cm). High relative humidity (95±5 % RH) was provided by keeping wet foam pads in the rearing trays and a temperature of 25±1ºC was maintained in the rearing room. Three replications were maintained for each feed schedule. Muscardine incidence was recorded for ten days post inoculation. LT_{50} and LT_{90} values were calculated for each feed schedule following probit analysis (Finney, 1971).

Similar experiments were conducted with four different maturities of leaves (tender, medium, matured and normal) and also with mulberry leaves from different sources (tree leaves, bush leaves and shade leaves). Each treatment had 3 replications and 100 larvae were kept per replication. The mortality due to muscardine was recorded every day post inoculation on daily basis and LT_{50} and LT_{90} was calculated for each treatment following probit analysis (Finney, 1971).
RESULTS

Influence of feeding three different mulberry varieties on the susceptibility of silkworm to *B. bassiana* is presented in Table 1. It is observed that mortality due to white muscardine was comparatively less up to 8 DPI (71.67%) when the larvae were fed with K2 variety mulberry leaves. The feeding of V1 variety resulted in maximum mortality (100%) followed by S36 (89%) by 8 DPI. However, by 9 DPI, feeding on different varieties of mulberry resulted in 100% mortality due to muscardine.

Results of feeding leaves of different maturity viz., tender, medium and matured leaf vis-à-vis normal leaves on the susceptibility of silkworm to *B. bassiana* are presented in Table 2. Mortality started appearing on 5 DPI and 100% mortality was recorded by 8 or 9th day in the last three treatments while it was on 7 PDI when fed with tender leaves. The LT$_{50}$ value was 6.18 days when tender leaves were provided. It was 6.34, 6.62 and 6.59 with medium, matured and normal leaves, respectively. The LT$_{90}$ value varied between 8.07 and 8.65 days in the different batches.

Observations made on feeding mulberry leaves from different sources i.e., tree, shade grown plants and mulberry grown in the form of bush on the susceptibility of silkworm to *B. bassiana* are presented in Table 3. It is observed that leaves from tree mulberry resulted in less mortality by 8 DPI (74.07%) than from the others. However by 9 DPI, 100% mortality due to muscardine was recorded, irrespective of quality of mulberry fed. The LT$_{50}$ value with tree leaf was 6.88 days and with shade and bush leaves it was 6.42 and 6.55 days, respectively.

DISCUSSION

Stressed hosts are more susceptible to entomopathogens than non-stressed hosts (Steinhaus, 1958; Vago, 1963). Stresses brought about by malnutrition, metabolic imbalances, physical and other factors may result in infection by potential pathogens or by the activation of chronic to acute infection. Certain stresses may enhance the chronic infection or activate latent (occult viral infections).

In the present study there was significantly reduced mortality up to 8 DPI when the larvae were fed with K2 variety mulberry leaves. The V1 variety feeding resulted in maximum mortality followed by S36 after 8 days of inoculation. However, in all the varieties 100% mortality was observed by 9 days post inoculation. Here, the difference in the humidity conditions in these varieties might have influenced the difference in mortality. It is well known that the V1 variety is superior in nutritional point of view to silkworm (Sarkar et al., 2000). But its leaf moisture content was high and also it retains leaf moisture for longer periods. This may enhance the bed humidity facilitating fast growth of the fungus. Declining nutrient and water content in the mature foliage of perennial plants was reported to reduce the growth rates of lepidopteran larvae compared with those of closely related species feeding on younger leaves or the foliage of herbaceous plants (Krischik & Denno, 1983). It has also been reported that high protein concentrations in an insect’s diet can counter balance the toxic effect of secondary metabolites, such as alkaloids (Costa & Gaugler, 1989).

The effect on feeding leaves of different maturity leaves viz., tender, medium and matured leaves revealed that mortality was very fast with tender leaves when compared to other quality leaves. The LT$_{50}$ value was low when tender leaves were provided, which was followed by medium, matured and normal leaves
respectively. Usually the tender leaves which contain high moisture are provided to young age worms (80-85 %). Medium leaves contain 65 to 70 % leaf moisture and mature leaves contain 55 to 60 % moisture. The tender leaves with high moisture content when fed to fifth instar larvae may grow faster (Rahamathulla et al., 2004) but it will increase the bed humidity to higher levels. This predisposes to B. bassiana infection at a greater rate. The concentration of secondary metabolites in plants is said to be higher in young leaves than in older leaves, but older leaves contain fewer nutrients (i.e. nitrogen and water) (Fenny, 1992).

The effect of feeding mulberry leaves from different sources i.e. tree leaves, shade grown leaves and bush leaves, on the muscardine disease development indicated that the tree leaves induced less mortality when compared to the others. The LT50 value with tree leaf was more. The plants growing under shade produce thin leaves with low dry matter content due to low photosynthetic activity (Nagarjunaiah, 1976). As reported by Balakrishna et al. (1999) shading creates a stress environment for mulberry and all the parameters were decreased when it was grown in shade.

Nutrition is a very important factor regulating the susceptibility of insects to entomopathogens and inadequate nutrition often leads to its increased susceptibility. Conversely, diet can also decrease the susceptibility of insect pests to entomopathogensc Hyphomycetes. Ekesi et al. (2000) reported that thrips (Megalurothrips sjostedti as less susceptible to Metarhizium anisopliae on certain cow- pea cultivars because of plant derived fungistatic compounds.

ACKNOWLEDGEMENT

The authors are thankful to the Director, Central Sericultural Research and Training Institute, Mysore and also to the colleagues in Silkworm Pathology section of the Institute.

LITERATURE CITED


Table 1. Influence of feeding leaves of different mulberry varieties on the susceptibility of silkworm to *B. bassiana*.

<table>
<thead>
<tr>
<th>Mulberry variety</th>
<th>Cumulative mortality due to white muscardine in days after inoculation (%)</th>
<th>LT&lt;sub&gt;50&lt;/sub&gt; (Days)</th>
<th>LT&lt;sub&gt;90&lt;/sub&gt; (Days)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>V1</td>
<td>5.67 ±1.55</td>
<td>30.33 ±4.04</td>
<td>55.33 ±3.52</td>
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<tr>
<td>S36</td>
<td>4.67 ±1.528</td>
<td>29.33 ±2.517</td>
<td>50.67 ±2.082</td>
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<td>K2</td>
<td>2.67 ±0.577</td>
<td>22.00 ±3.606</td>
<td>39.33 ±1.528</td>
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<tr>
<td>SE±</td>
<td>0.94</td>
<td>2.82</td>
<td>2.06</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>2.31</td>
<td>6.89</td>
<td>5.03</td>
</tr>
</tbody>
</table>

Table 2. Influence of feeding leaves of different maturity on the susceptibility of silkworm to *B. bassiana*.

<table>
<thead>
<tr>
<th>Leaf maturity</th>
<th>Cumulative mortality due to white muscardine in days after inoculation (%)</th>
<th>LT&lt;sub&gt;50&lt;/sub&gt; (Days)</th>
<th>LT&lt;sub&gt;90&lt;/sub&gt; (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Tender</td>
<td>12.00 ±2.00</td>
<td>42.00 ±3.00</td>
<td>100.00 ±0.00</td>
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<tr>
<td>Medium</td>
<td>7.67 ±1.53</td>
<td>34.00 ±2.00</td>
<td>84.67 ±2.52</td>
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<tr>
<td>Mature</td>
<td>4.67 ±0.58</td>
<td>23.67 ±2.52</td>
<td>52.00 ±3.00</td>
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<tr>
<td>Normal</td>
<td>5.00 ±1.00</td>
<td>29.00 ±1.00</td>
<td>57.67 ±3.06</td>
</tr>
<tr>
<td>SE±</td>
<td>1.13</td>
<td>1.84</td>
<td>2.03</td>
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<tr>
<td>CD at 5%</td>
<td>2.61</td>
<td>4.25</td>
<td>4.68</td>
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Table 3. Influence of feeding mulberry leaves from different sources on the susceptibility of silkworm to *B. bassiana*.

<table>
<thead>
<tr>
<th>Mulberry type</th>
<th>Cumulative mortality due to white muscardine in days after inoculation (%)</th>
<th>LT&lt;sub&gt;50&lt;/sub&gt; (Days)</th>
<th>LT&lt;sub&gt;90&lt;/sub&gt; (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Tree</td>
<td>3.67 ±0.58</td>
<td>24.33 ±3.22</td>
<td>42.00 ±3.00</td>
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<tr>
<td>Shade grown</td>
<td>6.00 ±2.00</td>
<td>35.00 ±3.00</td>
<td>72.33 ±3.06</td>
</tr>
<tr>
<td>Bush</td>
<td>5.00 ±1.00</td>
<td>32.33 ±3.06</td>
<td>57.33 ±2.52</td>
</tr>
<tr>
<td>SE±</td>
<td>1.09</td>
<td>2.52</td>
<td>2.34</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>2.66</td>
<td>6.18</td>
<td>5.73</td>
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ARANEO-FAUNA OF KEMALİYE (ERZİNCAN) FROM TURKEY

Tuncay Türkeş* and Hayriye Karabulut*

* Department of Biology, Faculty of Science and Arts, Niğde University, TR–51100 Niğde, TURKEY. E-mail: tuncayturkes@nigde.edu.tr


ABSTRACT: In this study, Araneae fauna of Kemaliye was investigated. In Kemaliye, 132 species belonging to 69 genera within 24 families were confirmed to occur. Of these species, 1 species (Nigma flavescens (Walckenaer, 1830) of Dictynidae, 1 species (Asianellus festivus (C. L. Koch, 1834)) of Salticidae, 1 species (Zoropsis oertzeni Dahl, 1901) of Zoropsidae are new records for Turkish araneo-fauna.

KEY WORDS: Arachnida, Araneae, Fauna, Kemaliye, Turkey.

Kemaliye is located to upper Euphrates River in the East Anatolia Region. Although average altitude of the East Anatolia Region is about 1300 m, altitude of the Kemaliye changes from 600 to 3500 m. Both the Siberian and the Mediterranean climates are dominant in a confined area. As a result of the being on the Anatolian Diagonal, which causes biological separation of continents, both composition of the flora and fauna of the Kemaliye is diverse, plentiful and interesting. For these reasons Kemaliye a privileged position in terms of biodiversity.

MATERIALS AND METHODS

This study was carried out through 2005-2007. Spiders were collected using aspirator from among leaves and stems of plants, fallen leaves in forests, on ground, algae upon rocks, soil cracks, stones, boulders and tree bark. They were preserved in 70% ethanol. Examined specimens were deposited in the NUAM. The identification was made by means of a SZ-61 Olympus stereomicroscope, depending on the keys of Heimer & Nentwig (1991) and Roberts (1995) were used.

RESULTS

FAM.: SCYTODIDAE Blackwall, 1864
Scytodes thoracica (Latreille, 1802)
Distribution in world: Holarctic (Platnick, 2013). Distribution in Turkey: Central Anatolia Region, East Anatolia Region, Mediterranean Region, Southeast Anatolian Region (Topçu et al., 2005).

FAM.: PHOLCIDAE C. L. Koch, 1851
Hoplopholcus cecconii Kulczyn'ski, 1908
Material examined: The road of Kabataş, Ala Cave, 03.06.2007, 3 ♀♂, 2 ♂♂, leg. T. Türkeş.
Distribution in world: Turkey, Israel, Lebanon (Platnick, 2013). Distribution in Turkey: Marmara Region, Central Anatolia Region (Topçu et al., 2005).

Holocnemus pluchei (Scopoli, 1763)
Material examined: Kemaliye (centre), 05.07.2006, 3 ♀♂; - Yuva Köy, 04.07.2005, 1 ♂, 740 m., leg. T. Türkeş.

**Pholcus opilionoides** (*Schrank, 1781*)
Material examined: Kemaliye (centre), 05.07.2006, 1 ♂; -Subatan, 04.24.2007, 1 ♀, 37°45′N, 43°40′E, 1661 m., leg. T. Türkeş.

**Pholcus phalangioides** (*Fuesslin, 1775*)
Material examined: Kemaliye (centre), 05.07.2006, 2 ♀♀, 1 ♂; -Kırkgöz, 1 ♀, 17.05.2006, 37°45′N, 43°44′E, 1184 m., leg. T. Türkeş.
Distribution in world: Cosmopolitan (Platnick, 2013). Distribution in Turkey: Marmara Region, Aegean Region, Middle Black Sea Region, Mediterranean Region, Central Anatolia Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

FAM.: **PALPIMANIDAE** *Thorell, 1870*

**Palpimanus gibbulus** (*Dufour, 1820*)
Distribution in world: Mediterranean, Central Asia (Platnick, 2013). Distribution in Turkey: Aegean Region, Mediterranean Region, Central Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

FAM.: **ERESIDAE** *C. L. Koch, 1851*

**Eresus kollari** (*Rossi, 1846*)
Material examined: Geşo Beli, 08.07.2006, 1 ♀, 37°46′N, 43°47′E; -Dutluca, 24.04.2007, 1 ♀, 37°46′N, 43°31′E, leg. T. Türkeş.
Distribution in world: Palearctic (Platnick, 2013). Distribution in Turkey: Central Anatolia Region, Mediterranean Region (Topçu et al., 2005).

FAM.: **OECOBIIDAE** *Blackwall, 1862*

**Uroctea durandi** (*Latreille, 1809*)
Material examined: Salihli village, 09.07.2006, 1 ♀; -Geşo Beli, 08.07.2006, 2 ♀♀, 37°46′N, 43°47′E; Yeşilyayla (Hınson village), 04.06.2007, 1 ♀, 37°46′N, 43°31′E, leg. T. Türkeş.
Distribution in world: Mediterranean (Platnick, 2013). Distribution in Turkey: Mediterranean Region (Topçu et al., 2005).

FAM.: **ULOBORIDAE** *Thorell, 1869*

**Uloborus walckenaerius** (*Latreille, 1806*)
Distribution in world: Mediterranean (Platnick, 2013). Distribution in Turkey: Central Anatolia Region, Aegean Region (Topçu et al., 2005).

FAM.: **THERIDIIDAE** *Sundevall, 1833*

**Parasteatoda lunata** (*Clerck 1757*)
Material examined: Yuva Köy, 07.07.2006, 3 ♀♀, 1 ♂, 37°45′N, 43°44′E, leg. T. Türkeş.

**Achaearanea riparia** (*Blackwall, 1834*)
Material examined: Kemaliye (centre), 06.07.2006, 1 ♂, leg. T. Türkeş.
Distribution in world: Palearctic (Platnick, 2013). Distribution in Turkey: Ordu province (Bayram et al., 2007).

**Crustulina sticta** (*O. P.-Cambridge, 1861*)

**Dipoena melanogaster** (*C. L. Koch, 1837*)
Distribution in world: Europe, Europe, North Africa to Azerbaijan (Platnick, 2013). Distribution in Turkey: Ordu province (Bayram et al., 2007).

**Enoplognatha caricis** (Fickert, 1876)
Material examined: Sarıçiçek plateau (Mazgalbaşı), 02.06.2007, 1 ♂, 39°12N, 38°26E, 1635 m, leg. T. Türkeş.
Distribution in Turkey: Ankara province (Kunt KB and Yagmur AE, 2008).

**Enoplognatha oelandica** (Thorell, 1875)
Material examined: Subatan, 02.06.2007, 3 ♀♀, 39°11N, 38°24E, 1887 m., leg. T. Türkeş.
Distribution in Turkey: Gaziantep province (Bayram et al., 2012)

**Enoplognatha ovata** (Clerck 1757)
Material examined: Kekikpınarı, 06.07.2006, 1 ♀, 37°45N, 43°32E, leg. T. Türkeş.
Distribution in Turkey: Middle Black Sea Region (Bayram, 2002; Topçu et al., 2005).

**Enoplognatha thoracica** (Hahn 1833)
Material examined: Kumluyazı, 03.06.2007, 4 ♀♀, 39°20N, 38°28E, 1360 m; -Yuva Köy (Kırkgöz), 08.07.2006, 1 ♀; -Başbağlar village, 05.07.2006, 4 ♀♀; -Subatan, 02.06.2007, 1 ♀, 39°11N, 38°24E, 1887 m; -Başbağlar (Barasor, Ziyancık stream), 05.07.2006, 1 ♀; -Yuva Köy, 04.07.2005, 2 ♀♀, 740 m., leg. T. Türkeş.
Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region (Bayram, 2002; Topçu et al., 2005).

**Episinus angulatus** (Blackwall 1836)
Material examined: Kumluyazı, 03.06.2007, 4 ♀♀; Yuva Köy, 04.07.2006, 1 ♀, leg. T. Türkeş.
Distribution in world: Europe to Russia (Platnick, 2013).
Distribution in Turkey: Ankara province, Yozgat province (Türkeş and Mergen 2005a).

**Episinus truncatus** Latreille 1809
Material examined: Kekikpınarı, 06.07.2006, 2 ♀♀, 2 ♂♂, leg. T. Türkeş.
Distribution in Turkey: Nevşehir province, Ankara province, Kırşehir province, Çankırı province (Türkeş and Mergen 2005b).

**Euryopis quinqueguttata** Thorell 1875
Material examined: Sarıçiçek plateau (Subatan), 02.06.2007, 1 ♀, 39°11N, 38°24E, 1887 m., Başpınar (the road of Balkırı, Doymuş Hill, Munzur), 04.06.2007, 1♀,1 ♂, 2238 m., leg. T. Türkeş.
Distribution in world: Europe to Turkmenistan (Platnick, 2013).
Distribution in Turkey: Niğde province (Türkeş and Mergen 2005b).

**Latrodectus tredecimguttatus** (Rossi, 1790)
Distribution in world: Mediterranean to China (Platnick, 2013).
Distribution in Turkey: Marmara Region, Mediterranean Region, Central Anatolia Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**Steatoda albomaculata** (De Geer, 1778)
Material examined: Sarıçiçek plateau (Subatan), 02.06.2007, 4 ♀♀, 2 ♂♂, 39°11N, 38°24E, 1887m., leg. T. Türkeş.
Distribution in world: Cosmopolitan (Platnick, 2005b).
Distribution in Turkey: Mediterranean Region, Aegean Region, Central Anatolia Region (Bayram, 2002; Topçu et al., 2005).

**Steatoda dahli** (Nosek, 1905)
Material examined: Venkağ Village (Venkağ Tepesi), 09.07.2006, 1 ♀, 37°45N, 43°52E, 1364 m., Sarıçiçek plateau (Subatan), 17.05.2006, 1 ♀, leg. T. Türkeş.
Distribution in world: Turkey, Israel, Central Asia (Platnick, 2013).
Distribution in Turkey: Central Anatolia Region, East Anatolia Region (Topçu et al., 2005).

**Steatoda paykulliana** (Walckenaer 1806)
Material examined: Çanakçı village, 02.06.2007, 1 ♀, leg. T. Türkeş.
Distribution in world: Europe, Mediterranean to Central Asia (Platnick, 2013).
Steatoda phalerata (Panzer 1801)
Material examined: Sarıçiçek plateau (Mazgalbaşı), 02.06.2007, 3 ♀♀, 39°12N, 38°26E, 1635 m., Başpar (The road of Balkırı, Doymuş Hill, Munzur), 04.06.2007, 1 ♂, 2238 m., leg. T. Türkeş.
Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region, Central Anatolia Region (Bayram, 2002; Topçu et al., 2005).

Theridion betteni Wiehle 1960
Material examined: Yuva Köy (Kırkgöz), 08.07.2006, 1 ♀, leg. T. Türkeş
Distribution in Turkey: Marmara Region, Aegean Region, East Anatolia Region, Central Anatolia Region (Bayram, 2002; Topçu et al., 2005).

FAM.: LINYPHIIDAE Blackwall, 1859
Erigone dentipalpis (Wider, 1834)
Material examined: Subatan, 02.06.2007, 2 ♀♀, 2 ♂♂ 39°11N, 38°24E, 1887 m., leg. T. Türkeş.
Distribution in Turkey: Aegean Region, East Anatolia Region (Topçu et al., 2005).
*Frontinellina frutetorum* (C. L. Koch, 1834)
Material examined: Yuva Köy, 24.04.2007, 1♀, 37°45N, 43°44E, 920 m; Dutilucu, 24.04.2007, 1♀, 37°46N, 43°31E, 1136 m; Yuva köy, 04.07.2006, 1♂, leg. T. Türkeş.
Distribution in Turkey: Marmara Region, Central Anatolia Region (Topçu et al., 2005).

*Megalephyphantes collinus* (L. Koch, 1872)
Material examined: Dilli brook, 03.06.2006, 3♀♀; Yuva köy, 24.04.2007, 1♀, 37°45N, 43°44E, 920 m; Başbağlar village, 05.07.2006, 1♂, leg. T. Türkeş.
Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

*Neriene furtiva* (O. P. Cambridge, 1871)
Material examined: The road of Kabataş village, İkisu local, 03.06.2007, 1♀, 1♂, leg. T. Türkeş.
Distribution in world: Europe, North Africa, Russia, Ukraine (Platnick, 2010).
Distribution in Turkey: Marmara Region, Mediterranean Region, West Black Sea Region (Topçu et al., 2005).

*Tenuiphantes tenuis* (Blackwall, 1852)
Material examined: Kekikpınar, 06.07.2006, 3♀♀, 37°45N, 43°32E, 1264 m., leg. T. Türkeş.
Distribution in Turkey: Marmara Region, Aegean Region (Topçu et al., 2005).

Metellina meriana (Scopoli, 1763)
Material examined: Kekikpınar, 06.07.2006, 4♀♀, 5♂♂, 37°45N, 43°32E, 1264 m; Yuva köy–Kırkgöz, 08.07.2006, 1♀; Yuva Köy, 04.07.2006, 2♀♀, 37°45N, 43°44E, 920 m; Dilli brook, 03.06.2006, 1♀, leg. T. Türkeş.
Distribution in world: Europe to Georgia (Platnick, 2010).
Distribution in Turkey: Marmara Region, Central Anatolia Region, Mediterranean Region, West Black Sea Region (Topçu et al., 2005).

Pachygnatha degeeri Sundevall, 1830
Material examined: Kekikpınar, 06.07.2006, 1♀, 1♂, 37°45N, 43°32E, 1264 m., leg. T. Türkeş.
Distribution in Turkey: Marmara Region, Central Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

Tetragnatha extensa (Linnaeus, 1758)
Material examined: The entrance of Kırkgöz, 24.04.2007, 2♀♀, 37°45N, 43°44E, 1184 m; Kekikpınar, 06.07.2006, 1♂, 37°45N, 43°32E, 1264 m., leg. T. Türkeş.
Distribution in Turkey: Marmara Region, Central Anatolia Region (Topçu et al., 2005).

FAM.: ARANEIDAE Simon, 1895

Aculepeira ceropegia (Walckenaer 1802)
Material examined: Sarıçiçek plateau (subatan), 07.07.2006, 2♀♀, 1♂, 39°11N, 38°24E, 1887 m., leg. T. Türkeş.
Distribution in Turkey: Mediterranean Region, Central Anatolia Region (Bayram, 2002; Topçu et al., 2005).

Agalenatea redii (Scopoli, 1763)
Material examined: The road of Yeşilyayla (Kesen Dere), 08.07.2006, 1♀; Yuva Köy (Kırkgöz), 08.07.2006, 1♂; Dutilucu, 24.04.2007, 1♂, 37°46N, 43°31E, 1136 m., leg. T. Türkeş.
Distribution in Turkey: Marmara Region, Mediterranean Region (Bayram, 2002; Topçu et al., 2005).

Araneus angulatus Clerck, 1757
Material examined: Venkağ, 09.07.2006, 1♀, 37°45N, 43°52E, 1364 m., leg. T. Türkeş.
Distribution in Turkey: Marmara Region, Middle Black Sea Region (Bayram, 2002; Topçu et al., 2005).

*Araneus diadematus* Clerck, 1757
Distribution in world: England, North Europe, (Roberts, 1995), Holarctic (Platnick, 2013). Distribution in Turkey: Marmara Region, Middle Black Sea Region, Central Anatolia Region, Southeast Anatolia Region (Bayram, 2002; Topçu et al., 2005).

*Araniella cucurbitina* (Clerck, 1757)
Material examined: Sarıçiçek plateau (Mazgalbaşı), 02.06.2007, 1♀, 39°12N, 38°26E, 1635 m, leg. T. Türkeş.
Distribution in world: Britannia, North Europe (Roberts, 1995), Palearctic (Platnick, 2013). Distribution in Turkey: Marmara Region, North Europe, East Anatolia Region, Southeast Anatolia Region (Bayram, 2002; Topçu et al., 2005).

*Araniella opisthographa* (Kulczynski 1905)
Material examined: Sarıçiçek plateau (Subatan), 07.07.2006, 1♀; Kabataş, İkisu local, 03.06.2007, 1♀, 2♂♂, leg. T. Türkeş.

*Cyclosa conica* (Pallas 1772)
Material examined: Dilli brook, 03.06.2007, 1♀; Yuva Köy, 04.07.2006, 1♀, 37°45N, 43°44E, 920 m; Yuva Köy, 24.04.2007, 1♀, 37°45N, 43°44E, 1184 m; Yuva Köy, 24.04.2007, 1♀, 37°45N, 43°44E, 920 m; Taş yol, Karanlıkdere, 03.07.2007, 1♀, leg. T. Türkeş.

*Gibbaranea bituberculata* (Walckenaer 1802)
Material examined: Sırakonak, 24.04.2006, 1♀, 1♂, 37°45N, 43°41E, 1183 m; Yuva Köy, 24.04.2007, 1♀, 37°45N, 43°44E, 920 m; Dutluca, 24.04.2007, 1♀, 37°46N, 43°31E, 1136 m., leg. T. Türkeş.

*Hipsosinga albovittata* (Westring 1851)
Material examined: Kırkgöz, 24.04.2007, 1♀, 37°45N, 43°44E, 1184 m., leg. T. Türkeş.

*Mangora acalypha* (Walckenaer 1802)
Material examined: Yuva Köy, 24.04.2006, 1♀, 37°45N, 43°44E, 920 m; Başpınar, 24.04.2007, 1♀, 37°47N, 43°38E, 1405 m., leg. T. Türkeş.

*Neoscona adianta* (Walckenaer 1802)
Material examined: Yuva Köy, 04.07.2006, 6♀♀, 2♂♂, 37°45N, 43°44E; Kabataş , İkisu local, 13.07.2005, 2♀♀; Yuva Köy (Kırkgöz), 08.07.2006, 1♀; Sırakonak-sarıçiçek Plateau, Manzan fountain, 07.07.2006, 1♀, 2♂♂; Kekkipınarı, 06.07.2006, 2♀♀, 2♂♂, 37°45N, 43°32E; Buğdaypinar, 05.07.2006, 1♀, 1♂; Yuva Köy, 04.07.2005, 1♀, leg. T. Türkeş.
Distribution in world: England, Ireland, North Europe (Roberts, 1995), Palearctic (Platnick, 2013). Distribution in Turkey: Marmara Region, Middle Black Sea Region (Karol, 1967), Central Anatolia Region, Marmara Region, Aegean Region (Bayram, 2002; Topçu et al., 2005).

*Zilla diodia* (Walckenaer 1802)
Material examined: Sırakonak, 24.04.2006, 2♀♀, 37°45N, 43°41E, 1183 m; Kırkgöz, 24.04.2006, 3♀♀, 37°45N, 43°44E, 1184 m; Kabataş , İkisu local, 03.06.2007, 2♀♀; Dilli
brook, 03.06.2007, 3 ♀; Yuva köy, 24.04.2006, 7 ♀, 37°45N, 43°44E, 920 m., leg. T. Türkeş.
Distribution in world: Europe to Azerbaijan (Platnick, 2013).
Distribution in Turkey: Mediterranean Region (Topçu et al., 2005).

*Zygia la x-notata* (Clerck 1757)
Material examined: Geşo beli, 04.06.2007, 1 ♂, 37°46N, 43°47E, 1675 m; Aksöğüt-Tuğlu, 24.04.2006, 1 ♂, 37°46N, 43°40E, 839 m; Kemalyye centre, 06.07.2006, 1 ♀, leg. T. Türkeş.
Distribution in world: Britainia, North Europe, Finland (Roberts, 1995), Holarctic, Neotropical (Platnick, 2013).
Distribution in Turkey: Yozgat (Türkeş and Mergen 2007).

**FAM.: LYCOSIDAE**

*Sundevall, 1833*

*Alopecosa aculeata* (Clerck, 1757)
Material examined: Sarıçiçek plateau (Subatan), 02.06.2007, 1 ♂, 39°11N, 38°24E, 1887m., leg. T. Türkeş.
Distribution in Turkey: Adana (Topçu et al., 2005).

*Alopecosa albofasciata* (Brullé, 1832)
Material examined: Başbağlar, 01.07.2006, 1 ♀, 1 ♂, leg. T. Türkeş.
Distribution in world: Mediterranean, Central Asia (Platnick, 2013).
Distribution in Turkey: Marmara Region, Aegean Region, Mediterranean Region, Central Anatolia Region, East Black Sea Region (Topçu et al., 2005).

*Alopecosa striatipes* (C. L. Koch, 1839)
Material examined: Kırkgöz, 1 ♀, 37°45N, 43°44E, leg. T. Türkeş.
Distribution in world: Europe, Central Asia (Platnick, 2013).
Distribution in Turkey: Southeast Anatolia Region (Varol et al., 2006).

*Arctosa leopardus* (Sundevall, 1833)
Material examined: Çanakçı village, 02.06.2007, 1 ♀; -Başbağlar (Barasor, Ziyaret stream), 05.07.2006, 1 ♂, leg. T. Türkeş.
Distribution in Turkey: Marmara Region, Southeast Anatolia Region (Topçu et al., 2005).

*Arctosa lutetiana* (Simon, 1876)
Material examined: Subaşı Village (Remziye Kaya Çeşme), 04.06.2007, 3 ♀, 1 ♂; -Yuva Köy (Kırkgöz), 08.07.2006, 1 ♀; - Kabataş Village (İkisu Local), 03.06.2007, 1 ♀; -Canakçı Village, 02.06.2007, 4 ♀, 1 ♂; -Başbağlar Village, 05.07.2006, 1 ♀; -Yuva Köy, 04.07.2005, 2 ♀, 37°45N, 43°44E, 740 m; -Kekikpinarı, 06.07.2006, 1 ♀, 37°45N, 43°32E; -Dilli brook, 03.06.2007, 1 ♂, leg. T. Türkeş.
Distribution in world: Europe, Rusya (Platnick, 2013).
Distribution in Turkey: East Black Sea Region (Sancak, 2007).

*Aulonia kratochvili* Dunin, Buchar & Absolon, 1986
Material examined: Kabataş village, 03.06.2007, 1 ♂; - Yuva Köy, 04.07.2006, 1 ♀, 37°45N, 43°44E; -Dilli Deresi, 03.06.2007, 2 ♀, leg. T. Türkeş.
Distribution in world: Yunanistan, Central Asia (Platnick, 2013).
Distribution in Turkey: Southeast Anatolia Region (Özdemir et al., 2006).

*Hogna radiata* (Latreille, 1817)
Material examined: Başpinar, 16.05.2006, 1 ♀, 39°11N, 38°39E, leg. T. Türkeş.
Distribution in world: Middle Europe, Middle Asia, Middle Africa (Platnick, 2013).
Distribution in Turkey: Marmara Region, Aegean Region, Mediterranean Region Central Anatolia Region (Topçu et al., 2005).

*Lycosa praegrands* C. L. Koch, 1836
Material examined: Sarıçiçek plateau (Subatan), 07.07.2006, 1 ♂, 39°11N, 38°24E, 1887m., leg. T. Türkeş.
Distribution in world: Yunanistan, Central Asia (Platnick, 2013).
Distribution in Turkey: Marmara Region, Aegean Region, Mediterranean Region Central Anatolia Region, East Black Sea Region (Topçu et al., 2005).

*Pardosa hortensis* (Thorell, 1872)
Material examined: Çanakçı Village, 02.06.2007, 1 ♂, leg. T. Türkeş.
Distribution in Turkey: Aegean Region, Central Anatolia Region (Topçu et al., 2005).

**Pardosa monticola** (Clerck, 1757)
Material examined: Sarıçiçek plateau (Subatan), 07.07.2006, 6 ♀♀, 39°11N, 38°24E, 1887m; -Geço Beli, 08.07.2006, 1 ♀, 37°46N, 43°47E; -Canakçı village, 02.06.2007, 1 ♀, leg. T. Türkeş.
Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**Pardosa morosa** (L. Koch, 1870)
Material examined: Kekikpınarı, 06.07.2006, 1 ♀, 37°45N, 43°32E; - Yuva Köy, 06.07.2006 1 ♀, 37°45N, 43°44E; -Dilli brook, 03.06.2007, 7 ♀♀, 2 ♂♂; -Sirakonak, 1 ♂, 37°45N, 43°41E; -Subaşı Village (Remziye Kaya Fountain), 04.06.2007, 1 ♀; - Yuva Köy, 1 ♂, 37°45N, 43°44E; -Çanakçı Village, 02.06.2007, 4 ♀; -Kumluyazı, 03.06.2007, 1 ♂, 39°20N, 38°28E, 1360 m., leg. T. Türkeş.
Distribution in world: Europe, Central Asia (Platnick, 2013).
Distribution in Turkey: Aegean Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**Pardosa proxima** (C. L. Koch, 1847)
Material examined: Sarıçiçek plateau (Mazgalbaşı), 02.06.2007, 1 ♂, 39°12N, 38°26E, 1635 m; -Çanakçı Village, 02.06.2007, 2 ♀♀, 1 ♂; -Kırkgöz, 1 ♀, 37°45N, 43°41E; -Sarıçiçek plateau (Subatan), 07.07.2006, 1 ♀; -Yuva Köy (Kırkgöz), 08.07.2006, 1 ♂; -Baspinar (Balkırı Yolu, Doymuş hill, Munzur), 04.06.2007, 1 ♂, 2238 m., leg. T. Türkeş.
Distribution in Turkey: Marmara Region, Aegean Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**Pardosa tatarica** (Thorell, 1875)
Material examined: Başbağlar (Barasor, Ziyancık stream), 05.07.2006, 1 ♀, 1 ♂; -Kabataş village (İkisu local), 03.06.2007, 4 ♀♀, 1 ♂; -Aksöğüt (Tuğlu), 2 ♀♀, 3 ♂♂, 37°46N, 43°40E, leg. T. Türkeş.
Distribution in Turkey: Turkey (Topçu et al., 2005).

**Pardosa wagleri** (Hahn, 1822)
Material examined: Sirakonak, 2 ♀♀, 37°45N, 43°41E, leg. T. Türkeş.
Distribution in Turkey: Mediterranean Region, East Anatolia Region (Topçu et al., 2005).

**Pirata insularis** Emerton, 1885
Material examined: Subaşı Village (Remziye Kaya Fountain), 04.06.2007, 1 ♂; - Dutluca, 24.04.2007, 1 ♂, 37°46N, 43°31E, leg. T. Türkeş.
Distribution in Turkey: Black Sea Region (Sancak, 2007).

**Pirata latitans** (Blackwall, 1841)
Material examined: Sarıçiçek (Manzan Fountain), 07.07.2006, 1 ♀; - Sarakonak, 37°45N, 43°41E, 2 ♀♀, 1 ♂; - Kekikpınarı, 06.07.2006, 1 ♂, 37°45N, 43°32E; - Yuva Köy, 04.07.2006, 2 ♀♀, 1 ♂, 37°45N, 43°44E; - Aksöğüt (Tuğlu), 1 ♂, 37°46N, 43°40E; -Subaşı Village (Remziye Kaya Fountain), 04.06.2007, 1 ♂, leg. T. Türkeş.

**FAM.: PISAURIDAE** Simon, 1890

**Pisaura mirabilis** (Clerck, 1757)
Material examined: Kırkgöz, 1 ♂, 37°45N, 43°44E; - Kekikpınarı, 15.05.2006, 7 ♀♀, 3 ♂♂, 37°45N, 43°32E; - Dutluca, 1 ♂, 37°46N, 43°31E; - Yuva Köy, 2 ♀♀, 37°45N, 43°44E; - Sarıçiçek plateau (Mazgalbaşı), 07.07.2006, 1 ♂; -Kabataş village (İkisu local), 03.06.2007, 2 ♂♂, leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region, East Anatolia Region, Marmara Region, Aegean Region, Southeast Anatolia Region (Topçu et al., 2005).
FAM.: OXYOPIDAE Thorell, 1870

**Oxyopes lineatus** Latreille, 1806

Material examined: Yuva Köy, 04.07.2006, 2 ♀♂, 37°45N, 43°44E, 740 m.; - Kekikpinar, 06.07.2006, 4 ♀♂, 37°45N, 43°32E, 1264 m, leg. T. Türkeş.


Distribution in Turkey: Mediterranean Region (Topçu et al., 2005).

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**Oxyopes ramosus** (Martini & Goeze, 1778)

Material examined: Yuva Köy (Kırkgöz), 08.07.2006, 1 ♀, leg. T. Türkeş.


Distribution in Turkey: Niğde province (Topçu et al., 2005).

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FAM.: ZOROPSIDAE Bertkau, 1882

**Zoropsis oertzeni** Dahl, 1901

Material examined: Kabataş Village (İkisu local), 03.06.2007, 1 ♀, leg. T. Türkeş.

Distribution in world: Italy, Greece, Balkans (Platnick, 2013).

Distribution in Turkey: New record for Turkey.

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FAM.: AGELENIDAE C. L. Koch, 1837

**Agelena labyrinthica** (Clerck, 1757)

Material examined: Yuva Köy, 04.07.2006, 2 ♀♂, 1 ♂, 37°45N, 43°44E; - Kekikpinar, 06.07.2006, 1 ♀, 37°45N, 43°32E; - Başbaşılar Village, 05.07.2006, 1 ♂, 1 ♀; - Sarıciçek plateau (Subatan), 07.07.2006, 1 ♂, 39°11N, 38°24E, 1887m., leg. T. Türkeş.


Distribution in Turkey: Marmara Region, Central Anatolia Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

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**Agelescape gideoni** Levy, 1996

Material examined: Sarıciçek plateau, 07.07.2006, 2 ♀♂, 2 ♂♂, 39°11N, 38°24E, 1887m; - Başpınar- Balkır (Munzur), 1 ♂, 04.06.2007, 2300m, Venkağ, 09.07.2006, 1 ♀, 37°45N, 43°52E, 1364 m., leg. T. Türkeş.

Distribution in world: Turkey, Israel (Platnick, 2013).

Distribution in Turkey: East Anatolia Region (Topçu et al., 2005).

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**Malthonica pagana** (C. L. Koch, 1840)

Material examined: Centre (indoor), 1 ♂, leg. T. Türkeş.

Distribution in world: Europe, Middle Asia, America, New Zealand (Platnick, 2013).

Distribution in Turkey: Marmara Region, Aegean Region, Mediterranean Region, Southeast Anatolia Region (Topçu et al., 2005).

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**Tegenaria argaeica** Nosek, 1905

Material examined: Çanakçı village, 02.06.2007, 1 ♂, leg. T. Türkeş.

Distribution in world: Bulgaria, Turkey (Platnick, 2013).

Distribution in Turkey: Central Anatolia Region (Topçu et al., 2005).

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FAM.: DICTYNIDAE O. P.-Cambridge, 1871

**Nigma flavescens** (Walckenaer, 1830)

Material examined: Yuva Köy, 1 ♀, 2 ♂♂, 37°45N, 43°44E, leg. T. Türkeş.


Distribution in Turkey: New record for Turkey.

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**Dictyna uncinata** Thorell, 1856

Material examined: Çanakçı village, 02.06.2007, 1 ♂; -Sarıciçek plateau (Mazgalbaşı), 02.06.2007, 1 ♂, 39°12N, 38°26E, 1635 m., leg. T. Türkeş.


Distribution in Turkey: New record for Turkey.

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**Dictyna arundinacea** (Linnaeus, 1758)

Material examined: Başbaşılar Village (Barasor, Ziyancık stream), 05.07.2006, 1 ♀; -Yuva Köy (Kırkgöz), 1 ♀, 37°45N, 43°44E, leg. T. Türkeş.


Distribution in Turkey: Central Anatolia Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).
**Dictyna civica** (Lucas, 1850)

Material examined: Kekikpınarı, 06.07.2006, 1 ♀, 37°45' N., 43°32' E.; Kabataş Village (İkisu local), 02.06.2007, 1 ♀, 1 ♂, leg. T. Türkeş.


Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**FAM.: TITANOECIDAE Lehtinen, 1967**

*Nurscia albomaculata* (Lucas, 1846)

Material examined: Geşo Beli, 08.07.2006, 1 ♀, 37°46' N., 43°47' E., 1675 m., Sarıcıçek plateau (Manzan fountain), 07.07.2006, 1 ♀, 1 ♂; Başbağlar village, 05.07.2006, 1 ♀, 1 ♂; Venkağ, 09.07.2006, 1 ♀, 37°45' N., 43°52' E., 1364 m; Yuva Köy (Kırkgöz), 08.07.2006, 1 ♀; leg. T. Türkeş.

Distribution in world: Europe, Central Asia (Platnick, 2013).

Distribution in Turkey: Marmara Region, Central Anatolia Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**FAM.: MITURGIDAE Simon, 1885**

*Cheiracanthium elegans* Thorell, 1875

Material examined: Geşo Beli, 04.06.2007, 1 ♂, leg. T. Türkeş.

Distribution in world: Europe, Asia (Platnick, 2013).

Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**FAM.: CLUBIONIDAE Wagner, 1887**

*Clubiona lutescens* Westring, 1851

Material examined: Yuva Köy, 04.07.2005, 1 ♀, 37°45' N., 43°44' E., 740 m, leg. T. Türkeş.


Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**FAM.: ZODARIIDAE Thorell, 1881**

*Zodarion gallicum* (Simon, 1873)

Material examined: Yuva Köy, 04.07.2005, 1 ♀, 37°45' N., 43°44' E., 740 m, leg. T. Türkeş.

Distribution in world: France, Corsica, Italy, Balkans, Turkey (Platnick, 2013).

Distribution in Turkey: Central Anatolia Region (Topçu et al., 2005).

**FAM.: GNAPHOSIDAE Pocock, 1898**

*Drassodes lapidosus* (Walckenaer, 1802)

Material examined: Başbağlar, 05.07.2006, 2 ♀; Başpinar (Konsar village), 04.06.2007, 1 ♀; - Canakçı Village, 02.06.2007, 2 ♀♂; Sarıcıçek plateau (Manzan fountain), 07.07.2006, 2 ♀♂, leg. T. Türkeş.


Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region, Central Anatolia Region, Mediterranean Region, Marmara Region (Topçu et al., 2005).

*Drassodes pubescens* (Thorell, 1856)

Material examined: Yuva Köy, 04.07.2005, 1 ♀, 37°45' N., 43°44' E., 740 m, leg. T. Türkeş.


Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region, Central Anatolia Region (Topçu et al., 2005).

*Drassyllus praeficus* (L. Koch, 1866)

Material examined: Yuva Köy, 04.07.2005, 1 ♀, 37°45' N., 43°44' E., 740 m, leg. T. Türkeş.

Distribution in world: Europe, Central Asia (Platnick, 2013).

Distribution in Turkey: Central Anatolia Region, Southeast Anatolia Region, East Anatolia Region (Topçu et al., 2005).

*Gnaphosa lucifuga* (Walckenaer, 1802)

Material examined: Başpinar (Konsar Village), 04.06.2007, 1 ♀; Sarıcıçek plateau, 07.07.2006, 1 ♀, 37°44' N., 43°37' E., leg. T. Türkeş.

Distribution in Turkey: Central Anatolia Region, Southeast Anatolia Region, Marmara Region, East Black Sea Region (Topçu et al., 2005).

**Haplodrassus dalmatensis** (L. Koch, 1866)
Material examined: Sarıçık plateau, 02.06.2007, 1 ♂, 39°12′N, 38°26′E, 1635 m, leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region, East Anatolia Region (Topçu et al., 2005).

**Haplodrassus signifer** (C. L. Koch, 1839)
Material examined: Sarıçık plateau (Subatan), 02.06.2007, 1 ♀, 39°11′N, 38°24′E, 1887 m, leg. T. Türkeş.
Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region, Central Anatolia Region, Aegean Region, Marmara Region (Topçu et al., 2005).

**Micaria coarctata** (Lucas, 1846)
Material examined: Geşo Beli, 08.07.2006, 1 ♀, 2 ♂♂, 37°46′N, 43°47′E; leg. T. Türkeş.
Distribution in world: Mediterranean, Central Asia (Platnick, 2012).
Distribution in Turkey: Central Anatolia Region, Mediterranean Region (Topçu et al., 2005).

**Micaria albovittata** (Lucas, 1846)
Material examined: Sarıçık plateau (Subatan), 02.06.2007, 1 ♀, 39°11′N, 38°24′E, 1887 m; Kabataş Village (İkisu Local), 03.06.2007, 1 ♂, 1 ♂, leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region, Southeast Anatolia Region, East Anatolia Region (Topçu et al., 2005).

**Nomisia ripariensis** (O. P.-Cambridge, 1872)
Material examined: Sarıçık plateau, 1 ♀, 37°44′N, 43°37′E, leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region, Mediterranean Region, (Topçu et al., 2005).

**Poecilochroa senilis** (O. P.-Cambridge, 1872)
Material examined: Sarıçık plateau, 1 ♀, 37°44′N, 43°37′E, leg. T. Türkeş.
Distribution in world: Corsica to Turkmenistan (Platnick, 2013).
Distribution in Turkey: Niğde province (Seyyar, 2006).

**Pterotricha kochii** (O. P.-Cambridge, 1872)
Material examined: Başpınar (Ziyaret Tepe), 04.06.2007, 1 ♀, leg. T. Türkeş.
Distribution in world: Mediterranean, Ukraine (Platnick, 2013).
Distribution in Turkey: Central Anatolia Region (Topçu et al., 2005).

**Zelotes electus** (C. L. Koch, 1839)
Material examined: Yeşilyayla, 08.06.2006, 1 ♀, leg. T. Türkeş.
Distribution in world: Europe, Central Asia (Platnick, 2013).
Distribution in Turkey: East Anatolia Region, Southeast Anatolia Region, Central Anatolia Region (Topçu et al., 2005).

**Zelotes longipes** (L. Koch, 1866)
Material examined: Başpınar-Balkı (Munzur), 1 ♀, 04.06.2007, 2300 m, leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region, Marmara Region, East Anatolia Region (Topçu et al., 2005).

**Zelotes subterraneus** (C. L. Koch, 1833)
Material examined: Başpınar, 05.07.2006, 1 ♀, 37°47′N, 43°38′E, leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region (Topçu et al., 2005).

**Zelotes tenuis** (L. Koch, 1866)
Material examined: Sarıçık plateau (Mazgalbaşı), 02.06.2007, 1 ♀, 39°12′N, 38°26′E, 1635 m, leg. T. Türkeş.
Distribution in world: Mediterranean, Ukraine, USA (Platnick, 2013).
Distribution in Turkey: Niğde province (Seyyar, 2004).
FAM.: PHILODROMIDAE Thorell, 1870

**Thanatus striatus** C. L. Koch, 1845
Material examined: Başpınar- Balkırı road (Munzur), 3 ♀♀, 04.06.2007, 2300 m; Venkağ, 09.07.2006, 1 ♂, 37°45'N, 43°52'E, 1364 m; Taş road, Karanlkondere, 03.06.2007, 1 ♀; Çanakçı Village, 02.06.2007, 1 ♀, leg. T. Türkçe.
Distribution in Turkey: Aegean Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**Thanatus formicinus** (Clerck, 1757)
Material examined: Subatan road, 04.24.2007, 1 ♀, 37°45'N, 43°40'E, 1661 m; Yuva Köy (Kırkgöz), 08.07.2006, 1 ♀, leg. T. Türkçe.
Distribution in Turkey: Aegean Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**Philodromus cespitum** (Walckenaer, 1802)
Material examined: Dilli brook, 03.06.2006, 1 ♀, leg. T. Türkçe.
Distribution in Turkey: Southeast Anatolia Region (Topçu et al., 2005).

**Philodromus histrio** (Latreille, 1819)
Material examined: Yeşilyayla (Kesen stream), 08.07.2006, 1 ♀; Başpınar, 05.07.2006, 1 ♀, 37°47'N, 43°38'E, leg. T. Türkçe.
Distribution in Turkey: East Anatolia Region (Topçu et al., 2005).

**Philodromus longipalpis** Simon, 1870
Material examined: Salihli Village, 08.07.2006, 2 ♀♀; Yuva Köy, 04.07.2006, 1 ♀, 37°45'N, 43°44'E, 920 m; Yuva Köy, 04.07.2005, 1 ♀, 740 m; Sarıççek plateau, 07.07.2006, 2 ♀♀, 1 ♂, 39°11'N, 38°24'E, 1887 m; Venkağ, 09.07.2006, 1 ♀, 37°45'N, 43°52'E, 1364 m; Yuva Köy (Kırkgöz), 08.07.2006, 1 ♀; Dilli brook, 03.06.2006, 1 ♂, leg. T. Türkçe.
Distribution in world: Europe, Iran, Azerbaijan (Platnick, 2013).
Distribution in Turkey: Marmara Region (Topçu et al., 2005).

FAM.: THOMISIDAE Sundevall, 1833

**Heriaeus hirtus** (Latreille, 1819)
Material examined: Dilli brook, 03.06.2006, 1 ♀; Başpınar, 05.07.2006, 1 ♀, 37°47'N, 43°38'E, leg. T. Türkçe.
Distribution in world: Europe to Georgia (Platnick, 2013).
Distribution in Turkey: Marmara Region (Topçu et al., 2005).

**Misumena vatia** (Clerck, 1757)
Material examined: Kırkgöz, 24.04.2007, 1 ♀, 37°45'N, 43°44'E, 1184 m., leg. T. Türkçe.
Distribution in Turkey: Marmara Region (Topçu et al., 2005).

**Synema globosum** (Fabricius, 1775)
Material examined: Dutluca, 24.04.2007, 1 ♀, 37°46'N, 43°31'E, 1136 m., -Kekikpınarı, 15.05.2006, 2 ♂♂, - Dilli brook, 03.06.2006, 1 ♂, - Yeşilyayla (Hınson Village), 04.06.2007, 1 ♀, leg. T. Türkçe.
Distribution in Turkey: Marmara Region, Aegean Region, Mediterranean Region, Central Anatolia Region (Topçu et al., 2005).

**Thomisus onustus** Walckenaer, 1805
Material examined: Subatan, 02.06.2007, 1 ♀, 39°11'N, 38°24'E, 1887 m; Subaşı Village (Remziye Kaya fountain), 04.06.2007, 1 ♂ - Baspınar (Balkırı Yolu, Doymuş Tepesi, Munzur), 04.06.2007, 1 ♂, 2238 m., leg. T. Türkçe.
Distribution in Turkey: Marmara Region, Aegean Region, Mediterranean Region, Central Anatolia Region, East Anatolia Region, Southeast Anatolia Region (Topçu et al., 2005).

**Tmarus piger** (Walckenaer, 1802)
Material examined: Yuva köy 01.06.2007, 1 ♀, leg. T. Türkçe.
Distribution in Turkey: Diyarbakır province, Mardin province, Siirt province (Bayram et al., 2008)

**Xysticus edax** (O. P.-Cambridge, 1872)

**Xysticus kempeleini** Thorell, 1872
Material examined: Kekikpınar, 06.07.2006, 1 ♀, 37°45′N, 43°32′E, 1264 m leg. T. Türkeş. Distribution in Turkey: Mediterranean Region, Central Anatolia Region (Topçu et al., 2005).

**Xysticus kempeleni** Thorell, 1872

**Xysticus kochi** Thorell, 1872
Material examined: Dutluca, 24.04.2007, 1 ♂, 37°46′N, 43°31′E, 1136 m; Yuva Köy, 24.04.2007, 1 ♂, 37°45′N, 43°44′E, 920 m; -Kekikpınarı, 15.05.2006, 3 ♀♀, 3 ♂♂, 37°45′N, 43°32′E, leg. T. Türkeş. Distribution in world: Europe, Mediterranean, Middle Europe (Platnick, 2013).

**Xysticus lanio** C. L. Koch, 1835

**Xysticus ninnii fuscivinentris** Crome, 1965
Material examined: Sarıçiçek plateau (Subatan), 07.07.2006, 1 ♀, 39°11′N, 38°24′E, 1887 m; Kekikpınar, 06.07.2006, 1 ♀, 37°45′N, 43°32′E, 1264 m; leg. T. Türkeş. Distribution in world: Eastern Europe to Mongolia (Platnick, 2013).

**Xysticus pseudorectilineus** (Wunderlich, 1995)
Material examined: Kemaliye (centre), 06.05.2006, 1 ♀, leg. T. Türkeş. Distribution in world: Greece, Turkey (Platnick, 2013).

**Xysticus striatipes** L. Koch, 1870
Material examined: Sarıçiçek plateau(Subatan), 17.05.2006, 1 ♀, leg. T. Türkeş. Distribution in world: Paleartic (Platnick, 2013).

**Xysticus tristrami** (O. P.-Cambridge, 1872)
Material examined: Dilli brook, 03.06.2006, 1 ♂; Sarıçiçek plateau (Subatan), 17.05.2006, 1 ♀, leg. T. Türkeş. Distribution in world: Saudi Arabia to Central Asia (Platnick, 2013).

**FAM.: SALTICIDAE** Blackwall, 1841

**Aelurillus v-insignitus** (Clerck, 1757)

**Asianellus festivus** (C. L. Koch, 1834)

**Euophrys frontalís** (Walckenaer, 1802)

**Evarcha arcuata** (Clerck, 1757)

**Fam.:** SALTICIDAE Blackwall, 1841

**Aelurillus v-insignitus** (Clerck, 1757)

**Asianellus festivus** (C. L. Koch, 1834)

**Euophrys frontalís** (Walckenaer, 1802)

**Evarcha arcuata** (Clerck, 1757)
Heliophanus cupreus (Walckenaer, 1802)
Material examined: Subatan road, 04.24.2007, 2 ♂♂, 37°45N, 43°40E, 1661 m., leg. T. Türkeş.
Distribution in Turkey: Mediterranean Region (Bayram et al., 2013).

Heliophanus edentulus Simon, 1871
Material examined: Başbağlar (Barasor, Ziyancık stream), 05.07.2006, 2 ♂♂; Kabataş village road, İkisu local, 03.06.2007, 1 ♂; Çanakçı village, 02.06.2007, 1 ♀; Subatan, 02.06.2007, 2 ♂♂, 1 ♀, 39°11N, 43°24E, 1887 m; Subaşı village (Remziye Kaya fountain), 04.06.2007, 2 ♂♂, leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region (Topçu et al., 2005).

Heliophanus flavipes (Hahn, 1832)
Material examined: Kekikpınar, 06.07.2006, 1 ♀, 37°45N, 43°32E, 1264 m, leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region (Topçu et al., 2005).

Heliophanus kochii Simon, 1868
Material examined: Venkağ, 09.07.2006, 1 ♀, 37°45N, 43°52E, 1364 m; Kırkgöz, 24.04.2007, 1 ♀, 37°45N, 43°44E, 1184 m, leg. T. Türkeş.
Distribution in Turkey: Mediterranean Region (Topçu et al., 2005).

Heliophanus melinus L. Koch, 1867
Distribution in Turkey: Aegean Region, Mediterranean Region, Middle Black Sea Region (Topçu et al., 2005).

Heliophanus mordax (O. P.-Cambridge, 1872)
Distribution in world: Greece to Central Asia (Platnick, 2013).
Distribution in Turkey: Mediterranean Region, Middle Black Sea Bölgesi (Topçu et al., 2005).

Myrmarachne formicaria (De Geer, 1778)
Material examined: Subaşı Village (Remziye Kaya Fountain), 04.06.2007, 1 ♂; leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region, Marmara Region (Topçu et al., 2005).

Philaeus chrysops (Poda, 1761)
Material examined: Dutbeli 15.05.2006, 2 ♀♀; Venkağ, 09.07.2006, 2 ♀♀, 37°45N, 43°52E, 1364 m; -Sıarakonak- Sarıçük plateau, Manzan fountain, 07.07.2006, 2 ♀♀; Kekikpınar, 06.07.2006, 1 ♀, 2 ♂♂, 37°45N, 43°32E, 1264 m; Dutluca, 24.04.2007, 2 ♀♀, 1 ♂, 37°46N, 43°31E, 1136 m; Çanakçı Village, 02.06.2007, 1 ♂; leg. T. Türkeş.
Distribution in Turkey: Central Anatolia Region, East Anatolia Region, Marmara Region, Aegean Region, Mediterranean Region, East Black Sea Region (Topçu et al., 2005).

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LITERATURE CITED


A FAUNISTIC STUDY ON THE PSEUDOSCORPIONS (ARACHNIDA: PSEUDOSCORPIONES) OF OAK-HORNBEAM FORESTS IN SW SLOVAKIA

Jana Christophoryová*

* Department of Zoology, Faculty of Natural Sciences, Comenius University, Mlynská dolina B-1, SK–84215 Bratislava, SLOVAK REPUBLIC. E-mail: christophoryova@gmail.com

ABSTRACT: The faunistic research on pseudoscorpions was performed at 13 study plots in the Malé Karpaty Mts. and at two study plots in Trnavská pahorkatina hills (SW Slovakia). A faunistic survey of the study area is presented in this contribution. All study plots were situated in oak-hornbeam forests; differed in altitude, mean age of forest stands, floristic composition, degree of human impact and fragmentation. The pseudoscorpions were collected by the square method combined with sifting during eight years. A total of 4051 pseudoscorpion specimens of 12 species and four families were examined during the research in the whole study area. The species Roncus sp. was identified only on the genus level. The species Neobisium carcinoides (Hermann, 1804) was common for all study plots, Roncus sp. and Chernes cimicoides (Fabricius, 1793) were found only at one study plot. From the faunistic point of view, the record of quite a rare species Allochernes peregrinus Lohmander, 1939 was valuable.

KEY WORDS: Pseudoscorpiones, faunistics, oak-hornbeam forest, Slovakia, Central Europe.

The oak-hornbeam forests in Slovakia used to be the most frequent forest climatic zone formation at lower altitudes. In past they covered continuous and large areas, especially in plains and lowlands from the altitude of 100 m a.s.l., in hilly and submountainous regions up to 600 m a.s.l. and in all the Inner-Carpathian hollows (Michalko et al., 1986). Most of the natural oak-hornbeam forests were transformed to very productive agricultural land; nowadays oak-hornbeam forests cover only 15 % of its natural range (Barbati & Morchetti, 2004). In Slovakia, mainly partial data on pseudoscorpions inhabiting oak-hornbeam forests were contained in several systematic faunistic and ecological papers (Krumpál & Krumpálová, 2003; Christophoryová, 2009; Christophoryová & Krumpál, 2010). Christophoryová (2010) recorded species Neobisium carcinoides (Hermann, 1804) and Pselaphochernes scorpioides (Hermann, 1804) in oak hollows. Lately, two species were recorded for the first time from Slovakia in oak and oak-hornbeam forests: Chthonius hungaricus Mahnert, 1980 and Allochernes powelli (Kew, 1916) (Christophoryová et al., 2011a,b).

Our research originated in the grant concerning animal communities in oak-hornbeam forests in SW Slovakia. Several studies of various groups of soil arthropods in this area have been already published (for example Fend'a & Ciecková, 2005; Holecová et al., 2005a,b; Krumpálová, 2005; Vrabec et al., 2012). Partial results about pseudoscorpions from the study area were published as well; containing only ecological data on assemblages and seasonal dynamics of two species (Christophoryová & Krumpál, 2005, 2007; Christophoryová & Holecová, 2012).

The aim of this study was to complete the currently unpublished faunistic data on pseudoscorpions from oak-hornbeam forest of SW Slovakia.
MATERIAL AND METHODS

The faunistic research was performed on several study plots in the Malé Karpaty Mts. and in the Trnavská pahorkatina hills during the years 1999 – 2002 and 2005 – 2008 (leg. M. Holecová, Z. Krumpálová, I. Országh).

13 study plots situated in oak-hornbeam forests were selected in the Malé Karpaty Mts. (Fig. 1):

1. **Briežky (BR):** 48°10' N, 17°06' E, GRN (Grid Reference Number of the Databank of the Fauna of Slovakia) 7868b, 340 m a.s.l. 80-100 years old oak-hornbeam forest belonging to *Querco petraeae-Carpinetum typicum* association; commercially used stand with managed suburban forest.

2. **Cajla (CA):** 48°20' N, 17°16' E, GRN 7669c, 280 m a.s.l. 80-100 years old oak-hornbeam forest of *Galio sylvaticae-Carpinetum* association; economically managed forest neighbouring with meadows and vineyards.

3. **Devínska Kobyľa 1 (DK1):** 48°11' N, 16°59' E, GRN 7868a, 340 m a.s.l. 60-80 years old oak-hornbeam forest of the *Querco petraeae-Carpinetum melicetosum uniflorae* subassociation; a protected stand in the National Nature Reserve, very attractive for tourism.

4. **Devínska Kobyľa 2 (DK2):** 48°10' N, 16°59' E, GRN 7868a, 300 m a.s.l. 40-60 years old oak-hornbeam forest belonging to the *Aceri-Carpinetum* association; study site situated within the National Nature Reserve.

5. **Devínska Kobyľa 3 (DK3):** 48°11' N, 16°59' E, GRN 7868a, 452 m a.s.l. 80 years old thermophilous oak-hornbeam forest of the *Primulo veris-Carpinetum* association; study plot located in the area of the National Nature Reserve; forest is affected by tourism.

6. **Dúbravská Hlavica (DH):** 48°11' N, 17°00' E, GRN 7868a, 350 m a.s.l. 80-100 years old oak-hornbeam forest of the *Querco petraeae-Carpinetum typicum* association; relatively well-preserved forest.

7. **Fúgelka (FU):** 48°22' N, 17°19' E, GRN 7669b, 350 m a.s.l. 80-100 years old oak-hornbeam forest *Galio sylvaticae-Carpinetum* facies with *Rubus fruticosus* and *R. hirtus* (oceanic species); economically exploited forest with approx. 20 year old underplanting of *Acer pseudoplatanus* in lines due to transformation from a low forest to high-trunked forest.

8. **Horský park (HP):** 48°09' N, 17°05' E, GRN 7868a, 212 m a.s.l. Fragmented remnant of an 80 years old oak-hornbeam forest of the association *Querco petraeae-Carpinetum* variant with *Melica uniflora*; an isolated, fragmented forest park, strongly used by human.

9. **Koliba (KO):** 48°10' N, 17°06' E, GRN 7868b, 380 m a.s.l. 90-100 years old oak-hornbeam forest belonging to the *Querco petraeae-Carpinetum melicetosum uniflorae* subassociation; commercially used suburban forest.

10. **Lošonec háj grove (LH):** 48°28' N, 17°24' E, GRN 7570b, 260 m a.s.l. 80-100 years old oak-hornbeam forest *Querco petraeae-Carpinetum caricetosum pilosae*; Nature Reserve; economically exploited forest surrounded by closed forest complexes.

11. **Lošonec lom quarry (LL):** 48°29' N, 17°23' E, GRN 7570a, 340 m a.s.l. 80-100 years old oak-hornbeam forest *Querco petraeae-Carpinetum caricetosum pilosae*; economically exploited forest, intensively and systematically impacted by dust from the quarry.

12. **Mlynská dolina (MD):** 48°09' N, 17°04' E, GRN 7868a, 190 m a.s.l. An isolated, fragmented 80-100 years old maple-hornbeam forest of *Aceri-
Carpinetum association; surrounded by road communication and the urban agglomeration; intensively affected by tourism and recreation.

13. **Vinosady (VI)**: 48°19' N, 17°17' E, GRN 7669d, 280 m a.s.l. 60-80 years old oak-hornbeam forest of *Querco petraeae-Carpinetum* variant with *Poa nemoralis*; economically managed forest, former vineyard, neighbouring with drier subxerophilous meadows and shrub complexes.

Two study plots situated in oak-hornbeam forests were selected in the Trnavská pahorkatina hills (Fig. 1):

1. **Horný háj grove (HH)**: 48°29' N, 17°27' E, GRN 7570b, 240 m a.s.l. 60-80 years old oak-hornbeam forest *Querco petraeae-Carpinetum* variant with *Melica uniflora*; economically exploited forest, former vineyard; larger complex of isolated forest surrounded by vineyards and farmland.

2. **Lindava (LI)**: 48°22' N, 17°22' E, GRN 7670a, 240 m a.s.l. 80-100 years old oak-hornbeam forest of *Quercetum petraeae-cerris*; Nature Reserve; former economically exploited forest; large complex of island forest surrounded by fields and road.

For a detailed characteristic of the study plots (soil properties, floristic compositions, expositions, slope etc.) see Zlinská et al. (2005) and Holecová et al. (2012).

The pseudoscorpions were collected by the square method combined with sifting. At app. 1-month intervals the material was collected from the leaf litter and the upper part of soil from 16 squares at each study plot. Each square has included 25x25 cm of the area, i.e. altogether an area of 1 m² was sifted, representing one sample. The samples were extracted using xereclectors of the Moczarski - Winkler’s type. The specimens were preserved in 80 % ethyl alcohol and were studied as permanent slide mounts. The specimens were identified using the keys of Beier (1963), Mahnert (2004) and Christophoryová et al. (2011c). The nomenclature for all taxa follows Harvey (2011). The material is deposited in the Comenius University in Bratislava, Slovakia.

Following abbreviations of all developmental stages are used in the text: ♀ – female, ♂ – male, Tn – tritonymph, Dn – deutonymph, Pn – protonymph; abbreviations of study plots vide supra.

**RESULTS AND DISCUSSION**

A total of 4051 pseudoscorpion specimens of 12 species and four families were examined during the research in the whole study area (Table 1). The species *Roncus* sp. was identified only on the genus level. 578 specimens of seven species were collected in Trnavská pahorkatina hills, 3473 of 11 species in Malé Karpaty Mts. (Table 1). The most specimens were recorded at study plots Koliba, Fúgelka and Lindava; the lowest amount of them at study plot Vinosady. The most species were identified from Dúbravská Hlavica. On the contrary, the lowest species number was recorded at study plot Vinosady. The species *Neobisium carcinoides* was common for all the study plots, *Roncus* sp. and *Chernes cimicoides* were found only at one study plot (Table 1).

The list of the species with examined material and their distribution is given below (abbreviations of study plots and developmental stages see in Material and methods).
Family Chthoniidae Daday, 1888

*Chthonius* (*Ephippiochthonius*) *boldorii* Beier, 1934

Chthonius (Ephippiochthonius) fuscimanus Simon, 1900


Distribution: Austria, Croatia, Germany, Italy, Slovakia (Harvey, 2011; Christophoryová et al., 2012).

Chthonius (Ephippiochthonius) tetrachelatus (Preyssler, 1790)


Distribution: Austria, Czech Republic, Georgia, Germany, Italy, Slovakia, Turkey (Harvey, 2011; Christophoryová et al., 2012).
Family Neobiidae Chamberlin, 1930

**Neobius (Neobius) carcinoides (Hermann, 1804)**

Remark: *N. carcinoides* is considered to be eurytopic, mainly epigeic species and often the most common species of the family of Neobiidae (Beier, 1963; Christophorová, 2009).
**Neobisium (Neobisium) carpathicum** Beier, 1935


**HH:** 16/VII/2002, 1♂. **LI:** 26/IV/1999, 1♂, 3Tn. **Distribution:** Poland, Romania, Serbia, Slovakia (Harvey, 2011).

**Remark:** Some specimens were previously misidentified as *Neobisium erythrodactylum* (L. Koch, 1873), all misidentification were corrected in Christophoryová et al. (2012).

**Neobisium (Neobisium) sylvaticum** (C.L. Koch, 1835)

**Material examined:** DK2: 24/IX/1999, 1♂; 26/VII/2000, 1Dn. **DH:** 26/V/2006, 1Tn; 8/X/2005, 1Dn. **HP:** 7/IV/2005, 1♂; 29/VI/2005, 1Dn; 3/VII/2006, 1Tn; 1/IX/2006, 2Tn. **Distribution:** Albania, Armenia, Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Italy, Moldova, Montenegro, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Switzerland, Turkey, Ukraine (Harvey, 2011).

**Roncus sp.**

**Material examined:** HH: 6/VI/2001, 2Tn; 16/VII/2002, 1♂. **Remark:** This species was previously identified as *Roncus lubricus* L. Koch, 1873. The application of the karyological methodology approach and molecular data has recently enabled to recognize a cryptic species in this genus in Slovakia (Christophoryová & Štáhlavský, 2012). As long as the detailed redescription will not be done, the accurate identification is impossible.

**Family Cheliferidae Risso, 1826**

**Dactylochelifer latreilli** (Leach, 1817)

**Material examined:** DK1: 26/V/2006, 1Tn. **MD:** 29/VI/2005, 1Dn; 6/XII/2006, 1♀. **Distribution:** Albania, Algeria, Armenia, Austria, Azerbaijan, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Georgia, Germany, Greece, Hungary, Ireland, Italy, Kazakhstan, Netherlands, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Tunisia, Ukraine, United Kingdom (Harvey, 2011).

**Family Chernetidae Menge, 1855**

**Chernes cimicoides** (Fabricius, 1793)

**Material examined:** DK3: 5/IV/2005, 1♂. **Distribution:** Armenia, Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Georgia, Germany, Greece, Hungary, Ireland, Italy, Kazakhstan, Latvia, Netherlands, Norway, Poland, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Turkey, United Kingdom (Harvey, 2011).

**Chernes similis** (Beier, 1932)

**Material examined:** DK3: 3/VI/2005, 1♀, 1♂. **HH:** 8/X/2005, 1Tn. **DH:** 11/IX/2001, 1♀, 1♂, 1Tn, 1Dn; 16/VII/2002, 3♀♀, 45♀♀, 5Tn, 25Dn.
**Distribution:** Austria, Bulgaria, Czech Republic, Hungary, Macedonia, Montenegro, Poland, Romania, Slovakia, Turkey (Harvey, 2011; Novák, 2012).

**Remark:** This species was the most numerous one from the family of Chernetidae (Table 1). 110 specimens were found only at the study plot Horný háj, where the leaf litter containing high amounts of dead wood was sifted.

**Allochernes peregrinus** Lohmander, 1939  

**Distribution:** Austria, Czech Republic, Germany, Hungary, Poland, Slovakia, Switzerland, Sweden, U.S.A. (DeVore-Scribante, 1999; Harvey, 2011).

**Remark:** From the faunistic point of view, the record of this species is valuable; it is a rare species listed in the Red Data Book of the Czech Republic as vulnerable (Šťáhlavský & Ducháč, 2005).

**Pselaphochernes scorpioides** (Hermann, 1804)  

**Distribution:** Algeria, Armenia, Austria, Azerbaijan, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iran, Ireland, Israel, Italy, Latvia, Lebanon, Morocco, Netherlands, Norway, Pakistan, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Syria, Turkey, U.S.A., Ukraine, United Kingdom, Uzbekistan (Harvey, 2011).

**ACKNOWLEDGEMENTS**

I would like to express my thanks to my colleagues Milada Holecová, Zuzana Krumpálová and Ivan Országh for the collecting of the pseudoscorpion material. I acknowledge Juraj Holec for the design of the study area map. The research was financially supported by the VEGA 2/0035/13 project.

**LITERATURE CITED**


Table 1. List of the pseudoscorpion species and numbers of specimens collected at individual study plots in Malé Karpaty Mts. and Trnavská pahorkatina hills.

<table>
<thead>
<tr>
<th>Species</th>
<th>BR</th>
<th>CA</th>
<th>DK1</th>
<th>DK2</th>
<th>DK3</th>
<th>DH</th>
<th>FU</th>
<th>HP</th>
<th>KO</th>
<th>LH</th>
<th>LL</th>
<th>MD</th>
<th>VI</th>
<th>HH</th>
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<td>C. bockhorstii</td>
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<td>18</td>
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<td>C. fusciarius</td>
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<td>290</td>
<td>259</td>
<td>383</td>
<td>174</td>
<td>248</td>
<td>475</td>
<td>272</td>
<td>558</td>
<td>120</td>
<td>100</td>
<td>215</td>
<td>57</td>
<td>158</td>
<td>420</td>
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</table>

Figure 1. Study area of the Malé Karpaty Mts. and Trnavská pahorkatina hills with the position of all the study plots (design: Juraj Holec).
EFFECT OF SOME ECOLOGICAL FACTORS ON THE DISTRIBUTION AND DIVERSITY OF PYRGOMORPHIDAE (ORTHOPTERA: PYRGOMORPHOIDEA) IN PUNJAB OF INDIA

H. Kumar*, M. K. Usmani* and M. H. Akhtar*

* Section of Entomology, Department of Zoology, Aligarh Muslim University, Aligarh-202002, INDIA. E-mail: usmanikamil94@gmail.com


ABSTRACT: Twelve species of grasshoppers of family Pyrgomorphidae belonging to five genera and four tribes were collected during consecutive survey of Punjab. From Southwestern Punjab eleven species of grasshoppers collected belonging to four tribes and five genera. The value of Shannon Diversity index, Species richness, Evenness and Simpson’s dominance value are 1.92, 1.70, 0.80 and 0.19 respectively. From Central Punjab eight species of grasshoppers collected belonging to five genera and four tribes. The value of Shannon Diversity index, Species richness, Evenness and Simpson’s dominance value are 1.86, 1.11, 0.89 and 0.15 respectively. From Eastern Punjab seven species of grasshoppers collected belonging to two genera and two tribes. The value Shannon Diversity index, Species richness, Evenness and Simpson’s dominance value are 1.42, 1.22, 0.73 and 0.31 respectively.

KEY WORDS: Ecology, Distribution, Diversity Pyrgomorphidae, Orthoptera, Punjab, India.

Punjab has been divided into South-Western Punjab, Central Punjab and Eastern Punjab on the basis of soil and climatic conditions. South-western Punjab includes the districts bordering Haryana and Rajasthan and having some arid climatic conditions. In Central Punjab the climatic conditions are semi-arid type. While the Eastern Punjab covers the districts which are present in the foot hills of Himachal Pradesh and the climatic conditions are sub-humid type.

Pyrgomorphidae is a family of the Order Orthoptera belonging to suborder Caelifera under the superfamily Pyrgomorphoidea. The members of this family are commonly known as gaudy grasshoppers. Pyrgomorphids are very colorful insects and due to their bright colours they seem to be poisonous to their predators(called aposematic colouration). It contains 29 genera and at least 70 species and subspecies worldwide. They are characterized by the presence of fastigial furrow, lower basal lobe of hind femur longer than the upper one, absence of antennal grooves and Krauss’ organ and presence of apical fastigial areolae etc. The members of this family are mostly preferred to live in desert areas.

Grasshoppers constitute one of the largest and most diverse groups of insects causing damage to agricultural crops (Joshi et al., 1999) are considered as oligophagous (Mulkern, 1967). Studies on Ecological study of grasshoppers has been done by Mondal and Shishodia (1982), Julka et al. (1982), Tandon & Khera (1978) in India. Locusts are probably the most formidable enemy of man since the onset of agriculture. Although only a few species are considered serious pests, other non-gregarious species can become very dangerous when climatic conditions facilitate their multiplication. Therefore, it is necessary to have systematic knowledge of all locust species that settle in a territory. It no longer makes sense in the field of Acridology to publish taxonomical lists without the necessary basic environmental species distribution data (Lecoq, 1991). For this
region a preliminary inventory of Pyrgomorphoidea in relation to different vegetation types in the three different regions of Punjab is provided.

The present study is mainly based on a few ecological aspects such as distribution, diversity and host plant interaction of Pyrgomorphid insects in three different regions of Punjab. The specimens are deposited in Insect Museum, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India.

**MATERIALS AND METHODS**

1. **Study area:** The present study was conducted in the Punjab state which is situated in the northwest India. It stretches from 29º32' to 32º32'N latitude and 73º55' to 76º50'E longitude, occupying a land of 50,362 sq. kms in the northwestern part of India. Its average elevation is 300 m from the sea level. On the basis of soil types Punjab can be divided into following three distinct regions.

   **A. South-western Punjab**
   This region covers Muktsar, Bhatinda, Mansa, Faridkot and Ferozepur which border Haryana and Rajasthan states in the south-west. The soil is predominantly calcareous, developed under hot and arid to semi-arid conditions. The pH value ranges from 7.8 to 8.5 which shows that the soil is normal in reaction. Temperature ranges from 2°C to 48°C and annual rainfall is 380-450 mm.

   **B. Central Punjab**
   The region covers the districts of Sangrur, Ludhiana, Jalandhar, Kapurthala, and Amristar. The soil of this zone is of semi-arid type showing sandy loam to clayey with pH ranging from 7.8 to 8.5. Problem of alkalinity and Salinity is quite acute, especially in districts of Amristar, Sangrur. The soil of the central zone is generally recognised as alluvial. Temperature ranges from 4°C to 45°C and annual rainfall is 680-780 mm.

   **C. Eastern Punjab**
   The soil has developed in the sub-humid foothill areas bordering Himachal Pradesh covering eastern parts of Gurdaspur, Hoshiarpur, Rupnagar and Nawanshahar district etc. Because of the undulating topography and fair amount of rainfall, normal erosion is quite common. The fertility of the soil is medium to low and the texture is loamy to clayey. The soil is neutral in reaction (pH 6.5 to 7.5). Temperature ranges from 4°C to 44°C and annual rainfall is 780-900 mm.

2. **Collection of grasshoppers**
Authors surveyed agricultural crops and grassland ecosystems of Punjab to collect the grasshoppers and locusts during the period 2011 and 2012. They were caught by hands, forceps, and through the ordinary aerial insect net. The net was used for catching insects individually or by sweeping on grasses, bushes and other vegetables. Attempts were made to collect the specimens from their host plants. The collected specimens were killed in cyanide bottles.

3. **Preparations for morphological studies**
Dry mounts were prepared for better understanding the certain characters like size, colour, texture etc. For this purpose, the specimens were first relaxed, stretched, later pinned and labeled. Complete records were also maintained indicating the reference number, locality, data of collection and name of host plants. Permanent collections of pinned specimens were kept in store boxes and cabinets for further studies on their morphological structures.
4. Preparations for genitalic studies
For detailed study, permanent slide of their genatalic structure (Supra anal plate, Sub genital plate, Epiphallus, Aedeagus, Ovipositor and Spermatheca) were prepared, examined under the microscope and drawings were made with the help of Camera Lucida. Details were filled in by conventional microscope examination.

5. Data analysis
Diversity indices, richness, evenness and dominance were calculated by using SPECDIV program

A. Shannon and Wiener (1963) diversity index: \(H = -\sum pi \log pi\)
B. Species richness \(SR = (S-1)/\ln N\),

C. Simpson’s Dominance:
\[\lambda = \sum \frac{ni(ni-1)}{N(N-1)}\]

D. Evenness \(J = H/\ln S\)
Where \(H = \) Species diversity, \(Pi = ni/N\) is the probability of an individual to belong to a species, \(ni = \) Number of individuals of one species in sample, \(\ln = \) Natural log, \(N = \) Total number of individuals in samples, \(R = \) Species richness, \(S = \) Total number of species, \(J = \) Evenness, \(\lambda = \) Dominance

RESULTS

In the present study authors collected 155 specimens of the family Pyrgomorphidae from different hosts and various areas of Punjab. In all, twelve species belonging to five genera and four tribes were identified (Plate 1: Table 1). From South-western Punjab region seventy eight specimens of the family were collected. The collected materials include eleven species belonging to four tribes and five genera (Plate 1: Table 2). The maximum number of specimens collected were of *Chrotogonus trachypterus trachypterus* species (Plate 2: Figure 1). The value of Shannon Diversity index 1.92 shows moderate range of diversity. Species richness, Evenness and Simpson’s dominance value are 1.70, 0.80 and 0.19 respectively. In this region maximum numbers of specimens were collected from grasses followed by jowar and then oak (Plate 3: Figure 5). From the central Punjab region fifty one specimens were collected having the eight species over five genera and four tribes (Plate 1: Table 3). Specimens of *Atractomorpha psittacina psittacina* were in maximum number from this region (Plate 2: Figure 2). The value of Shannon Diversity index 1.86 shows medium range of diversity. Species richness, Evenness and Simpson’s dominance value are 1.11, 0.89 and 0.15 respectively. In central Punjab the maximum number of samples were collected from grasses followed by paddy and then oak (Plate 3: Figure 5). Twenty six individuals were collected from the eastern region of Punjab. These individuals include seven species from two genera and two tribes (Plate 1: Table 4). Specimens of *Atractomorpha psittacina psittacina* were also in maximum number in this region (Plate 2: Figure 3). The value of Shannon Diversity index 1.42 shows lesser range of diversity. Species richness, Evenness and Simpson’s dominance value are 1.22, 0.73 and 0.31 respectively. In this region the maximum catch was from paddy followed by grasses and then maize (Plate 3: Figure 5).

No record of Pyrgomorphid grasshoppers occurs from punjab except Thakur *et al* (2004) who reported only two species of Pyrgomorphidae i.e. *Atractomorpha crenulata crenulata* and *Chrogonus trachypterus trachypterus* out of 21 species representing 19 genera of Acridoidea from Roper wetland
Punjab. Tewari & Kaushal (2007) worked on insect’s diversity in Himalayan Tarai region. Similarly Usmani et al., (2010) reported only four species of Pyrgomorphidae out of 33 species from Western Uttar Pradesh whereas Usmani and Nayeem 2012 also reported four species of Pyrgomorphidae out of 37 species from Bihar while no species have been described by Nayeem and Usmani 2012 from Jharkhand. Paulraj et al in 2009 studied the distribution of grasshoppers from two districts of Tamil Nadu and described five species of Pyrgomorphidae out of 33 species of grasshoppers. Shoshodia and Gupta (2009) reported seven species of Prygomorphidae out of 165 species from Himachal Pradesh. The comparison in the values of Shannon Diversity, Species richness, Evenness and Simpson’s dominance are shown in Plate 3: figure 1, 2, 3 and 4 respectively.

**DISCUSSION**

Agriculture is one of the largest industries in Punjab and provides maximum amount of cereals and food grains to India. Locusts and grasshoppers cause considerable damage to agricultural crops which produce food both for humans and livestock. Keeping the economic importance of these insect pests, systematic and ecological studies were undertaken. Due to low diversity index from all three regions of Punjab, Pyrgomorphids can not be considered as major pests but its plague may be. Since South-Western Punjab is more diverse among three that indicates favourable climatic factors for the family, hence needs attention from agricultural community. Due to Biting and chewing type of mouthparts grasshoppers tear plant tissue and feed on foliage, flowers, fruits, seed heads, stems causing heavy loss in agriculture industry. To increase the yield it is recommended to control these pests for the sake of agriculture.

**ACKNOWLEDGEMENTS**

Authors are grateful to Department of Science & Technology, New Delhi for financial assistance. Authors are also thankful to Prof. Irfan Ahmad, Chairman, Department of Zoology, Aligarh Muslim University, Aligarh for providing necessary facilities.

**LITERATURE CITED**


Table 1. Showing species of family Pygromorphidae collected from Punjab.

<table>
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<tr>
<th>S. No.</th>
<th>FAMILY</th>
<th>TRIBES</th>
<th>SPECIES</th>
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<td>1.</td>
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<td>Chrotonogus oxyturus (Blanchard)</td>
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<tr>
<td>2.</td>
<td></td>
<td>Chrotonogus trachypus torquatus (Blanchard)</td>
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</tr>
<tr>
<td>3.</td>
<td>Pygromorphidae</td>
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<tr>
<td>4.</td>
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<td>Chrotonogus armatus Steinmann</td>
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<td>Pygromorphidae</td>
<td>Atractornora angusta Karsch</td>
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<td>6.</td>
<td></td>
<td>Atractornora brevicauda Bolivar, l.</td>
<td></td>
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<tr>
<td>7.</td>
<td>Pygromorphidae</td>
<td>Atractornora crenelata crenelata (Fabricius)</td>
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<td>8.</td>
<td>Pygromorphidae</td>
<td>Atractornora psittacea psittacea (Haan)</td>
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<td>9.</td>
<td></td>
<td>Atractornora psittacea psittacea Bolivar, l.</td>
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<tr>
<td>10.</td>
<td>Pygromorphidae</td>
<td>Pygromorpha consors consors (Oliver)</td>
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<td>11.</td>
<td>Poecilocerini</td>
<td>Zorites squamosus brevicauda (Kirby)</td>
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<td>12.</td>
<td></td>
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Table 2. Showing distribution of species in different districts of South-Western Punjab.

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<td>Chrotonogus trachypus torquatus (Blanchard)</td>
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<tr>
<td>3.</td>
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<td>4.</td>
<td>Chrotonogus armatus Steinmann</td>
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<td>5.</td>
<td>Atractornora brevicauda Bolivar, l.</td>
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<td>6.</td>
<td>Atractornora crenelata crenelata (Fabricius)</td>
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<td>7.</td>
<td>Atractornora psittacea psittacea (Haan)</td>
<td>+</td>
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<td>8.</td>
<td>Atractornora psittacea psittacea Bolivar, l.</td>
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<tr>
<td>9.</td>
<td>Pygromorpha consors consors (Oliver)</td>
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<tr>
<td>10.</td>
<td>Zorites squamosus brevicauda (Kirby)</td>
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<tr>
<td>11.</td>
<td>Poecilocerus pictus (Fabricius)</td>
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Table 3. Showing distribution of species in different districts of Central Punjab.

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<tr>
<td>2.</td>
<td>Chrotonogus armatus Steinmann</td>
<td>+</td>
</tr>
<tr>
<td>3.</td>
<td>Atractornora angusta Karsch</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>Atractornora psittacea psittacea (Haan)</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td>Atractornora psittacea psittacea Bolivar, l.</td>
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<tr>
<td>6.</td>
<td>Pygromorpha consors consors (Oliver)</td>
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<tr>
<td>7.</td>
<td>Zorites squamosus brevicauda (Kirby)</td>
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<tr>
<td>8.</td>
<td>Poecilocerus pictus (Fabricius)</td>
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</tbody>
</table>

Table 4. Showing distribution of species in different districts of Eastern Punjab.

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<tr>
<td>2.</td>
<td>Chrotonogus armatus Steinmann</td>
<td>+</td>
</tr>
<tr>
<td>3.</td>
<td>Atractornora angusta Karsch</td>
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<td>4.</td>
<td>Atractornora brevicauda Bolivar, l.</td>
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</tr>
<tr>
<td>5.</td>
<td>Atractornora crenelata crenelata (Fabricius)</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>Atractornora psittacea psittacea (Haan)</td>
<td>+</td>
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<td>7.</td>
<td>Atractornora psittacea psittacea Bolivar, l.</td>
<td>+</td>
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PLATE 1
Figure 1. Percentage occurrence of different species of Pygromorphidae in South Western Punjab.

Figure 2. Percentage occurrence of different species of Pygromorphidae in Central Punjab.

Figure 3. Percentage occurrence of different species of Pygromorphidae in Eastern Punjab.

PLATE 2
Comparision of Shannon Diversity of three different regions of Punjab

Comparision of Species richness of three different regions of Punjab

Comparision of Evenness of three different regions of Punjab

Comparision of Simpson’s Dominance of three different regions of Punjab

Showing Number of individuals on different host plants in three different regions of Punjab

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

PLATE 3
A PECULIAR NEW SPECIES OF *ENTEDON DALMAN, 1820* (HYMENOPTERA: EULOPHIDAE) FROM ŞANLIURFA PROVINCE, TURKEY

Mikdat Doğanlar*

* Mustafa Kemal Üniversity, Faculty of Agriculture, Department of Plant Protection, 31034, Hatay, TURKEY. E-mail: doganlar@mku.edu.tr


ABSTRACT: A peculiar new species, *Entedon bakacakicus* Doğanlar of the sparetus-group of *Entedon* Dalman (Hymenoptera: Eulophidae) was described from Şanlıurfa Province, Turkey. Some diagnostic characters of the new species were illustrated, and its taxonomic position was discussed.

KEY WORDS: Hymenoptera, Entedon, morphology, new species, Şanlıurfa, Turkey.

*Entedon* Dalman, 1820 (Eulophidae, Entedoninae) comprises small to middle-sized (1.8–8.8mm long) parasitoid wasps, which are endoparasitoid koinobionts of beetles, chiefly Curculionidae (Dalman, 1820; Boucek & Askew, 1968; Graham, 1971; Schaff, 1988; Rasplus, 1990; Noyes, 2012).

The *E. sparetus* species group was initially formalized as the subgenus *Megalentedon* by Erdős (1944). Then it was treated as a group of species related to *E. sparetus* Walker by Graham (1963, 1971), which was accepted thereafter (Askew, 1992; Gumovsky, 1997a). Gumovsky and Boyadzhiev (2003) studied Bulgarian species of *Entedon*, including the sparetus-group, and Gumovsky (2007) made a taxonomic revision of the *Entedon sparetus* species group of Palearctic region.

The aim of this work is describe an interesting peculiar new species in Entedoninae, as a part of forthcoming works on the revision of *Entedon* species of Turkey.

This study is based upon examination and identification of the specimens collected from Bakacak, Akçakale, Şanlıurfa (Turkey). The examined specimens were deposited in Insect Museum of Plant Protection Department, Agriculture Faculty, Mustafa Kemal University, Antakya, Hatay, Turkey (MKUI). Specimens were collected by sweeping and putting the whole contents of the swept materials directly in 96 % ethanol. After sorting the materials, individuals were stuck on card for morphological studies. Wings and antennae of male paratype were slide-mounted in Canada balsam. Morphological terminology follows Gibson (1997) and Gumovsky & Boyadzhiev (2003). Abbreviations used in the key and descriptions are OOL=distance between ocello-ocular line, POL= distance between posterior ocelli, MDO= distance between median and dorsal ocelli, OCL=distance between dorsal ocellus and occipital carina.

*Entedon bakacakicus* sp. nov.

(Figs. 1-3)

**Diagnosis.** Mesoscutum and scutellum with unusual broad, coarse reticulations medially, meshes are about 3 times wider than meshes on side part, side lobes finely reticulated. Head with frons having coarse reticulations. Fore tibia with
dorsal pale longitudinal stripe along entire tibia. Metasoma as long as head plus mesosoma. Female antenna with 3 funicle, 2 club segments, male antenna with 4 funicles, one club segment. Breadth of mouth opening twice as long as malar space. Clypeus reticulate, its anterior margin weakly produced. Apical margin of forewing of female almost bare, without fringe, but that of male very short fringe on posterior margin apically.

**Description.**

**Female.** (Fig. 1a,b). Length 2.4 mm. Body metallic blue, with bronze tint. Entire antennae dark. Legs dark, except knees, extreme distal ends of tibiae and first two tarsomere of mid and hind legs, pale, apical ones dark; fore leg with tarsi pale brown. Dorsal pale longitudinal stripe on fore tibia discernible along entire tibia. Fore wing hyaline, veins dark brown.

Head (Fig. 1c,d) in dorsal view 2.85 times as broad as long; POL: OOL: MDO: OCL= 27 : 11 : 15 : 3 in holotype. Occipital margin distinctly sharp. Eye with short sparse setae, eye height 2.9 times as long as malar space. Head in facial view 1.5 times as broad as long. Interocular distance 1.9 times as long as eye breadth. Malar sulcus fine, genae with fine reticulation. Breadth of mouth opening twice as long as malar space. Clypeus reticulate, its anterior margin weakly produced. Frons with coarse reticulations as (Fig. 1d).

Antennae (Fig. 2c) inserted slightly above the level of ventral eye margins. Antennal scape of female 7.0 times as long as broad; pedicel about 3.0 times as long as broad; F1 about 2.3, F2 1.6, F3 1.5 times as long as broad, clava two-segmented, about 2.25 times as long as broad, slightly more than 1.5 times longer than the preceding segment, with terminal spine almost null.

Mesosoma (Fig. 1b) as long as broad. Pronotal collar not carinated, postero-lateral corners of pronotum evenly rounded, pronotum 3.2 times as broad as long. Mesoscutum 2.4 times as broad as long, notauli traced anteriorly as very fine sutures, medially with 15 broad coarse reticulations, which are about 3 times wider than meshes on side part, side lobes finely reticulated (Fig. 1c); scutellum slightly longer than broad and 1.3 times as long as mesoscutum, its surface coarsely reticulated, but medially meshes narrower than ones on sides, which are about 3 times wider than meshes on median part (Fig. 1b,f). Propodeum 0.3 times as long as broad, and about half length of scutellum, propodeal surface coarsely reticulate medially and finely reticulate on callus, median carina complete, lateral sulcus complete; supracoxal flange moderate; spiracular elevation with blunt projection below, propodeal callus with 2 long setae. Hind coxa reticulate dorsally. Fore femur about 3.3 times as long as broad, fore tibia 7.3 times as long as broad, 0.8 times as long as its femur; mid femur 3.5 times as long as broad; mid tibia 6.3 times as long as broad, spur of mid tibia as long as breadth of tibia, 0.6 times as long as dorsal margin of mid basitarsus; hind femur about 3.6 times as long as broad, hind tibia about 7.4 times as long as broad, spur of hind tibia about 0.8 times as long as breadth of its tibia, about 0.7 times as long as dorsal margin of hind basitarsus. Hind tarsus 0.7 times as long as its tibia, mid tarsus 0.8 times as long as its tibia. Ratio of tibiae and tarsi of holotype are as follows: fore tibia : tarsus 44 : 40; fore tarsomeres: 8 : 10 : 6 : 8 (+ pretarsus 8); mid tibia : tarsus 63 : 50; mid tarsi: 16 : 12 : 10 : 10 (+ pretarsus 8); hind tibia : tarsus 74 : 50; hind tarsi: 11 : 17 : 10 : 10 (+ pretarsus 7). Fore wing (Fig. 2a) 2.1 times as long as broad; costal cell bare, comparatively wide, 7.5 times as long as broad, as long as marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein as long as stigma vein; speculum open; apical margin without fringe (Fig. 2b). Petiole about 0.4 times as long as broad. Metasoma as long as head plus
mesosoma, about 1.7 times as long as broad; syntergum 0.5 as long as broad, about two-tenth of length of the metasoma.

**Male.** (Fig. 3a) length 2.3 mm. Similar to female except as follows: Head as in fig.3c. Scutellum with coarse reticulation medially, and laterally with broad reticulations (Fig. 3b) Antenna (Fig. 2d) with 4 funicle, one club segments, scape 2.5 times as long as broad, pedicel 1.6 times as long as broad; 1st funicle segment 1.6 times as long as broad, and 1.7 times as long as pedicellus, 2nd segment 1.25 times as long as broad, 0.7 times as long as 1st segment; 3rd segment 1.25 times as long as broad, and as long as 2nd segment; 4th segment 0.9 times as long as broad, 0.7 times as long as 3rd segment; club twice as long as broad (including spicula), spicula 1/5 length of club. Plesiome (Fig. 3d) almost as long as broad. Metasoma 0.7 times as long as head plus mesosoma, about 1.8 times as long as broad.

**Type material.** Holotype ♀, Bakacak, Akçakale, Şanlıurfa, Turkey, 36 43 85 N; 38 49 52 E, 773 m, swept from Cercium sp., M. Doğanlar (ICMKU). Paratype: 1♂, same data as Holotype. The types were deposited in Insect Museum of Plant Protection Department, Agriculture Faculty, Mustafa Kemal University, Antakya, Hatay, Turkey (MKUI).

**Remarks.** The new species belongs to the sparetus-group (Graham, 1971) of Entedon in having fore tibia with dorsal pale longitudinal stripe along entire tibia, other tibiae mostly darkened, trochanters darkened, occipital margin sharp, anteriar margin of clypeus truncate; speculum open. Entedon bakacakicus n.sp. is close to E. thomsonianus Erdős in having fore wing margin without fringe, but it can be easily distinguished from the latter species and as well as other species of the genus in having unusual sculpture on mesosoma.

**Etymology.** The species name is derived from the type locality Bakacak.

**LITERATURE CITED**


Figure 1. Entedon bakacakicus n. sp. Female. a. body in dorsal view; b. head and mesoscutum and scutellum; c. head, in dorsal view; d. head, in frontal view; e. mid lobe of mesoscutum; f. scutellum, propodeum, anterior part of metasoma. Scale bar for a= 0.50 mm; for b, c, f= 0.30 mm; for d= 0.25 mm; for e= 0.10 mm.
Figure 2. *Entedon bakacakicus* n. sp. a-c. female. a. forewing; b. apical margin of forewing; c. antenna; d. male antenna. Scale bar for a=0.125 mm; for b= 0.05 mm; for c, d= 0.10 mm.

Figure 3. *Entedon bakacakicus* n. sp. Male. a. body, in lateral view; b. head and mesosoma, in dorsal view; c. head, in frontal view; d. part of propodeum and anterior part of metasoma. Scale bar for a= 0.50 mm; for b, c= 0.30 mm; for d= 0.25 mm.
NEW EVIDENCE ON THE DISTRIBUTION OF OXYTHYREA CINCTELLA (SCHAUM, 1841) IN THE CRIMEA, UKRAINE (COLEOPTERA: SCARABAEOIDEA: CETONIINAE)

Igor V. Kizub*

* Department of Experimental Therapeutics, Institute of Pharmacology and Toxicology of National Academy of Medical Sciences of Ukraine, 03680, Kiev, UKRAINE. E-mail: buzzmann@ukr.net


ABSTRACT: The paper presents new faunistic information regarding *Oxythyrea cinctella* (Schaum, 1841) species (Coleoptera: Scarabaedae: Cetoniinae) distribution in the Crimea, Ukraine. An updated map of *Oxythyrea cinctella* (Schaum, 1841) distribution in Palearctic region is given.

KEY WORDS: *Oxythyrea cinctella*, Coleoptera, Scarabaeidae, Cetoniinae, Crimea, Ukraine.

The genus *Oxythyrea* Mulsant, 1842 belongs to the subtribe Leucocelina of the tribe Cetoniini Leach, 1815 and comprises 10 species distributed in the Western Palearctic (Sabatinelli, 1981; Krikken, 1984; Smetana, 2006; Tauzin, 2012). Based on external morphology and structure of aedeagus three groups of species (Sabatinelli, 1981) are divided among the Mediterranean species of the *Oxythyrea* genus: *O. funesta*, *O. abigail*, and *O. cinctella* (Sabatinelli, 1981; Vasko & Gerasimov, 2005). Until recently only the species *Oxythyrea funesta* (Poda von Neuhaus, 1761) had been known from Ukraine, widely distributed over its territory (Medvedev, 1964; Vasko & Gerasimov, 2005). Recently, a new species for Ukraine, *Oxythyrea cinctella* (Schaum, 1841), has been reported by Vasko & Gerasimov (2005) recorded from the Crimean Peninsula (Karadag). Three males of this species were collected in the Kurortnoe village environs of Feodosia district by R. Gerasimov and D. Kurinnyi (Vasko & Gerasimov, 2005). We have obtained new evidence on the distribution of *Oxythyrea cinctella* in the Crimea based on our collected material and material collected by G. Shayakhmetova and O. Kharchenko at the same location: Novy Svet village, Sudak district.

MATERIALS AND METHODS

The insects were collected manually in the daytime in the Sudak district of the Crimean Peninsula, Ukraine. The material used for this study is deposited in the private collection of the author, Kiev, Ukraine. The following keys were used for the identification of the specimens: Medvedev (1964), Vasko & Gerasimov (2005), and Rittner & Sabatinelli (2010).

RESULTS AND DISCUSSION

*Oxythyrea cinctella* (Schaum, 1841)

**Synonyms:** albella Illiger, 1802 (*Cetonia*); variegata Pallas in Gory & Percheron, 1833 (*Cetonia*); longula Desbrochers des Loges, 1872 (*Cetonia*); cinctelloides Reitter, 1898 (*Leucocelis*); natalia Olsoufieff, 1916 (*Leucocelidia*); cinctella ab. confluent Petrovitz, 1970; cinctella ssp. taftanensis Montreuil & Legrand, 2008. All the synonyms are given according to Tauzin (2012).
**Material examined:** Ukraine, the Crimea, Sudak dist., Novy Svet vill., 22-29. 05. 2011, Kizub I.V. leg. et det., 2 males and 1 female; Ukraine, the Crimea, Sudak dist., Novy Svet vill., 11-16. 06. 2012, Shayakhmetova G.M. and Kharchenko O.I. leg., Kizub I.V. det., 1 female. The studied material is deposited in the private collection of the author, Kiev, Ukraine.

**Chorotype:** Turano-Mediterranean (Carpaneto et al., 2000).

**Geographical distribution:** *O. cinctella* is widely distributed in the Palearctic region. The species is reported from **Croatia** (Medvedev, 1964; Alonso-Zaraza & Krell, 2004), **Montenegro** (Medvedev, 1964; Alonso-Zaraza & Krell, 2004; Smetana, 2006; Tauzin, 2012), **Eastern Serbia** (Medvedev, 1964; Alonso-Zaraza & Krell, 2004; Smetana, 2006; Gavriloîviç & Ćurčić, 2010), **Macedonia** (Medvedev, 1964; Alonso-Zaraza & Krell, 2004; Smetana, 2006; Rozner & Rozne, 2009a; Tauzin, 2012), **Albania** (Medvedev, 1964; Alonso-Zaraza & Krell, 2004; Smetana, 2006; Tauzin, 2012), **South Romania** (Medvedev, 1964; Alonso-Zaraza & Krell, 2004), **Bulgaria** (Medvedev, 1964; Bunański, 2000; Alonso-Zaraza & Krell, 2004; Smetana, 2006; Tauzin, 2012), **Greece** including Andikithira, Evia, Samothraki, Thasos, Northern Sporades, North Aegean, Ionian, and the Dodecanese Islands (Medvedev, 1964; Alonso-Zaraza & Krell, 2004; Smetana, 2006; Tauzin, 2012), **Crete** (Medvedev, 1964; Alonso-Zaraza & Krell, 2004; Tauzin, 2012), **Cyprus** (Medvedev, 1964; Tauzin et al., 2008), European and Asian parts of **Turkey** (Medvedev, 1964; Carpaneto et al., 2000; Alonso-Zaraza & Krell, 2004; Smetana, 2006; Tauzin et al., 2008; Şenyüz and Şahin, 2009; Rozner & Rozne, 2009b; Anlaş et al., 2011; Demirizer et al., 2011; Tauzin, 2012), **Syria** (Medvedev, 1964; Smetana 2006; Tauzin et al., 2008; Tauzin, 2012), **Lebanon** (Medvedev, 1964; Chikatunov & Pavliček, 1997; Smetana, 2006; Tauzin et al., 2008; Tauzin, 2012), **Israel** (Medvedev, 1964; Chikatunov & Pavliček, 1997; Smetana, 2006; Tauzin et al., 2008; Rittner & Sabatinelli, 2010; Tauzin, 2012), **Jordan** (Medvedev, 1964; Chikatunov & Pavliček, 1997; Smetana, 2006; Tauzin et al., 2008; Tauzin, 2012), the Sinai part of **Egypt** (Tauzin, 2012), **Ukraine** (Vasko & Gerasimov, 2005; Martynov, 2010), **Russian Caucasus** (Medvedev, 1964; Smetana, 2006; Tauzin, 2012), **Georgia** (Medvedev, 1964; Smetana, 2006; Tauzin, 2012), **Azerbaijan** (Medvedev, 1964; Smetana, 2006; Tauzin, 2012), **Armenia** (Medvedev, 1964; Iablokoff-Khnazorian, 1967; Smetana, 2006; Tauzin, 2012), **Iran** (Medvedev, 1964; Modarres Awal, 2006; Smetana, 2006; Montreuil & Legrand, 2008; Tauzin, 2012), **Iraq** (Smetana, 2006; Tauzin, 2012), **Kazakhstan** (Medvedev, 1964; Nikolaev, 1987; Smetana, 2006; Tauzin, 2012), **Uzbekistan** (Medvedev, 1964; Nikolaev, 1987; Smetana, 2006; Tauzin, 2012), **Kyrgyzstan** (Medvedev, 1964; Frotsenko, 1968; Nikolaev, 1987; Smetana, 2006; Tauzin, 2012), **Tajikistan** (Medvedev, 1964; Nikolaev, 1987; Smetana, 2006), **Turkmenistan** (Medvedev, 1964; Nikolaev, 1987; Smetana, 2006; Tauzin, 2012), **Afghanistan** (Medvedev, 1964; Smetana, 2006; Tauzin, 2012), **Pakistan** (Smetana, 2006; Tauzin, 2012), and **China** (Xinjiang province) (Medvedev, 1964; Nikolaev, 1987; Smetana, 2006; Tauzin, 2012).

The occurrence of *O. cinctella* in Portugal, Spain, and South Italy, including Sicily, previously reported by Medvedev (1964) was not confirmed by recent data (Blanco Villero, 1985; Mozos-Pascual & Martin-Cano, 1988, 1992; San Martin et al., 2001; Smetana, 2006; Tauzin, 2012).

In Ukraine *O. cinctella* is known to be an extremely rare species and so far it has only been reported from Karadag (Vasko & Gerasimov, 2005) and Novy Svet in the Crimea. Figure 1 shows *O. cinctella* records from the Crimean Peninsula. Based on the above-mentioned references and our findings from Ukraine, an updated map of *O. cinctella* distribution in the Palearctic region is presented in Figure 2. The present study reveals new evidence on the *O. cinctella* distribution in Ukraine and allows shifting the previously known northern border of the *O. cinctella* areal to the southern part of the Crimea (Fig. 2).

**Comparative notes:** *O. cinctella* can be easily distinguished from *O. funesta* (Poda von Neuhau, 1761), the only other known Ukrainian species of *Oxythyrea*, which is widely distributed in the Western Palearctic, by hairless upper surface of the body, the presence of only two white spots near the base of the pronotum, the wide white border along the whole length of the pronotum sides, the white spots on the sides of the mesosternum, and by the absence of the longitudinal row of white spots in the middle of the 1st through 4th abdominal sternites (Medvedev, 1964; Vasko & Gerasimov, 2005).

From *O. noëmi* Reiche & Saulcy, 1856, which is closely related to *O. cinctella* and belongs together with this species to the «cinctella» species group (Sabatinelli, 1981; Vasko...
& Gerasimov, 2005), *O. cinctella* can be distinguished by the presence of only two white spots on the pronotum (Medvedev, 1964; Sabatinelli, 1981; Rittner and Sabatinelli, 2010). The distribution of *O. noëmi* is limited to Cyprus, Lebanon, Syria, Israel, Jordan, Turkey and the Sinai part of Egypt (Smetana, 2006; Rittner & Sabatinelli, 2010; Tauzin, 2012).

A few aberrations of *O. cinctella* have been described (Tauzin, 2012), notably the white spots of the pronotum and the elytra can decrease or disappear (ab. *cinctelloides* Reitter, 1898), enlarge (ab. *natalia* Olsoufieff, 1916), or merge (ab. *confluens* Petrovitz, 1970).

Some authors (Tauzin, 2012) relate *O. cinctella* to the subgenus Leucocelidia designated by Olsoufieff (1916) but synonymised by Smetana (2006) with the genus *Oxythyrea* Mulsant, 1842.

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Figure 1. Map of Oxythyrea cinctella (Schaum, 1841) known localities in the Crimea, Ukraine: 1 - Novy Svet; 2 - Kurortnoe (Vasko and Gerasimov, 2005).

Figure 2. An updated map of Oxythyrea cinctella (Schaum, 1841) distribution: 1 – Locality in Ukraine.
FIRST RECORD OF PARACOCCUS MARGINATUS (HEMIPTERA: PSEUDOCOCCIDAE), AN INVASIVE ALIEN SPECIES ON PAPAYA (CARICA PAPAYA L.) IN JAMMU (J&K), INDIA

Sheetal Sharma*, Sanjay Bhatia, Jyoti Sharma, Sarit Andotra, Madhu Sudan and Kapil Sharma

* Department of Zoology, University of Jammu, Jammu Tawi-180006, J & K, INDIA. E-mail: Sheetal613@gmail.com


ABSTRACT: The papaya mealybug, Paracoccus marginatus, an invasive alien species found to heavily infest papaya (Carica papaya), the major host. Paracoccus marginatus (Hemiptera: Pseudococcidae), was first described by Williams and Granara de Willink in 1992. It is a polyphagous species native to Mexico and Other Central American Countries. It is also recorded from many countries of the Caribbean region, causing huge economic losses to papayas since 1994. Paracoccus marginatus is a small hemipteran that attacks several genera of plants (more than 40 species), including economically important fruits, vegetables and ornamentals. It potentially posed a serious threat to numerous agricultural crops. Integrated pest Management (IPM) was identified as a key component in a management strategy for the papaya mealybug. Paracoccus marginatus damaging papaya in Jammu region is reported for the first time. Besides it, the fundamental biological data of Paracoccus marginatus, its existing host plants and its distribution in India and around the world was described.

KEY WORDS: Papaya mealybug, Paracoccus marginatus, Carica papaya, host range, control, Jammu (J&K).

Papaya mealybug, Paracoccus marginatus is an invasive pest and most of the mealybugs (Hemiptera: Pseudococcidae) are serious pests of agricultural plants, horticultural plants and ornamentals. Papaya mealybug, Paracoccus marginatus Williams & Granara de Willink was recently found in Jammu (J&K). It is a polyphagous species native to Mexico and Other Central American Countries and became a pest when it invaded the Caribbean region. Since 1994, it has been recorded from many countries and distributes over a wide range in the world (Tanwar et al., 2010). This pest induces leaf yellowing, reduce plant growth and destroy fruits of the host plants. Papaya mealybug was reported infesting papaya plants in Jammu (J&K), India for the first time in May 2009. The pest was observed to spread rapidly and occurred in large colonies on all aerial parts of the plant, including leaves and fruits. This paper summarizes the information collected on the identity, host plants, distribution and damage caused by mealybug and the control measures adopted against it.

MATERIAL AND METHODS

Sampling
The infested area was visited in June 2009, immediately after the problem was reported. Mealybugs were collected from 4 locations for identification. The insects collected from infested plants material were brought to the laboratory and
transferred from infested papaya plants fragments to glass vials. The three quarters of the vial was then filled with 90% ethanol, labeled, sealed and immersed in a water bath (100°C) for 20 minutes.

Identification

Preserved specimens and live mealybugs were studied under a binocular microscope to observe morphological and taxonomic characters for identification. The preserved samples (each containing approximately 70 specimens including all developmental stages were collected from host plant *Carica papaya* L. from four different locations in Jammu, (J&K) and was initially determined by comparison with descriptions given by Miller & Miller (2002) and then authoritative identification was made by using keys and description given by Williams & Granara de Willink (1992).

OBSERVATIONS AND DISCUSSION

Distribution

*Paracoccus marginatus* was originally reported from the Neotropical region including Mexico, Belize, Costa Rica, Guatemala (Williams & Granara de Willink, 1992) and subsequently from the Caribbean region, Florida, Antigua, British Virgin Islands, Montserrat, United States, St. Kittis and Nevis (Watson and Chandler, 1999) and also in Cuba, Dominican Republic, Haiti, Puerto Rico, St. Marten, Guadeloupe, St. Barthelemy, Barbados and St. Lucia.

In India, pest was reported from Tamil Nadu, Karnataka, Andhra Pradesh, Kerala, Tripura, Odisha and Maharashtra.

Hosts

The papaya mealybug is a polyphagous pest, which was recorded from at least 22 plant families and over 40 species that includes economically important crops such as papaya, cassava, citrus, *Annona* sp., sweet potato, peas, beans, ochro, egg plant, guava, *Acacia*, *Morus alba*, cotton, Red gram (*Cajanus cajan*), tomato (*Lycopersicon esculentum*), *Allamanda*, *Acalypha*, *Hamelia*, *Frangipani*, *Mangifera*, capsicum and ornamental plants such as hibiscus, *Jathropha*, and Leander and weeds such as sida, *Ipomoea* and *Parthenium* (Ben-Dov, 2008; Miller & Miller, 1999; McComie, 2000; Meyerdirk et al., 2000).

Morphological and taxonomic characteristics of papaya mealybug, *Paracoccus marginatus*

**Adult female**

Adult females are soft bodied about 2-3 mm long and 1.4 mm wide covered with mealy white wax and the body contents are yellow. The surface wax on the dorsum showed transverse creases between the body segments. The mature female secreted an ovisac of white wax filaments from the ventral margins of the abdomen which eventually extended three to four times to the body length and entirely covered the female. Slide mounted adult female possess upto 18 pairs of cerarri on body margins, eight segmented antennae, ventral anal lobe bars, translucent pores on the hind coxa and usually on the tibia, auxiliary setae are present in the anal lobe cerarri only and oral rim ducts are present somewhere on the body. Dorsal surface with short slender setae; cerarri numbering 16 or 17 pairs only; oral rim tubular ducts restricted to marginal area of dorsum and venter; hind legs with translucent pores present on coxa only (Williams & Granara de Willink, 1992; Miller & Miller, 2002; Walker et al., 2003; Heu et al., 2007).
Adult male

The adult male appears yellow and approximately 1.0 mm long with an elongate oval body widest at the thorax (about 0.3 mm). The antennae were 10 segmented; the thorax and head were heavily sclerotized and a pair of lateral pores clusters occurred near the apex of the abdomen. The lateral pore clusters secreted a pair of white wax caudal filaments.

Biology

Mealybugs were most active in warm and dry weather and had piercing and sucking type of mouth parts and fed by inserting their mouth parts into the plant tissue and sucked the sap. Females had no wings and moved by crawling to short distances or blown in air currents. A female laid 200-500 eggs in an ovisac that is 3 to 4 times the body length and entirely covered with wax. The ovisac was developed ventrally on the adult female. Egg laying usually occurred over the period of one to two weeks. Eggs were greenish yellow in color and hatched in about ten days. Nymphs or crawlers actively searched feeding sites. Female crawlers have four instars with a generation taking approximately one month to complete depending on the temperature. Males have five instars, the fourth instar was produced in a cocoon and referred as pupa. The fifth instar of the male was the only winged form of the species capable of flight. Adult females attracted the males with sex pheromones. Reproduction occurred throughout the year and there were several generations per year.

Seasonal occurrence

Adults breed throughout the year, though activity slows down during December to March. During winter the papaya mealybugs remained confined to the covered parts of the host and became more active during pre-monsoon and monsoon period i.e. May to September. A widespread infestation occurred with hundreds of similar aged nymphs gregariously on the papaya. During these outbreaks, each papaya fruit and leaf of the infested plants fully covered with the mealybugs.

Damage

*Paracoccus marginatus* attacked and damaged various parts of the host plant including the leaves, stems, flowers and fruits. On lightly infested plants, papaya mealybugs looked like small pieces of cotton masses attached to the aerial parts of the plant. On severe infested plants, this symptom was more prominent as the insects were attached to the fruits and looked like the oozing of milky sap.

The papaya mealy bugs feeds on the sap of the plants by inserting its stylets into the epidermis of the leaf, as well as into the fruits, flowers and stems. In doing so, it injected a toxic substance into the plant parts. New flushes of growth on damaged plants were deformed due to toxicity of the saliva injected into the plant by the mealybugs while feeding.

The infestation led to chlorosis, plant stunting, leaf deformation, early leaf and fruit drop and a heavy build up of honey dew. Honey dew excreted by the mealybugs resulted in heavy sooty mould growth. The sooty mould turned the leaves completely black, blocking out light and air, so interfering with photosynthesis. Heavy infestations are capable of rendering fruit inedible due to the buildup of thick white wax. Heavily attacked plants were killed (Walker et al., 2003; Hue et al., 2007).

Damage symptoms of different parts of the host plant

Leaf damage – Curling, crinkling, rosetting, twisting and general leaf distortion; reduced in leaf size and surface area.
Stem and shoot damage - Shoots and young stems distorted and malformed; arrested growth at the shoot terminals lead to shortened internodes and rosetting at the shoot tip.

Flower damage - Flowers also distorted and failed to open; where they open, petals became twisted or malformed or show various types of blemishes. Premature flower drop and poor fruit set occurred.

Fruit damage - Fruits failed to develop normally and such fruits eventually shrivel and drop. Fruit blemish and sooty mould reduced the market value of the fruit.

Pest significance

Paracoccus marginatus attacks over 40 species of plants, field crops, fruit trees, ornamentals, weed and scrub vegetation. The potential economic loss due to this pest has not been quantified. It is a serious risk when infested plants material is transferred from place to place. The waxy secretions with papaya mealy bugs may become attached to animals or birds or human clothing and may be transported from one place to another place in this way. ‘Crawlers’ may also become wind borne and be transported from place to place.

Outbreak and control of Papaya Mealybug

The pest was first observed on papaya crop (Carica papaya L.) in Jammu during 2009-2010. Rapid spread of Paracoccus marginatus among agricultural and horticultural crops of economic importance was noticed and the pest emerged as a serious threat to papaya crop. It was necessary to take up immediate steps to manage it in the places of occurrence to limit the yield and crop losses.

An integrated pest management (IPM) including cultural practices, chemical and biological control can be applied to manage papaya mealybug. The parasitoid natural enemies of the papaya mealybug include Acerophagus papaya, Anagyrus loecki, Anagyrus californicus Compere, and Pseudaphycus sp. (Noyes & Schaff, 2003). All the above parasitoids have been observed attacking 2nd and 3rd instar nymphs but not capable of reducing high population of this pest in a short period. Spalgius epius Westwood (Lepidoptera: Lycaenidae) being the dominant predator, feeds efficiently on the ovisacs, nymphs and adults of the papaya mealybug (Tanwar et al., 2010). The predatory larvae could devour about 42 to 53 (48.15± 4.08) ovisacs and 196 to 222 (210.99± 10.77) nymphs and adults of Paracoccus marginatus (Thangamalar et al., 2010) during the whole larval period (Chen et al., 2011). Botanical insecticides such as neem oil (1 to 2%), NSKE (5%), or Fish Oil Rosin Soap (25 g/L) and chemical insecticides such as profenophos 50 EC (2 mL/L), chlorpyriphos 20 EC (2 mL/L), buprofezin 25 EC (2 mL/L), dimethoate 30 EC (2 mL/L) etc were suggested to control this pest (Thangamalar et al., 2010). However, papaya mealybug is difficult to control because it inhabits protected areas such as cracks and under the bark of their host plants, where cultural practices and chemical control treatments are difficult to reach. Integrating monitoring and pest control measures are necessary for crop production.

ACKNOWLEDGEMENTS

The authors are greatly thankful to Head, Department of Zoology, University of Jammu for providing necessary facilities to work.
LITERATURE CITED


A NEW SPECIES OF DORCADION DALMAN, 1817 FROM TURKEY (COLEOPTERA: CERAMBYCIDAE)

Hüseyin Özdikmen* and Özgür Koçak**

* Gazi Üniversitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü, 06500 Ankara / TÜRKİYE. E-mail: ozdikmen@gazi.edu.tr
** Karaman, TURKEY. E-mail: turkelebek@yahoo.com


ABSTRACT: The following new taxon is described: Dorcadion (Cribridorcadion) karamanense sp. n. from Karaman province (Turkey), close to D. oezdurali Önalp, 1988.

KEY WORDS: Cerambycidae, Dorcadioninae, Dorcadion, new species, Turkey.

Dorcadion (Cribridorcadion) karamanense sp. n.
(Figs. 1, 2)


Description:

Body length: 14.3 mm.

Body black or blackish-dark brown, covered with very dense, recumbent, short yellowish-white pubescence.

Head completely black with very dense, recumbent, short yellowish-white pubescence; on vertex with two triangular areas of blackish-brown ground hairs. Antennae completely black or blackish-dark brown; first and second antennal segments covered with very dense, recumbent, short yellowish-white pubescence.

Pronotum with three (2 lateral and 1 median) complete longitudinal bands of dense yellowish-white hairs. Median band complete. Each medio-lateral part on pronotum (between lateral and median hairy bands) with distinct longitudinal dark part that forms dense, recumbent blackish-brown pubescence. They extends to the triangular areas on vertex. Punctuation of pronotum invisible. Lateral process of pronotum rather short, but rather pointed.

Scutellum triangular, but more or less rounded apically; margins of scutellum with very dense, recumbent, short yellowish-white pubescence.

Elytra with very dense, recumbent, blackish-brown ground pubescence and with patterns shaped as bands of dense recumbent yellowish-white hairs.

Each elytron with 5 bands as lateral, humeral, dorsal, presutural and sutural. Lateral band rather thick and complete. In dorsal view, this band invisible. Humeral and dorsal bands combined, but interrupted almost behind the middle of elytron; this combined band with spotted by elytral ground pubescence, thicker than lateral band and reaches to elytral apex. Presutural band distinctly and longitudinal. Sutural band the thinnest band on elytron. Elytral apex flattened and rounded.

Apex of pygidium visible in dorsal view.
Abdomen black or blackish-dark brown with very dense, recumbent, short yellowish-white pubescence except middle parts of 1-4\textsuperscript{th} sternites that have very sparsely pubescence.

Legs completely black or blackish-dark brown; with very dense, recumbent, short yellowish-white pubescence.

**Differential diagnosis.** The new species definitely belongs to the subgenus *Dorcadion* (*Cribridorcadion*) Pic, 1901. It is closely related to *D. oezdurali* Önalp, 1988 (Fig. 3).

*D. oezdurali* was described by Önalp (1988) from Kahramanmaraş province in Eastern Mediterranean Region of Turkey. She compared the species only with *D. smyrnense* (Linnaeus, 1757). Pesarini & Sabbadini (1998) also compared the species with *D. smyrnense* (Linnaeus, 1757) and *D. lohsei* Braun, 1976 and accepted as a distinct species. According to Özdikmen (2010), *D. oezdurali* is distributed only in Kahramanmaraş province in Turkey (Map 2).

The new species is easily distinguished from *D. oezdurali* Önalp, 1988 by first and second antennal segments that covered with very dense, recumbent, short yellowish-white pubescence (at most with sparsely pubescence in *D. oezdurali*); very widened area of yellowish-white hairs on vertex between triangular areas that are smaller (narrowed area of whitish-gray hairs on vertex between triangular areas that are larger in *D. oezdurali*); the interruption of humeral and dorsal bands (combined or not combined) on the upperside almost evenly truncated (the interruption of humeral and dorsal bands (combined or not combined) on the upperside more or less obliquely truncated in *D. oezdurali*); head without median glabrous line (head with a median glabrous line in *D. oezdurali*); much denser yellowish-white pubescence (dense whitish-gray pubescence in *D. oezdurali*).

**Variability of paratypes.** Body length changes between 14.3 mm in male and 15 mm in female. Body width changes between 6 mm in male and 7 mm in female. In female, humeral and dorsal bands especially on the basal half of elytra not combined and abdomen completely covered with very dense, recumbent, short yellowish-white pubescence.

**Etymology.** From the type locality “Karaman”.

**LITERATURE CITED**


Figure 1. *D. karamanense* sp. n. (holotype ♂).
Figure 2. *D. karamanense* sp. n. (allotype ♀).

Map 1. Location of Karaman province that is the type locality of *D. karamanense* Özdikmen & Koçak sp. n..

Map 2. Location of Kahramanmaraş province that is the type locality of *D. oezdurali* Önalp, 1988.
DISTRIBUTION AND DIVERSITY OF HEMIPTERA FAUNA OF SINGHORI WILDLIFE SANCTUARY, RAISEN DISTRICT, MADHYA PRADESH, INDIA

Kailash Chandra* and Sandeep Kushwaha**

* Zoological Survey of India, ‘M’ Block, New Alipore, Kolkata-700 053 West Bengal, INDIA. E-mail: kailash611@rediffmail.com
** Zoological Survey of India, Central Zone Regional Centre, Scheme No. 5, Plot No. 168-169, Vijay Nagar, Jabalpur-482 002 Madhya Pradesh, INDIA. E-mail: sandeepkushwaha_17@yahoo.com


ABSTRACT: The study yielded the identification of 38 species belonging to 13 families of the order Hemiptera and all these species are reported first time from this sanctuary.

KEY WORDS: Singhori Wildlife Sanctuary, Hemiptera.

Singhori Wildlife sanctuary is located in Raisen district of Madhya Pradesh with headquarter at Bari, which is situated on NH 12, 249 km away from the Jabalpur. Sanctuary lies between 22°45' and 22°55' N latitudes and 77° 15' and 78° 00' E longitudes (Fig-1). This SWLS was notified on 2nd July 1976 vide Govt. of Madhya Pradesh notification no. 15/4/76/10/2 dated 02.07.1976. Most of the area of sanctuary is hilly and consist of hills, valleys, gorges and at places plains. There are two main streams in the sanctuary, Ghoghara and Barna respectively. Barna dam is the only permanent water source for sanctuary and its wildlife, whereas a large area of the sanctuary gets dry during summers. Mixed and deciduous are two main forest type. *Tectona grandis* is dominant species of the sanctuary, *Anogeissus latifolia*, *Pterocarpus marsupium*, *Boswellia serrata*, *Terminalia alata*, and *Dendrocalamus strictus* are the others crops of the sanctuary.

Hemiptera is a diverse group of true bugs. There are 133 families of Hemiptera found worldwide, consisting about 184000-193000 species (Hodkinson & Casson, 1991). A detailed account of Hemiptera fauna of central India had been done by Distant (1902, 1904 & 1906). Later on brief account of this order were described by Ghosh & Biswas (1995), Ramakrishna et al. (2006), Chandra (2000, 2008 & 2009), Chandra et al. (2010), Chandra et al. (2011), Chandra et al. (2012), Chandra et al. (2012) respectively from Madhya Pradesh. Present paper reports 38 species of bugs from the sanctuary.

MATERIAL AND METHODS

During the four years survey (2009-2012) of the sanctuary by the Zoological Survey of India Jabalpur, altogether 256 bugs were collected from various localities of the WLS viz., Bamhori, Belgaon, Sitapur, Jaitagarh, Siyalwada, Peer Badanala, Gaganwada, etc. (Fig. 2) by hand picking, net trap and light tarp methods. The specimens were shorted out and bugs were pinned and dried and identified with the help of literature available. Morphology of bugs were studied by Leica microscope M 205-A.
### RESULTS

List of Hemiptera studied from Singhori Wildlife Sanctuary, Madhya Pradesh.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>SUBORDER / INFRAORDER / SUPERFAMILY / FAMILY / SPECIES</th>
<th>No. of Ex.</th>
<th>Locality In SWLS</th>
<th>Occurrence</th>
<th>Date of Collection</th>
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<tr>
<td>1</td>
<td><em>Callitettix versicolor</em> (Fabricius), 1794</td>
<td>2</td>
<td>Bajani</td>
<td>R</td>
<td>08.xii.10</td>
</tr>
<tr>
<td>2</td>
<td><em>Poophilus costalis</em> (Walker), 1851</td>
<td>1</td>
<td>Jaitgarh</td>
<td>VR</td>
<td>17.ix.11</td>
</tr>
<tr>
<td>3</td>
<td><em>Dictyophorus pallidus</em> (Don.) 1800</td>
<td>1</td>
<td>Bambori</td>
<td>VR</td>
<td>01.iv.11</td>
</tr>
<tr>
<td>4</td>
<td><em>Dictyophorus consanguinea</em> Distant 1906</td>
<td>1</td>
<td>Sitarpur</td>
<td>VR</td>
<td>21.ix.11</td>
</tr>
<tr>
<td>5</td>
<td><em>Tribelocephala indica</em> (Walker) 1873</td>
<td>3</td>
<td>FRH Baddi</td>
<td>L</td>
<td>04.ix.2000</td>
</tr>
<tr>
<td>6</td>
<td><em>Scadra annulipes</em> Reuter 1881</td>
<td>5</td>
<td>Bambori</td>
<td>H</td>
<td>17.ix.09</td>
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<td>8</td>
<td><em>Polidius armatissimus</em> Stal, 1855</td>
<td>8</td>
<td>Naya Kheda</td>
<td>VH</td>
<td>11.iv.11</td>
</tr>
<tr>
<td>9</td>
<td><em>Onchocephalus schloethei</em> Reuter 1883</td>
<td>2</td>
<td>Bambori R H</td>
<td>R</td>
<td>03.iii.11</td>
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<tr>
<td>10</td>
<td><em>Prostenina carduelis</em> Dohrn 1859</td>
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<td>Siyalwada</td>
<td>R</td>
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<tr>
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<td><em>Ectomocoris cordiger</em> Stal 1855</td>
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<td>Puratala</td>
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<td>12</td>
<td><em>Spilostethus hospes</em> (Fabricius), 1794</td>
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<tr>
<td>13</td>
<td><em>Spilostethus panduris militaris</em> (Fabricius), 1775</td>
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<td>14</td>
<td><em>Metochus uniguttatus</em> (Thunberg), 1822</td>
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<td>Bambori R.H.</td>
<td>H</td>
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<tr>
<td>15</td>
<td><em>Elastomolus sordidus</em> (Fabricius), 1787</td>
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<td>Kartholi</td>
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<td>16</td>
<td><em>Physopelta gutta</em> (Burmeister), 1834</td>
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<td>17</td>
<td><em>Dysdercus koenigii</em> (Fabricius), 1775</td>
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<td>Banuri</td>
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<td>18</td>
<td><em>Antilochus coqueberti</em>, (Fabricius)1803</td>
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<td>Bambori RH</td>
<td>VH</td>
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<tr>
<td>19</td>
<td><em>Anoplocnemis phasiana</em> (Fabricius), 1781</td>
<td>1</td>
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<td>20</td>
<td><em>Elastomolus granulipes</em> (Westwood), 1842</td>
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<td>Kartoli</td>
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<td>21</td>
<td><em>Scrinetha abdominalis</em> (Fabricius), 1803</td>
<td>3</td>
<td>Kukwara</td>
<td>L</td>
<td>06.xii.10</td>
</tr>
</tbody>
</table>
Abbreviation used: VH—Very high; H—High; L—Low; R—Rare; VR—Very Rare; FRH—Forest Rest House; SWLS—Singhori Wild Life Sanctuary, DDM—Degrees and Decimal Minutes.

Geographical coordinates: All GPS reading was used in DDM format.

<table>
<thead>
<tr>
<th>S. No.</th>
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<th>Longitude</th>
<th>Altitude (m)</th>
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<td>Baddi FRH</td>
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<td>Bajliya Gaon</td>
<td>23°14.317N</td>
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<td>5</td>
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<td>Nava Kheda</td>
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<td>12</td>
<td>Sivalwada</td>
<td>23°08.752N</td>
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**DISCUSSIONS**

Bugs mainly occur as a pest on various plants. Present paper deals with study of 37 genera belonging to 38 species of order Hemiptera. All of them are reported
first time from records SWLS, belonging to 13 families of order Hemiptera. Of these, 4 species belong to suborder Auchenorrhyncha and 34 species to suborder Heteroptera. Family Pentatomidae and Reduviidae respectively show the maximum diversity among all the families.

ACKNOWLEDGEMENT

The authors are thankful to Dr. K. Venkataraman, Director Zoological Survey of India for providing necessary facilities and encouragement.

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Distant, W. L. 1904. The fauna of British India including Ceylon and Burma, I: 26-416.


Locality map of SWLS.
A NEW SPECIES OF APATOPHYSIS CHEVROLAT, 1860 FROM JORDAN (COLEOPTERA: CERAMBYCIDAe)

Pierpaolo Rapuzzi* and Gianfranco Sama**

* via Cialla, 48, 33040 Prepotto (UD), ITALY. E-mail: info@ronchidicialla.it
** via Raffaello 84, 47023 Cesena (FC), ITALY. E-mail: francescama@gmail.com


ABSTRACT: In this paper we describe a new species of Apatophysis Chevrolat, 1860 from Jordan and Syria. The new species is related with Apatophysis caspica Semenov, 1911 from Caspian area.

KEY WORDS: Cerambycidae, Apatophysis, new species, Jordan, Syria.

Among several Cerambycidae collected by prof. Katbeh-Bader Ahmad (Department of Plant Protection, Faculty of Agricultur, University of Jordan in Amman) we found a small series of Apatophysis that belong to a new species, related to Apatophysis caspica Semenov, 1911 from Caspian region.

Apatophysis katbehi n. sp.
(Fig. 1)


Description of the Holotype.
Length 14 mm, width 5 mm. Body reddish, head and pronotum darker than elytra. Head long, antennal tubercles prominent, a thin a long groove between eyes and antennal insertion. Eyes moderately big. Puncture dense and made by small points; pubescence whitish, made by short and lying setae. Many thin, long erect hairs on labrum. Pronotum as long as wide, its disk with four small callosities, two just up the middle and flat, the other two behind the middle, smaller but a little more prominent. Side of pronotum parallel, with a small tooth just up to the middle. Puncture made by small points, denser on the disk and more sparse at the sides. Pubescence made by short lying whitish setae, denser at the sides; few erect long thin white setae at lateral margin. Scutellum short, rounded posteriorly, densely covered by whitish short lying setae. Elytra relatively short, acuminate towards apex, lightly emarginated just behind middle. Punctures small, not dense and arranged in more or less evident longitudinal rows. Punctures denser in the first half and smaller and sparse towards apex. Pubescence made by very short whitish short lying setae. Only few long and thin erect hairs just around the base. Legs long and slender. Middle and posterior femora with hair brushes. Antennae long, 3rd and 4th joints of the same size. Exceeding apex with the last three joints. All antennal joints covered by very short light hairs.
Variability of the Paratypes
The type series shows a size range from a minimum of 11 mm. and a maximum of 20 mm. in the males and from 20 to 22 mm in the females. The color of the teguments sometimes are darker or lighter than the holotype.

Females: darker and larger than males; the body pubescence is sparser and elytra are shining, the punctures are sparser and denser towards the base. Antennae are shorter than body reaching the last quarter of elytra.

Discussion
Apatophysis katbehi n. sp. belongs to Apatophysis caspica Semenov, 1901 group. This group consist of several species (some of them not so good characterized) widespread from Caucasus, Iran and Turkey: Apatophysis caspica Semenov, 1901 from Daghestan to Iran, West Kazakhstan and Northern Afghanistan, Apatophysis karsica Danilevsky, 2008 from NE Turkey, Apatophysis anatolica Heyrovsky, 1938 from Central Turkey, Apatophysis vedica Danilevsky, 2008 from Armenia, Apatophysis farsicola Sama, Fallahzadeh, Rapuzzi, 2005 from Central Iran and Apatophysis kadleci Danilevsky, 2008 from SE Turkey. According Danilevsky (2008) A. caspica group can be divided according the rate between length and wide of elytra: A. caspica and A. anatolica show the smaller rate between 2.0 and 2.1. A. katbehi shows a smaller rate: 1.7 -1.8. Moreover the pronotum is shorter, long as wide in the largest number of specimens or rarely larger than long. From Apatophysis farsicola it can be divided by the more acuminate elytra towards the apex and the higher rate between wide and length of elytra (2,0 – 2,1).

Etymology
We dedicate the new species to prof. Katbeh-Bader as thanksgiving for the opportunity that he gives us to study part of his Cerambycidae.

LITERATURE CITED


Figure 1. *Apatophysis katbehi* n. sp. (Holotypus male).
NATURAL HISTORY OF REDUVIUS PERSONATUS LINNAEUS
(HEMIPTERA: HETEROPTERA: REDUVIIDAE) IN NORTH AMERICA

M. Javahery*

*c/o Lyman Entomological Museum & Research Laboratory, Macdonald Campus, McGill University, St-Anne-de-Bellevue, Quebec, CANADA H9X 3V9. E-mail: javahery@videotron.ca


ABSTRACT: Reduvius personatus is commonly known as the masked bed bug hunter. It is a European species which has successfully adapted to life in North America, where it was introduced at an unknown date. My study of the biology, ecology and distribution of this insect is from 1997-2012 in southern Quebec and Ontario, Canada. Adults were found in spring and summer, both inside and outside dwellings. Third and fifth nymphs were present indoors during the winter as well. Third and fifth nymphal instars exhibited dormancy during the first and second winter, respectively. Nymphs exude a sticky substance which facilitates body-masking with dust particles. This camouflage has given rise to the alternative names “masked bug” or “masked bed bug hunter”. Mating occurs in a lateral orientation. Four successive generations reared over a decade showed a two-year life cycle. The adult morphology, first instar, characteristics of egg, embryonic development, feeding, mating, and cannibalistic behaviour were studied and are illustrated. The distribution in its adapted (North America) and native (Western Palaearctic) habitats was studied and mapped. This insect was not found to be harmful to humans and household pets. This is the first long-term natural history study of R. personatus, in North America.

KEY WORDS: Assassin bug, Life cycle, Ecology, Dormancy, Distribution.

Reduvius personatus is an European insect species described by Linnaeus (1758) and now widely distributed in the Western Palaearctic and parts of North America (Fig. 8) (Blatchley, 1926; Southwood & Leston, 1959; Schuh & Slater, 1995; Ambrose, 1999, 2000; Dusoulier, 2007; Putshkov & Moulet, 2009). The species is nocturnal, employs camouflage, and is known as “the Assassin bug” or “the masked bed bug hunter”. Adults and very rarely nymphs have been reported from Quebec (Moore, 1950; Larochelle, 1984; Javahery, 2002; Boucher, 2006), Ontario (Marshall, 2006; Javahery, 2008), British Columbia (Scudder, 1961, 1992), Kansas (Readio, 1927) and Illinois (McPherson, 1999). European researchers have undertaken numerous studies on this insect (De Geer, 1773; Butler, 1923; Fabre, 1923; Harz, 1952; Immel, 1955; Southwood, 1956; Putshkov, 1980, 1981, 1986, 1987; P. Putshkov & V. Putshkov, 1996; Moulet, 2002; Putshkov & Moulet, 2009). However, very little is known about its new world natural history and distribution.

The main objective of the present study was to undertake a long-term biological and ecological investigation of R. personatus over several generations using representative samples from southeastern Canada.

Four successive generations of this species were produced from adults collected in Quebec and Ontario over the last 10 years in order to determine the life cycle (especially nymphal dormancy), reproductive potential, embryonic development, and cannibalism. Another objective was to study and illustrate feeding and mating behaviour, characteristics of eggs, egg-shell, instars, adults, terminalia, and aedeagus. Distribution maps of R. personatus in its adaptive (Nearctic) and native (Western Palaearctic) habitats were also prepared. Results
are compared with relevant publications on this insect in Europe and North America.

This is the first long-term natural history study of *R. personatus*, in North America.

**MATERIALS AND METHODS**

The present study was based on 345 adults (143 males, 202 females), 57 nymphs (39 third, 18 fifth) collected manually in 12 localities in the western suburbs of Montreal, Ottawa and Toronto. Adults and nymphs were reared in clear-polystyrene vessels (10 x10 x 25 cm) with a mesh cover and containing several pieces of crumpled paper towels and twigs. They were fed 2-3 times /week with small (5-10 mm) soft-bodied, field-collected insects or larvae or laboratory–cultured larvae of the flour moth *Anagasta kiehiella* (Zeller). Eggs from the laboratory culture (n=500) were incubated in 35-mm clear-plastic Petri dishes. Embryonic development was monitored by dissecting 10 randomly selected eggs every generation in isotonic solution of 0.9% NaCl. The egg-cup was cut off just below the cup circle and placed in a drop of xylene and was later mounted on a microscope slide in Canada balsam. The micropylar processes were examined under 200X magnification with an electronic binocular microscope. Ten specimens of adults, nymphs, eggs and terminalia were selected at random and measured (in mm). The terminalia, aedeagus, egg-cup, and egg-burster were removed with fine forceps in a relaxing fluid of 75% ethanol and illustrated on graph papers with the aid of an eyepiece graticle (Figs. 1. 5). The drawings were then scanned and transferred to the computer. Images of live bugs were taken at night. All cultures were maintained under ambient room conditions of variable temperature (12- to 36°C), relative humidity (55-to 98%) and light.

Voucher specimens of eggs, nymphs and adults have been deposited in the Lyman Entomological Museum, McGill University. Nymphal specimens are very rare because of their camouflage with dust particles (Fig. 4). Only two third instar nymphs were checked at the Canadian and B.C. National insect Collections in Ottawa and Victoria, B.C., respectively. Adult specimens (n >1000) from the Nearctic (southern Canada and eastern United States) and Western Palaearctic Regions, deposited in the following institutions or museums, were examined. In addition, reduviid collections in eastern Argentina, Australia and China were checked:

<table>
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RESULTS AND DISCUSSION

The habitats
Adults and nymphs were mostly found in houses and rarely in out-houses. The favorite habitats of adults and 2nd, 3rd, 4th, and 5th instar nymphs were floors, stairs, basements, garages, crevices, cracks, corners, underneath household objects, storehouses, cellars and stables. Adults and nymphs were not detected outdoors during daylight hours but adults were often found after sunset on walls and foliage close to light fixtures. Mature insects were observed to fly short distances towards light and were commonly sighted outdoors in June and July. Only two live female adults were captured indoors mid-January and February, 2005. Several adults were captured on spider's webs near light fixtures in out-houses, near roof corners inside garages, and indoors within air conditioning-heating canals. Two live 3rd instar nymphs were found outdoors in late winter (March 18, 2001), on the wall of a dwelling in a dusty hole (2 x 9 cm) covered by a spider's web, in South Beaconsfield, Quebec. The hole was located between two bricks and under an external light fixture. Adults were also collected in the West Island area of Montreal which includes the townships of Beaconsfield, Ste-Anne-de-Bellevue, Kirkland, Pointe Claire, Ile Perrot, St. Lazare and Oka. Scudder (1961,1992) reported a large number at dockside warehouses in Vancouver, and also indoors and in garden sheds in Osoyoos, British Columbia. DeGeer (1773), Fabre (1903), Butler (1923), and Readio (1927,1931) reported the habitats of this insect, in Europe and Kansas, USA. Popov (pers. comm.) observed that a number of adults of R. personatus flew towards the light after sunset in early July 2002, near the Black sea area of Russia.

Characteristics of Egg, Nymph and Adult
Description of different stages were reported by several researches. Readio (1927, 1931), Putshkov & Moulet (2009) reviewed the literature and described the life stages from materials collected in Kansas, USA, and Europe, respectively.

The following brief descriptions of the egg, nymphs, and adult of R. personatus are based on materials from southeastern Canada, field-collected or cultured by the writer.

Eggs - Oblong-oval, 1 mm long and 0.4 mm wide, shining brownish-yellow colour, distinct brown cap and minute micropylar processes (Figs. 1A, B).
First instar - Length of body 2-3 mm; colour whitish, eyes reddish and bean-shaped. Hind legs longer than body (Figs. 2A, B).
Second instar - Length of body 3.5 - 4.5 mm; slightly darker in colour than the first instar. Dorsum of head and thorax distinctly sclerotized and brownish (Fig. 7. Top row of A).
**Third instar** - Length of body 6-7 mm; Colour darker than the second instar; abdomen whitish; head, thorax, legs and antennae more sclerotised and brownish; eyes reddish; wing pads present (Figs. 4A, B; 7 top row of A).

**Fourth instar** - Length of body 8-9 mm; colour as in third instar; abdomen slightly darker with five dark spots on lateral margins of segment 2-6; wing pads extending to second abdominal segment (Figs. 3A; 7 top row of A).

**Fifth instar** - Length of body 12-14 mm; head elongate, narrowed to neck basally, and widest across eyes; wing pads extend to middle of abdomen; colour similar to fourth instar (Figs. 3B; 7 top row of A).

**Adult** - Length of body 17-21 mm; Antennae four-segmented and filiform particularly segments III and IV; the ocelli very large, shining brownish-black hue; the femora-tibia joint and tarsi pale or honey-coloured; wings fully developed and extending to end of abdomen (Figs. 6A, B; 7A, B).

The antennae and legs of adult and instars are covered with dark fine and long setae.

**Food**

Fabricius (1775), in his first reference to this insect stated “Larva horrida, personata, consumit C. lectularius”, and Linnaeus (1758) gave a very brief statement, “The larva preys upon the common house bug”.

De Geer (1773), Fabre (1923), Butler (1923) and Readio (1927,1931) commented that this insect feeds on the larva and adult of a number of other insects. Ambrose (1999, 2000) stated that this insect feeds on insects and ticks. Putshkov and Moulet (2009) reviewed the prey taken by this insect and mentioned that it attacks and feeds on ectoparasites and arthropods such as dermestids, flies, mites, as well as the larva and adult of Lepidoptera and other Coleoptera.

The writer has had excellent success in rearing four successive generations of this insect on a diet of flies, small larvae and adults of other insects, swept from fields. As well, nymphs and adults of this insect were fed on cultured larvae and adults of the flour moth, when prey were scarce in the field in early spring and late summer (Table, 1).

Throughout the present studies, many observations on habits of this insect, such as capturing, killing and feeding have been made. A summary of these follows.

Adults and nymphs are attracted to prey by their movement. They approach a potential prey, quietly touching it gently with their antennae, then grabbing it with their front legs. It inserts its styloids into the softer parts of the victim, and injects its venom (Fig. 6A). The prey is paralyzed within 0.5 to 3 minutes. Feeding continues for several hours during which the predator may change its feeding position to the head, thorax, or the abdomen. The process of capturing and killing the prey is thus distinct from that of predatory pentatomids (Javahery, 1986). Although this reduviid was able to grab carpenter ants, it could not kill them, because this potential prey reacted quickly with bites to fend off attacks. Extensive feeding was observed during the pre-maturation stage. Cannibalism was observed in the adult stage in the absence of prey (Fig. 7B). Additionally, first instar nymphs fed on other immatures or eggs. The insects caught in field or reared in the laboratory to feed R. personatus in this study are shown in Table 1.

This bug has not been known to be harmful to humans, but Leconte (1855) reported that “when caught or unskillfully handled it always stings with its beak.” J.T. Polhemus (pers. comm. ) observed that the two cats in his home in Englewood, Colorado near Denver, left their sleeping pads after this reduviid began feeding on them. Also, M. Giroux (pers. comm), reported that a person in
Montreal, received a painful bite on his foot from this bug when putting on his boots. However, no biting incidents of humans or pets were observed during this study.

The venom responsible for killing prey or causing pain or irritation in humans and pets has not been analyzed.

**Reproductive Biology**

The terminalia of the male, the aedeagus and claspers (Figs. 5A to F) and female genital plates (Figs. 5G, H) are illustrated. Captured and reared insects were reproductively active during summer. Females exhibited a maximum of three upright eggs within each ovariole. The eggs within the ovariole are honey-coloured. Eggs are fertilized in the common oviduct through the micropyle channels on the egg-cap. This mechanism is similar to other Heteroptera as seen through scanning electron microscope (e.g., Acrosternum hilare (Say), Pentatomidae; (Javahery, 1994). Adults survived without food for 2-3 weeks but were sensitive to food deprivation during the development of eggs and oviposition. Extensive feeding, walking and short flights were observed during reproduction.

**Mating behavior**

Mating in most Heteroptera is end-to-end (e.g., Eurygaster integriceps Puton, Javahery 1995). However, in *R. personatus*, mating was observed to occur in a lateral orientation (Fig. 6B). In this case, the responsive female would move slightly forward, and then the male would mount it, holding on to both sides of the female’s thorax with its front legs and would rapidly touch the head, front legs, and antennae of the female. Several seconds later, the male would move slightly backward with his genitalia out-stretched and insert its aedeagus into the genitalia of the female. The male would then lie laterally alongside the body of the female throughout the mating episode. Dispons (1955) reported that the male of *R. personatus* puts its rostrum on the anterior margin of the female’s pronotum. Mating was observed to last several minutes to five hours, during which the female would feed or move short distances, carrying the male on her side. Females usually mate 4-6 times while nonresponsive females moved away quickly. Harz (1952) states that many matings are necessary to fertilize all the eggs.

**Fecundity and Longevity**

The number of eggs deposited by each female of *R. personatus* is reported by several writers. Fabre (1923) obtained from 30 to 40 eggs, but Readio (1927) stated the total number deposited during the life of the female was 273. The writer observed that on average a female deposits 3-5 eggs in 24 hours with a total of 48-157 eggs over her life time. Males lived an average of 68 days and females 88 days. The maximum longevity of a female was 217 days.

**Oviposition, Incubation, Embryonic development, and Hatching**

Fabre (1923) and Readio (1927) noted June was the time of egg laying, and that eggs are not attached to the substrate. Fabre gave an interesting account of the hatching process of this reduviid. The writer has had excellent success in observing the oviposition, incubation, embryonic development, and hatching of this insect during the study. My observations indicated that mated females began to lay eggs in June and continued until early autumn with 85 percent of the eggs laid in July to mid-August. Incubation of the eggs and development of the embryo occurred within a 2-3 week period (Fig. 1C). Up to 98 percent of the eggs hatched in the morning period in July and August. Fabre (1923) observed hatching during the night or early morning but Dispons (1955) states that in North Africa hatching in *R. personatus* take place at night as well as during the day. The role of
the egg-burster in hatching is similar to a number of other true bugs (Javahery, 1994). The egg-burster was found to be of distinct shape; it had two very long semi-chitinized horns attached to the embryonic membrane (Figs. 1D, E). The tooth of the egg-burster is located between the horns and the underlying eyes of the embryo (Fig. 1D). The chorionic incision for lifting the egg-cap to hatch, results from peristalsis and focused pressure of the egg-burster within the circle of micropylar processes (Figs. 1D, E). The first instars appeared from early August to the end of September and moulted into the 2nd stadium after two weeks. Aggregation of 1st instars around egg-shells, common in some true bugs (Javahery, 1994), was not observed in this insect.

Nymphal diapauses

Different accounts on the life cycle of R. personatus are reported in Europe and North America, particularly on nymphal diapause or overwintering. Diapause starts in early winter and terminate in spring. Third, 4th and 5th instars, but rarely 2nd instars, do not feed during winter in southern Quebec and Ontario.

The habits, stages of development, and life cycle of this insect have been mostly studied by European workers. References on the life cycle of this species in North America are very limited, especially in Canada. However, there is variation in the length of the stages, particularly during nymphal diapauses. A summary of what is known of nymphal development is given below:

Butler (1923) reported that the life cycle of R. personatus was nonseasonal in England, because the species is a household insect and lives indoors. He states that the imago has been found from May to September, but is associated more or less with places of human occupation, and has no definite seasons for the different stages.

Readio (1927) points to a seasonal life history; winter was spent as a nymph usually in the 4th or 5th instar, although as 3rd instars in a few instances, and normally became adults in May or June. Some, however, did not undergo the final moult until July and possibly August. De Geer (1773) and Poujade (1888) (in Butler, 1923) reported similar overwintering nymphal dormancy in the fifth stage and moultng to the adult in June of the following year. Putchkov (1986) observed one generation per year while overwintering as a 4th or 5th instar in England, Germany and the Ukraine. He also mentioned a two-year life cycle in Germany and the United States, where the nymphs spend the first winter in the third instar. Scudder (1992) reported a two-year life cycle, overwintering in the 3rd and the 5th instars in British Columbia, Canada.

This writer’s experience on overwintering nymphs in Quebec and Ontario during four generations points to a two-year life cycle with an obligatory diapause during the first winter in the 3rd instar and overwintering the following winter in the 5th (Table, 2). The insect normally becomes an adult in May and June. However, the writer has collected two individual adults indoors at a temperature of 20°C in late January 2005 and at 22°C in early February 2008. It would seem that two successive winter dormancies in R. personatus is obligatory and not induced by the environmental conditions as mentioned by Readio (1931) and Scudder (1992).

The two-year life cycle observed in the writer’s study in eastern Canada appears to be similar to that reported for R. personatus in the west coast of this country (Scudder, 1992). However, it is not yet clear, that this insect also has a proportion of its population with a single generation a year as in its habitats as in England, Germany and the Ukraine (Butler, 1923; Putchkov, 1986).
Origin and Distribution

There is no definite information as to the time that *R. personatus* was introduced into North America (Blatchley, 1926; Readio, 1927; Schaefer, 1988; Schuh & Slater, 1995; Maw et al., 2000; Putshkov & Moulet, 2009). However, examination of specimens deposited in the National Collection of Insects in Ottawa, other collections in Canada, and several in the USA, showed that the first female was captured in 1905 by Arthur Gibson in Ottawa, and the second in July 20, 1917 by C.E. Petch in Hemingford, Quebec. One specimen of *R. personatus* collected in the USA was in June 20, 1917 by R.I. Mitchell in Norwalk, Ohio.

This alien true bug, like the predatory *Picromerus bidence* (L.) and the plant feeder *Acrosternum hilare* (Say) (Javahery, 1986, 1990), is well adapted in its new environment in Canada and the eastern USA (Fig. 8). Because there is no record of the importation of this bug for evaluation as a potential biocontrol agent of house pest insects or spiders by either the Canadian or the U.S. Department of Public Health, Environment or Agriculture, it is believed to have been introduced accidentally, perhaps carried with household goods (probably transported in the 3rd or 5th instars) when people migrated from Europe sometime in the late eighteenth or early nineteenth century into Canada and eastern US.

*R. personatus* has a wide distribution (30°-52° latitude and 12W-67 E longitude) in North America (Uhler, 1886; Van Duzee, 1917; Blatchley, 1926; Readio, 1927; Maldonado-Capriles, 1990; Scudder, 1992; Maw et al., 2000; Javahery, 2002, 2008), and within 35°-63° latitude and 10 W to 65 E longitude in the Western Palaearctic (Southwood & Leston, 1959; Putshkov & Moulet, 2009).

This bug has rarely been reported from the west coast of USA. Wygodzinsky and Usinger (1964) stated: that it has been collected from the states of Washington, Oregon, Utah, Nevada, and Colorado, and also some from Arizona, but the species is significantly very rare in California, and was never reported in the literature. They also reported having seen only one specimen, a male, in the Department of Entomology, University of California, Davis.

Adults, and nymphs, deposited in the institutions and collections listed have been examined by the writer and in several cases by curators or heteropteran colleagues. According to the current survey, distribution of this insect appears to be expanding in Canada, with a gap in the central states (Alberta, Manitoba, Saskatchewan), and in the east (Nova Scotia, Prince Edward Island, Newfoundland). The species is established in eastern USA (Fig. 8). In Europe, the insect has been found from southern Sweden and Norway to North Africa, and from England and Estonia to the southern Caspian Sea. It has not been found in Finland (Fig. 8). The writer has not seen specimens of this insect in collections in eastern China, Australia, and Argentina.

CONCLUSIONS

*Reduvius personatus*, was introduced into Canada and the USA probably sometime in the late eighteenth or early nineteenth century. This alien species is established, although not numerous in Canada (southern Ontario, Quebec, New Brunswick, British Colombia) and in the eastern USA above 32° latitude.

The life cycle and distribution of this insect has been studied in Europe, but very little was done in North America.

This large assassin bug has a two-year life cycle, overwintering the first winter in the 3rd instar and in the second winter as a 5th instars. Mating is side-by-side (lateral orientation), whereas, this is end to end in a number of other Heteroptera. It oviposits singly, dropping eggs which do not adhere to the substrate or to other
eggs. The egg-shell is relatively thick with minute micropylar processes. The embryonic membrane has two long semi-chitinized hooks connected to the egg-burster. The bug can withstand food deprivation but cannibalism occurs in the absence of prey.

The two-year life cycle of this insect is also recorded in the USA, Germany, and Canada. Single generation or seasonal development reported in England, Germany, and the Ukraine, was not observed in Canada in Ontario, Quebec, and British Colombia. However, two individual adults where collected in January and February in Beaconsfield, west of Montreal, Quebec. Nymphs exude a sticky substance which facilitate body-masking with dust particles. This camouflage has given rise to the alternative names “masked bug” or “masked bed bug hunter.”

Nymphs did not feed from December to April, although food was always provided and temperature was maintained between 16-19°C with variable day light. They entered into dormancy for the two winters. It seems dormancy in this bug is obligatory and not induced by environmental temperature or humidity and light.

This species may depress the population of small, soft-bodied insects in houses and out houses and may be considered a useful predatory true bug. However, its long period of nymphal development, its low rate of reproduction, and the wide range of prey acceptance, are disadvantages if this species were to be considered for biological control of specific insect pests in houses.

More rearing experiments from different populations of this reduviid both in the original habitats (Europe) and its newly adapted environments (Canada and USA) would be desirable to determine whether a single generation occurs as well in North America. It will also be useful to rear this bug at different photoperiods during nymphal development to determine whether photoperiodism is a regulator of dormancy in this insect.

ACKNOWLEDGEMENTS

My thanks to all colleagues associated with the institutions and collections listed in the text for allowing me to examine specimens under their care. Special thanks to C.W. Schaefer, P. Moulet, R. Manuel and the late N. Barthakur for reviews on the manuscript; S. Boucher, J. Brambila, A. Buchaman, C. Buddle, M. Carver, G. Cassis, M. Coscaron, the late I.M. Kerzhner, R.E. Linnavuori, J.E. McPherson, G. Monteith, V. Rinne, G.G.E. Scudder, and T. A. Wheeler for useful comments or providing references. I also thank I. Ahmad, P. Azmayesh Fard, W. Cai. Guo-Qing, F. Cherot, C. Copley, M. Goula, M. Modarres Awal, J. Mohaghegh, K.M. Needham, D. Pluot-Sigwalt, Y.A. Popov, E. Ribes, J.F. Roch, J-C Streito, M. Tomokuni for data on locating; Belgique Hainaul Centre for image 5 (top) and R. Lemke for image 5 (bottom).

Further thanks are due to S. Brooks, M. Giroux, J. Mlynarek, and C. Borkent for the identification of dipteran preys; J. Macdonald, D. Edge, and A. Ghassemian for running computers.

Finally, I am indebted to my family for their patience and help in collecting bugs and preys.

LITERATURE CITED


Figure 1. Reduvius personatus – Egg, A; operculum with minute micropylar processes, B; 200X; developed embryo, C; hatching process while embryo is enveloped in membrane, D; operculum and egg-burster are attached on top of egg-shell, E; egg-burster, F.
Figure 2. *Reduvius personatus* – First instar, dorsal view, A; ventral view, B.
Figure 3. Reduvius personatus – 4th instar, A; 5th instar nymph, B.
Figure 4. Masked 3rd instar of *Reduvius personatus* A and B.
Figure 5. *Reduvius personatus* – Male terminalia: Ventral view, A; dorsal view, B; genital organs, C; right and left clasper D and E; aedeagus, F. Female terminalia: Ventral view, G; dorsal view, H.
Figure 6. Female *Reduvius personatus* feeding on a mayfly, A (scale bar = 8 mm); side by side (lateral) copulation of *Reduvius personatus*, B (scale bar = 10 mm).
Figure 7. Development of *Reduvius personatus*, A: Egg to nymphal development (top row of A); a pair of adult *R. personatus* with female on the right (bottom row of A) (scale bar = 8mm). B. Cannibalism (*Reduvius personatus*: female feeding on male).
Figure 8. Geographical distribution of *Reduvius personatus* in Canada and the U.S.A. (top). Distribution of *Reduvius personatus* in Western Palaearctic in this study (bottom).
Table 1. Insect prey of *R. personatus* in this study

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<tr>
<td></td>
<td>Heptageniida</td>
<td><em>Heptagenia limbata</em> Pict</td>
<td></td>
</tr>
<tr>
<td>Odonata</td>
<td>Libellulidae</td>
<td><em>Libellula insesta</em></td>
<td>Dragonfly</td>
</tr>
<tr>
<td>Homoptera</td>
<td>Cicadellidae</td>
<td><em>Chlorotettis unicolor</em> (Fitch)</td>
<td></td>
</tr>
<tr>
<td>Heteroptera</td>
<td>Miridae</td>
<td><em>Lygus lineolaris</em> P. de B.</td>
<td>Tarnished Plant bug</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>Pyralida</td>
<td><em>Anagasta kuehniella</em> (Zeller)</td>
<td>Flour mouth</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Plodia interpunctella</em> (Hubner)</td>
<td></td>
</tr>
<tr>
<td>Orthoptera</td>
<td>Tettigoniida</td>
<td><em>Scudderia furcata</em> Brunner</td>
<td>Grig</td>
</tr>
</tbody>
</table>

Table 2. Nymphal development time of *R. personatus*.

<table>
<thead>
<tr>
<th>Nymphal stedia</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Forth</th>
<th>Fifth</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurrence</td>
<td>July to Sept.</td>
<td>Aug. to Sept.</td>
<td>Spring After First Winter of Dormancy</td>
<td>Spring and Summer</td>
<td>Spring and Summer and second Winter dormancy</td>
<td>Spring and Summer</td>
</tr>
<tr>
<td>Duration</td>
<td>15 - 25 (day)</td>
<td>18 - 28 (day)</td>
<td>5 - 6 (month)</td>
<td>3 - 4 (month)</td>
<td>6 - 7 (month)</td>
<td>4 - 6 (month)</td>
</tr>
</tbody>
</table>
EFFECT OF YELLOW MITE, POLYPHAGOTARSONEMUS LATUS (BANKS) DENSITY ON HOSTS (CORCHORUS CAPSULARIS L.) PHENOLOGY AND ASSESSMENT OF YIELD LOSS UNDER NET HOUSE CONDITION

A. S. M. Kamruzzaman*, M. Z. Alam** and M. R. U. Miah**

* Entomology Department, Bangladesh Jute Research Institute, Manik Mia Avenue, Dhaka-1207, BANGLADESH. E-mail: kzaman_s@yahoo.com
** Entomology Department, Bangabandhu Sheikh Mujibur Rahaman Agricultural University, Gazipur, BANGLADESH.

ABSTRACT: The yellow mite, Polyphagotarsonemus latus Banks (Acari: Tarsonemidae) population is one of the most destructive pests of jute crop (Corchorus capsularis L.) in Bangladesh. Jute plants of deshi (Corchorus capsularis L) varieties were considered as treatments viz., CVL-1, CVE-3, BJC-7370 and BJC-83. The paired plot treatments (miticide treated and miticide untreated control) were laid out under net house condition. The effect of yellow mite, Polyphagotarsonemus latus Banks, were studied on three stages of jute plants: 60 DAS, 90 DAS and 120 DAS. The higher number of mite stages observed upto 90 DAS then declined afterward upto 120 DAS in var. BJC-7370 among four C. capsularis varieties. A damage index scale (0-5) was to assess yellow mite injury to jute plants. The percent infestation and damage index was also used to relate yellow mite injury to number of leaves, leaf area, fresh leaf weight, dry leaf weight, soluble solids, plant height, base diameter, fibre weight, stick weight, number of flowers per plant, number of pods, pod weight per plant, seed per pod, seed weight and 1000 seed weight of plants infested at three different phenological stages. The yield contributing characters of untreated pots showed significant damage at 60, 90 and 120 DAS in C. capsularis varieties compared to treatment pots. The highest fibre yield losses due to mite infestation was found in the variety BJC-7370 (65.10%) followed by CVE-3 (61.46%), CVL-1 (58.83%) and the lowest was in BJC-83 (52.97%); the highest stick yield losses due to mite infestation was found in the variety BJC-7370 (51.29%) followed by CVE-3 (47.54%), BJC-83 (46.49%) and the lowest was in CVL-1 (44.21%) and the highest seed yield losses due to mite infestation was found in the variety BJC-7370 (38.25%) followed by CVE-3 (31.93%), CVL-1 (29.28%) and the lowest was in BJC-83 (28.89%) for Corchorus capsularis under net house condition. High yellow mite population in the untreated check decreased plant growth and showed significant yield loss in the variety BJC-7370.

KEY WORDS: Polyphagotarsonemus latus, Corchorus capsularis, abundance, yield.

The occurrence of mite in Brazil has been registered long ago. Bitancourt (1935) reported in cotton (Gossypium hirsutum L.) in the State of São Paul, the occurrence of symptoms called "Tear sheets", suggesting agent a small mite found on the underside of leaves. This suspicion was confirmed, and the species identified as Tarsonemus latus (Hambleton 1938) subsequently placed gender Polyphagotarsonemus (Beer & Nucifora, 1965, cited by Flechtmann, 1967).

In recent years there has been outbreak of yellow mite population almost regularly as one of the most serious pests of jute crop (Corchorus capsularis L.). Its population builds up continual increase, reaches a peak in mid-June and again during the third week of July. The years of most serious mite infestation of jute are those of dry periods prevailing in these months (Kabir, 1975).
This destructive pest causes terminal leaves and flower buds to become malformed. The mite’s toxic saliva causes twisted, hardened and distorted growth in the terminal of the plant (Baker, 1997). Mites are usually seen on the newest leaves and small fruit. Leaves turn downward and turn coppery or purplish. Internodes shorten and the lateral buds break more than normal. The blooms abort and plant growth is stunted when large populations are present (Denmark, 1980; Wilkerson et al., 2005; Anon, 2005). On fruit trees the damage is usually seen on the shaded side of the fruit, so it is not readily visible. Fruit is discolored by feeding and in severe cases premature fruit drop may occur. Severely damage fruit is not salable in the market but may be used for processing (Peña & Campbell, 2005).

Reduction in photosynthesis and instability of water balance are some the damaging effects to plants. Feeding damage also causes terminal leaves and flower buds to become cupped and distorted. As a result of feeding injury, cory brown areas appear between the main veins on the underside on the leaf. Young foliage sometimes becomes rust colored and nearly always deformed. Blooms abort, and the plant growth is stunted. Damaged leaves often become discolored, thickened and brown (Iacob, 1978).

Of frequent occurrence in many cultures as cotton (Oliveira & Calcagnolo, 1974), papaya (Carica papaya L.) (Manica, 1982), lemon (Citrus limon Burm, Citrus latifolia Tanaka, Citrus aurantifolia Swingle) (Silveira, 1993) and jute (Corchorus sp. L.) (Kabir, 1975), the species has required each years more attention from producers for present populations increasingly high and be increasing the number of cultures severely attacked.

In this study, we considered the damage and the plant response to infestation at morphological and phenological levels. Also measure the impact of mite density on yield under net house condition.

MATERIALS AND METHODS

The study was conducted in the field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) of Gazipur during the period from March to August, 2009.

Collection and rearing yellow mite
Polyphagotarsonemus latus were collected from the infested jute plant of the research field of Bangladesh Jute Research Institute, Dhaka in March 2009. The collected mites from infested leaves were transferred into the potted jute plants kept outside the laboratory. Fifteen plants were infested to have constant supply of mite for the study purpose.

Jute plants of deshi (Corchorus capsularis L) varieties considered as treatments viz., CVL1, CVE-3, BJC-7370 & BJC-83 were sown in earthen pots (5 plant/pot) at 15 March, 2009. Plants were fertilized with a spoonful of 15-2-3-4 NPKS and sprinkle irrigation twice daily. When the jute plants age as about 28th days, yellow mite (12 pairs female and male) infestation were allowed to build up by artificial inoculation. The paired treatments were laid out in a completely randomized design (strip trial) with three replication under net house condition (100% shaded by 0.05 mash white colored net). After population build up in the net house, the treatment pots were treated with miticide (Mycosul 80 WDG @ 3 gm per litre of water) and repeat treatment after 7 days interval until harvest to kill the nymphs which may hatch out after these treatments (kabir, 1975) and control pots were left untreated. Young 3rd leaf by each plant from the tip (from 5 plants/pot) described by Alagarmalai et al. (2009) were collected at 60, 90 & 120
days after sowing (DAS), because yellow mites are commonly found on the lower surfaces of young apical leaves and flowers, where they deposit their eggs. The number of mite stages (egg, larva, pupa, female and male) per cm² leaf was counted under a stereomicroscope.

**Damage index at different plant ages**

The experiment consisted of yellow mite infested plants and uninfested plants of each variety at different age (60, 90 & 120 DAS), where percentage of infestation, rating score of yellow mite infested plants were recorded at three stages of plants pre and post harvestation. To establish a damage index per plant, plants were separated into 5 categories of damage followed by Pradhan (1988) method. The rating scores of the categories were: 0=Fresh and healthy leaves, without any changes in colour, 1= Slight changes in colour of leaves, 2= Curling of leaves, 3= 1 to 3 infested leaves dropped from the top, 4= All infested leaves fall prematurely but top shoot alive and 5= Top shoots dead.

Different phenology viz., leaf area, fresh leaf weight, dry leaf weight, number of leaves, plant height, base diameter, fibre weight, stick weight, number of flowers per plant, number of pod per plant, pod weight, number of seed per pod, seed weight per plant and 1000’ seed weight from both treated and untreated plots was also assessed at 3 stages (60, 90 & 120 DAS) of plants during the course of study. Leaf area was determined with a leaf area meter (LI-COR, Lambda Instruments Corporation, Lincoln, NE) and water content was determined by subtracting dry leaf weight from fresh leaf weight.

**Assessing yield loss**

The difference between the weight of yield in treated and untreated plots was considered as loss. The percent loss in yield was calculated using the following formula (Khosla 1977):

$$\text{Per cent loss in yield} = \frac{X_1 - X_2}{X_1} \times 100$$

Where,

- $X_1$ is the mean yield in treated plots.
- $X_2$ is the mean yield in untreated plots.

**Data Analysis**

The experimental data were analyzed statistically after appropriate transformation. Density of mite population data were transformed into square root transformation and Tukey’s test (P=0.05) was done using the program MSTAT and analysis of variance (ANOVA) was used to determine differences among varieties. Differences in categories for treated and untreated plants were analyzed by t-test (P=0.05) using the program MSTAT and analysis of variance (ANOVA) was used to determined differences among plant ages. Yield data for both treated and untreated condition were transformed in to square root/logarithm transformation where necessary, percent data were transformed into arcsin ($y = \sin^{-1} x$) or square root ($y = x + 0.5$) and means were separated by Tukey’s test Test (Steel and Torrie, 1960).

**RESULTS AND DISCUSSION**

**Mite dynamics related to plant age**

The number of mite stages varied for different plant stages. The mean number
of eggs, larvae, pupae, females and males per cm² leaf in different varieties, viz., CVL-1, CVE-3, BJC-7370 and BJC-83 (*C. capsularis*) at different plant stages under net house condition is presented in table 1. Number of eggs, larvae, pupae, females and males increase over time upto 90 DAS then decreased. There are significant differences in the population of eggs, larvae, pupae, females and males among the different varieties of jute. The maximum number of eggs, larvae, pupae, females and males population was found at 90 DAS with *Corchorus capsularis* variety, BJC-7370. The ascending orders of infestation in case of egg population among the varieties were BJC-83 (61.45) < CVE-3 (78.11) < CVL-1 (87.67) < BJC-7370 (90.11); larvae population those were CVE-3 (34.89) < CVL-1 (40.89) < BJC83 (41.78) < BJC-7370 (43.22); pupal population those were CVE-3 (2.55) < BJC-83 (3.00) < CVL-1 (3.34) < BJC-7370 (4.22); female population among the varieties were CVL-1 (3.34) < BJC-83 (5.89) < CVE-3 (6.44) < BJC-7370 (11.11) and male population among the varieties were CVE-3 (2.44) < BJC-83 (3.22) < CVL-1 (4.00) < BJC-7370 (4.67), respectively. Similar trend of result was reported by De Coss-Romero and Peña (1998) in pepper plant. Apparently, tarsenemid mouthpart appendages are unsuitable for effective penetration of retent tissues (Jeppson et al., 1975). Thus *P. latus* may not be able to puncture the more lignified tissues found in after 90 days old plants as opposed to those tissues in 60-90 daysold plants. These data may be of value in programs for evaluating resistance of jute to *P. latus*. Assessments of plant resistance to *P. latus* made at early growth stages of jute would be particularly effective for identifying highly resistant plants.

**Incidence of *P. latus* on host (*Corchorus capsularis*) phenology and yield**

Yellow mites significantly reduced the leaf sizes of untreated plants compared to the treated plants in all varieties (CVL-1, CVE-3, BJC-7370 and BJC-83) at three plant growth stages (Table 2). Fresh leaf weight was reduced at all the three plant stages, but significant reductions in dry weight were observed at 90 DAS in CVE-3 & BJC-83 and 120 DAS in CVE-3, BJC-7370 & BJC-83. The level of significance associated with the soluble solids was also reduced at all the three plant growth stages (Table 3). The numbers of leaves per plant, plant heights, base diameter, fibre weight, stick weight, number of flowers, number of pods, pod weight, number of seed per pod, seed weight and 1000 seed weight per plant were also affected by mite injury as observed at three plant growth stages in all the varieties and was significantly reduced compared to those of uninfested plants (Table 4 & 5). The data suggest that yellow mite reduce height in the infested plants, and induced lateral shoot growth.

Fibre weight, stick weight and seed weight both in treated and untreated situation in varieties, CVL-1, CVE-3, BJC-7370 and BJC-83 (*C. capsularis*) and their respective yield loss due to yellow mite infestation are presented in Table 6. The differences in the fibre weight, stick weight and seed weight in different varieties, which could be minimized by the insecticidal treatment. The weight and percent yield losses have been found to vary in different varieties. Both in treated and untreated situation the highest fibre weight was obtained in the variety BJC-83 (20.44 gm/plant) followed by BJC-7370 (20.11 gm/plant), CVE-3 (18.22 gm/plant) and the lowest fibre weight was obtained in CVL-1 (17.00 gm/plant). Yield loss was varied because of mite population fluctuations due to host phenology and environmental condition. The highest fibre yield losses due to mite infestation was found in the variety BJC-7370 (65.10%) followed by CVE-3 (61.46%), CVL-1 (58.83%) and the lowest fibre yield losses was obtained in BJC-
The highest stick weight was obtained in the variety BJC-7370 (41.22 gm/plant) followed by BJC-83 (37.89 gm/plant), CVE-3 (35.56 gm/plant) and the lowest stick weight was obtained in CVL-1 (31.89 gm/plant). The highest stick yield losses was found in the variety BJC-7370 (51.29%) followed by CVE-3 (47.54%), BJC-83 (46.49%) and the lowest was in CVL-1 (44.21%). The highest seed weight was obtained in the variety BJC-83 (6.44 gm/plant) followed by CVE-3 (6.06 gm/plant) and the lowest seed weight was found in BJc-7370 (5.36 gm/plant). The highest seed yield losses was found in the variety BJC-7370 (38.25%) followed by CVE-3 (31.93%), CVL-1 (29.28%) and the lowest was found in BJc-83 (28.89%).

High levels of stress induced by *P. latus* feeding resulted in reduction in vegetative growth, flower development and reduction in quantity & quality of seed might be in response to some anatomical, physiological or biochemical differences between vegetative and reproductive stage of plants. These reductions were due to chronic feeding on plants younger leaf tissue, which appear to be more susceptible than plants with greater numbers of mature leaves. This effect has been shown to vary with the phenological development of hedera, reported by Nemestothy et al. (1982). Plants with younger hirsute leaves suffered the strongest damage compared to older plants with leaves with less hairs and where cell differentiation has already occurred. These results are in agreement with the reports of Smith (1935) who stated that the yellow mite cannot survive longer on the tough, mature leaves of most plants. It was reported that about 15.50% (O9897) & 10.00% (CVL-1) of fibre yield were decreased by the attack of yellow mite in potted plants and 12.30% (O-9897) of fibre yield was decreased under field condition (Faruquzzaman 1987). De Coss-Romero & Peña (1998) reported about 80% of yield reduced by *P. latus* in green house pepper plant.

The above discussion concluded that the variety BJC-7370 of *C. capsularis* showed most susceptible against *P. latus* under net house condition. The knowledge that the damage arises from mite responses to the phenological stage of the crop can enhance the efficiency and value of yellow mite monitoring programs and control strategies by focusing attention on the critical periods in jute crop. We observed in economic crop jute, *Corchorus capsularis* L., that rapid increases of yellow mite numbers coincided with different stages of the plant. However, yield responses to yellow mite damage under field conditions may differ from those observed under conditions in the net house.

**ACKNOWLEDGEMENTS**

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**LITERATURE CITED**


Table 1. Comparison of mean number of population at different stages of yellow mite per cm² of leaf at three DAS of *C. capsularis* under net house condition.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Egg</th>
<th>Larva</th>
<th>Pupa</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 DAS</td>
<td>90 DAS</td>
<td>120 DAS</td>
<td>60 DAS</td>
<td>90 DAS</td>
</tr>
<tr>
<td>CVL-1</td>
<td>25.66c</td>
<td>87.67a</td>
<td>15.00a</td>
<td>24.43c</td>
<td>40.89ab</td>
</tr>
<tr>
<td></td>
<td>(5.06)</td>
<td>(9.36)</td>
<td>(4.95)</td>
<td>(6.39)</td>
<td>(3.00)</td>
</tr>
<tr>
<td>CVE-3</td>
<td>31.67b</td>
<td>78.11b</td>
<td>19.89b</td>
<td>27.11b</td>
<td>34.89b</td>
</tr>
<tr>
<td></td>
<td>(5.63)</td>
<td>(8.84)</td>
<td>(5.21)</td>
<td>(5.90)</td>
<td>(4.51)</td>
</tr>
<tr>
<td>BJC-7370</td>
<td>39.22a</td>
<td>90.11a</td>
<td>34.44a</td>
<td>30.45a</td>
<td>43.22a</td>
</tr>
<tr>
<td></td>
<td>(6.26)</td>
<td>(9.49)</td>
<td>(5.52)</td>
<td>(6.57)</td>
<td>(5.89)</td>
</tr>
<tr>
<td>BJC-83</td>
<td>29.78b</td>
<td>61.45c</td>
<td>19.78b</td>
<td>27.66b</td>
<td>41.78ab</td>
</tr>
<tr>
<td></td>
<td>(5.46)</td>
<td>(7.84)</td>
<td>(5.26)</td>
<td>(6.46)</td>
<td>(3.30)</td>
</tr>
</tbody>
</table>

Means followed by same letter in column do not differ by Tukey’s test (P = 0.05). Figures in the parentheses are the square root transformed mean values.

Table 2. Comparison of mean percent infestation, damage rating, leaf area of jute plants infested with yellow mite at three plant stages under net house condition.

<table>
<thead>
<tr>
<th>Variety</th>
<th>% Infestation</th>
<th>Damage rating</th>
<th>Leaf area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>69 DAS</td>
<td>90 DAS</td>
<td>120 DAS</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Untreated control</td>
<td>Treated</td>
</tr>
<tr>
<td>CVL-1</td>
<td>0.03b</td>
<td>40.00a</td>
<td>0.00b</td>
</tr>
<tr>
<td>CVE-3</td>
<td>0.03b</td>
<td>45.67a</td>
<td>0.00b</td>
</tr>
<tr>
<td>BJC-7370</td>
<td>0.03b</td>
<td>55.53a</td>
<td>0.00b</td>
</tr>
<tr>
<td>BJC-83</td>
<td>0.03b</td>
<td>46.67a</td>
<td>0.00b</td>
</tr>
</tbody>
</table>

Means for each parameter within rows followed by the same letter are not significantly different (t-test, P = 0.05).

Table 3. Comparison of mean fresh leaf weight, dry leaf weight and soluble solids at three jute plant stages infested with yellow mite under net house condition.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Fresh leaf weight</th>
<th>Dry leaf weight</th>
<th>Soluble solids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 DAS</td>
<td>90 DAS</td>
<td>120 DAS</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Untreated control</td>
<td>Treated</td>
</tr>
<tr>
<td>CVL-1</td>
<td>0.09a</td>
<td>0.06b</td>
<td>0.22a</td>
</tr>
<tr>
<td>CVE-3</td>
<td>0.09a</td>
<td>0.06b</td>
<td>0.19a</td>
</tr>
<tr>
<td>BJC-7370</td>
<td>0.08b</td>
<td>0.07b</td>
<td>0.15a</td>
</tr>
<tr>
<td>BJC-83</td>
<td>0.08a</td>
<td>0.06b</td>
<td>0.19a</td>
</tr>
</tbody>
</table>

Means for each parameter within rows followed by the same letter are not significantly different (t-test, P = 0.05).
Table 4. Comparison of mean number of leaves, plant height and base diameter at three jute plant stages infested with yellow mite under net house condition.

<table>
<thead>
<tr>
<th>Variety</th>
<th>No. of leaves</th>
<th>Plant height</th>
<th>Base diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 DAS</td>
<td>90 DAS</td>
<td>120 DAS</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Uninfected control</td>
<td>Treated</td>
</tr>
<tr>
<td>CVL-1</td>
<td>63.07 ± 5.147</td>
<td>81.07 ± 0.63</td>
<td>91.06 ± 0.63</td>
</tr>
<tr>
<td>CVE-3</td>
<td>57.06 ± 4.5</td>
<td>63.0 ± 0.63</td>
<td>71.06 ± 0.63</td>
</tr>
<tr>
<td>BJC-7370</td>
<td>53.5 ± 3.5</td>
<td>57.06 ± 0.63</td>
<td>63.0 ± 0.63</td>
</tr>
<tr>
<td>BJC-83</td>
<td>39.5 ± 3</td>
<td>53.5 ± 3.5</td>
<td>57.06 ± 0.63</td>
</tr>
</tbody>
</table>

Means for each parameter within rows followed by the same letter are not significantly different (t-test, P=0.05).

Table 5. Comparison of mean fibre weight, stick weight, number of flowers, number of pods, pod weight, number of seed per pod, seed weight and 1000 seed weight at three jute plant stages infested with yellow mite under net house condition.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Fibre weight</th>
<th>Stick weight</th>
<th>No. flowers</th>
<th>Pod plant</th>
<th>Pod weight/plant</th>
<th>Seed pod</th>
<th>Seed weight/plant</th>
<th>1000 seed weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120 DAS</td>
<td>150 DAS</td>
<td>180 DAS</td>
<td>120 DAS</td>
<td>150 DAS</td>
<td>180 DAS</td>
<td>120 DAS</td>
<td>150 DAS</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Uninfected control</td>
<td>Treated</td>
<td>Uninfected control</td>
<td>Treated</td>
<td>Uninfected control</td>
<td>Treated</td>
<td>Uninfected control</td>
</tr>
<tr>
<td>CVL-1</td>
<td>17.00 ± 5.5</td>
<td>18.00 ± 5.5</td>
<td>17.00 ± 5.5</td>
<td>18.00 ± 5.5</td>
<td>17.00 ± 5.5</td>
<td>18.00 ± 5.5</td>
<td>17.00 ± 5.5</td>
<td>18.00 ± 5.5</td>
</tr>
<tr>
<td>CVE-3</td>
<td>18.00 ± 6.5</td>
<td>19.00 ± 6.5</td>
<td>18.00 ± 6.5</td>
<td>19.00 ± 6.5</td>
<td>18.00 ± 6.5</td>
<td>19.00 ± 6.5</td>
<td>18.00 ± 6.5</td>
<td>19.00 ± 6.5</td>
</tr>
<tr>
<td>BJC-7370</td>
<td>20.1 ± 7.5</td>
<td>21.0 ± 7.5</td>
<td>20.1 ± 7.5</td>
<td>21.0 ± 7.5</td>
<td>20.1 ± 7.5</td>
<td>21.0 ± 7.5</td>
<td>20.1 ± 7.5</td>
<td>21.0 ± 7.5</td>
</tr>
<tr>
<td>BJC-83</td>
<td>20.4 ± 8.5</td>
<td>21.0 ± 7.5</td>
<td>20.4 ± 8.5</td>
<td>21.0 ± 7.5</td>
<td>20.4 ± 8.5</td>
<td>21.0 ± 7.5</td>
<td>20.4 ± 8.5</td>
<td>21.0 ± 7.5</td>
</tr>
</tbody>
</table>

Means for each parameter within rows followed by the same letter are not significantly different (t-test, P=0.05).

Table 6. Yield loss of *C. capsularis* varieties due to *P. latus* infestation under nethouse condition.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Fibre weight/plant (gm.)</th>
<th>Stick weight/plant (gm.)</th>
<th>Seed weight/plant (gm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treated</td>
<td>Untreated control</td>
<td>Loss(%)</td>
</tr>
<tr>
<td>CVL-1</td>
<td>17.00 ± 5.5</td>
<td>(4.12)</td>
<td>6.95 ± 2.63</td>
</tr>
<tr>
<td>CVE-3</td>
<td>18.00 ± 6.5</td>
<td>(4.27)</td>
<td>6.99 ± 2.64</td>
</tr>
<tr>
<td>BJC-7370</td>
<td>20.1 ± 7.5</td>
<td>(4.48)</td>
<td>7.00 ± 2.64</td>
</tr>
<tr>
<td>BJC-83</td>
<td>20.4 ± 8.5</td>
<td>(4.51)</td>
<td>9.62 ± 3.10</td>
</tr>
</tbody>
</table>

In a column, treatment means having the same letter(s) are not significantly different by Tukey's test (P=0.05). Figures in the parentheses are the transformed mean values.
FIRST RECORD OF TRICHOFERUS PALLIDUS (OLIVIER, 1790) FOR ITALY (COLEOPTERA: CERAMBYCIDAE)

Pierpaolo Rapuzzi* and Bruno Grego**

* via Cialla, 48, 33040 Prepotto (UD), ITALY. E-mail: info@ronchidicialla.it
** via Lazzaretto Vecchio, 9, 34123 Trieste (TS), ITALY.

[Reapuzzi, P. & Grego, B. 2013. First record of Trichoferus pallidus (Olivier, 1790) for Italy (Coleoptera: Cerambycidae). Munis Entomology & Zoology, 8 (2): 712-713]

ABSTRACT: Trichoferus pallidus (Olivier, 1790) was firstly recorded for Italy after its description. Three new localities was found from Friuli Venezia Giulia and Veneto regions.

KEY WORDS: Cerambycidae, Trichoferus pallidus, new record, Friuli Venezia Giulia, Veneto, Italy.

Trichoferus pallidus (Olivier, 1790) was described without any detailed locality from “Italy” and for more than 2 centuries it was never collected. For this reason it was deleted from the count of the Italian species of Cerambycidae (Sama, 1988; Sama, 2005; Sama & Rapuzzi, 2011). Recently thanks to the investigation of Mr. Alberto Sette and Mr. Bruno Grego of the Fauna of Trieste area and the Verona’s province several specimens of this species were collected. The use of sugar traps has permitted to find many interesting and rare species. Recently Trichoferus pallidus was collected in Istria (Lovran) (Demelt & Schurmann, 1964) and in Cres Island, Filožici and Beli villages (!), both localities are in Croatia but close to the Italian border (the series of specimens collected in Cres island was found using sugar traps). It is interesting to note that this species was never collected before in this area although these localities are very well known by the entomologist from many years. We are sure that new records must be found in Italy and not only in the North East of Italy, but it is very likely that this species will be found in many other Italian region, in Central and Southern Italy as well.

Trichoferus pallidus (Olivier, 1790)

(Fig. 1)


Discussion
The two localities of Friuli Venezia Giulia are very close to the Adriatic Sea and they represent the relict belt of the indigenous forest between the sea and the Carsic plateau. In this small area the vegetation is mainly represented by Fraxinus ornus, Ostria carpinifolia, Prunus mahaleb, Quercus pubescens and Quercus ilex. The localities of Veneto region are very interesting. The first one (Cerea) is a small relict plane forest that it is a part of a park of a Venetian villa. The vegetation of this park consists of Acer sp., Ostrya carpinifolia, Populus sp.,...
Corylus avellana and Quercus sp. This locality is in the Southern part of the Verona province, surrounded by a very large agriculture area. The second locality is Monte Calvarina, it is a thermophile area in the North East of the Verona province and the vegetation consists by small and medium size trees of Quercus spp., Ostrya sp., Corylus avellana and Prunus sp. According these information it is very likely that other localities for Trichoferus pallidus can be found in future in Italy. The locality of Cerea shows as this species very probably was widespread in the past in the Padanian plane before this area became an intensive agriculture and industrial area. It will be necessary to investigate other relict plane forest to have an idea on its diffusion today in Northern Italy.

LITERATURE CITED


Figure 1. Trichoferus pallidus male, Trieste, Santa Croce, Monte San Primo.
PSEUDOSCORPIONS (ARACHNIDA: PSEUDOSCORPIONES) OF THE SOUTHWESTERN PART OF ČESKÝ KRAS PROTECTED LANDSCAPE, CZECH REPUBLIC

Katarína Krajčovičová*, Jana Christophoryová* and Miroslav Krumpál*

* Department of Zoology, Faculty of Natural Sciences, Comenius University, Mlynská dolina B-1, SK–842 15 Bratislava, SLOVAKIA. E-mails: katarina.krajcovicova@azet.sk; christophoryova@gmail.com; krumpal@fns.uniba.sk


ABSTRACT: Faunistic data on pseudoscorpions from the Protected Landscape Area of the southwestern part of Český Kras are presented. The selected fragmented landscape includes seventeen forest fragments of different size and different plant associations and three open non-forest localities. A faunistic survey was conducted during the years 2008 – 2011. Soil sampling and pitfall trapping were used as the sampling methods. Out of 3859 collected pseudoscorpions, 11 species belonging to 3 families including Chthoniidae, Neobisiidae and Chernetidae were identified. New localities and all nymphal stages of the rare species Allochernes peregrinus Lohmander, 1939 and Microbisium suecicum Lohmander, 1945 were found during this research.

KEY WORDS: Pseudoscorpiones, faunistics, Český kras, Czech Republic, Central Europe.

Pseudoscorpions are the fourth largest arachnid order with more than 3380 species described worldwide (Harvey, 2011). Attention to this arachnid group has been payed more intensively in the Czech Republic during the last 20 years. The local pseudoscorpion fauna includes 38 species from seven families (Christophoryová et al., 2012b). More numerous faunistic data are known only from few areas: Prague and surroundings (Šťáhlavský, 2001), National Park Podyjí (Šťáhlavský, 2006a), Protected Landscape Area Kokořínsko (Šťáhlavský, 2006b), Dolní Povltaví and Podřisko (Šťáhlavský & Krásný, 2007), Protected Landscape Area Litovelské Pomoraví (Šťáhlavský & Tuf, 2009) and Protected Landscape Area Třeboňsko and surroundings (Šťáhlavský, 2011). The pseudoscorpion fauna of Český Kras was studied for the first time and the research was supported by the project „Limits of biodiversity protection in fragmented landscape“. The aim of the project was to study the effect of forest fragmentation on habitat characteristics and their biodiversity. Some partial results have already been published: the first complete description of all developmental stages of pseudoscorpion Allochernes peregrinus Lohmander, 1939 (Christophoryová et al., 2012a) and the ecology of this rare species (Krajčovičová et al., 2012).

The Protected Landscape Area of Český Kras covers an area of 128 km² and is situated in the altitude of 208–499 m a.s.l. The diversiform landscape includes warm steppes, karst canyons and gorges. Besides many karst formations, there are many larger or smaller caverns and cave complexes. Oak and hornbeam forests are the most common forest communities.
MATERIALS AND METHODS

The material was examined in the southwestern part of the Protected Landscape Area Český Kras (Fig. 1). The selected fragmented landscape represented 17 forest fragments of different size and different plant associations and three non-forest open localities (Tab. 1). 57 sampling plots were selected during the years 2008 – 2011 (area of each 25 m²). The altitude of the plots ranged from 142 m a.s.l. to 472 m a.s.l. The pseudoscorpions were collected using soil samples and pitfall traps. Five pitfall traps (each with a diameter of 9 cm, containing formaldehyde killing-preserving solution) with a year continual exposition and monthly sampling intervals were used at each sampling plot. At each plot, five soil samples were taken in May and September (area of each 625 cm², depth ca 10 cm). All specimens were determined by K. Krajčovičová and J. Christophoryová using the identification key of Christophoryová et al. (2011b). Nomenclature for all taxa follows Harvey (2011). The part of the material was studied as temporary slide mounts and was deposited in ethanol. A part of it was studied as permanent slide mounts using Leica ICC50 microscope. The whole material is deposited in the zoological collections of the Comenius University, Bratislava.

Abbreviations used in the text: FF – forest fragment, NOL – non-forest open localities; PT – pitfall trap, SS – soil sample; m – male, f – female, tn – tritonymph, dn – deutonymph, pn – protonymph.

RESULTS

During the research, 11 species belonging to 3 families were identified. All of them are being newly reported for the studied area. A total number of the specimens, GPS position and plant associations are shown in the Table 2.

Family Chthoniidae Daday 1888
Chthonius (Chthonius) carinthiacus Beier, 1951
FF1: 466 m a.s.l.: PT: 2.4.-30.4.2008: 3m.
Distribution in the Czech Republic: Brná u Ústí nad Labem, Litovelské Pomoraví Protected Landscape, Třeboňsko Protected Landscape (Ducháč, 1997; Šťáhlavský & Tuf, 2009; Šťáhlavský, 2011). Range: Austria, Slovakia, Slovenia and Italy (Christophoryová et al., 2011a; Harvey, 2011).

Chthonius (Chthonius) orthodactylus (Leach, 1817)
FF1: 401 m a.s.l.: PT: 16.4.-13.5.2009: 1m, 1f; 8.6.-8.7.2009: 1f; 27.10.-25.11.2009: 1m; 22.3.-15.4.2010: 1f; SS: 8.9.2009: 1f; 426 m a.s.l.: PT: 18.3.-16.4.2009: 1m; 16.4.-13.5.2009: 1f, 1tn; SS: 5.5.2009: 1f; 8.9.2009: 1f, 1tn;
FF2: 311m a.s.l.: PT: 16.4.-13.5.2009: 1m, 1f; 420 m a.s.l.: PT: 13.10.-14.11.2008: 1tn; 2.3.-15.3.2009: 1m; 433 m a.s.l.: PT: 2.4.-30.4.2008: 1m, 2f;
FF3: 375 m a.s.l.: PT: 18.3.-16.4.2009: 3m; 16.4.-13.5.2009: 1m, 2f;
FF4: 358 m a.s.l.: PT: 18.3.-16.4.2008: 4m; 2f; 16.4.-13.5.2008: 3m, 1f; 8.7.-5.8.2009: 1m, 2f; 2.9.-30.9.2009: 1m, 1f, 1tn; 30.9.-27.10.2009: 1tn; 22.3.-15.4.2010: 1m; 11.8.-9.9.2011: 1f; SS: 5.5.2009: 1m; 8.9.2009: 1dn; 370 m a.s.l.: PT: 22.3.-14.4.2010: 1m; 380 m a.s.l.: PT: 18.3.-16.4.2009: 6m, 15f; 16.4.-13.5.2009: 7m, 6f; 8.6.-8.7.2009: 1m, 2f; 8.7.-5.8.2009: 1f, 1tn; 5.8.-2.9.2009: 1tn; 2.9.-30.9.2009: 1m, 1tn; 30.9.-27.10.2009: 1tn; 22.3.-14.4.2010: 7m, 4f; SS: 5.5.2009: 1f; 384 m a.s.l.: PT: 15.4.-25.5.2010: 1m, 1f; 24.6.-19.7.2010: 1f; 7.3.-12.4.2011: 1m;
**Chthonius (Ephippiochthonius) fuscimanus Simon, 1900**


**Chthonius (Ephippiochthonius) tetrachelatus (Preyssler, 1790)**

**FF6:** 347 m a.s.l.: PT: 5.8.-2.9.2009: 1m; 2.9.-30.9.2009: 1f; 352 m a.s.l.: PT: 18.3.-16.4.2009: 2m; 5f; 16.4.-15.5.2009: 3m, 2f, 1tn; 8.5.-8.7.2009: 1m; 8.5.-7.8.2009: 1m; 5f, 1tn; 5.8.-2.9.2009: 1m, 9f, 5t; 2.9.-30.9.2009: 7m, 7f, 2tn; 30.9.-27.10.2009: 2f; 22.3.-15.4.2010: 1m; SS: 8.9.2009: 1m;

**FF7:** 324 m a.s.l.: PT: 18.3.-16.4.2009: 8m, 2f, 1dn; 16.4.-13.5.2009: 1m, 6f, 5t; 8.6.-7.8.2009: 1m, 2f; 8.7.-5.8.2009: 4m, 2f; 5.8.-2.9.2009: 9m, 10f, 2tn, 1dn; 2.9.-30.9.2009: 8m, 4f; 30.9.-27.10.2009: 2m, 2f; 22.3.-15.4.2010: 1f; SS: 5.5.2009: 2f; 8.9.2009: 6tn;


**Chthonius (Ephippiochthonius) fuscimanus Simon, 1900**

**Neobisium (Neobisium) carcinoides** (Hermann, 1804)

**FF1:** 390 m a.s.l.: PT: 17.5.-16.4.2010: 5m, 1f; 3.10.-3.11.2011: 7f; 3.11.-29.11.2011: 1m, 2f; 29.11.2011-4.1.2012: 5m, 2f; 27.2.-27.3.2012: 3m; SS: 9.9.2011: 6m, 3f; 401 m a.s.l.: PT: 13.5.-8.6.2009: 2m; 8.7.-5.8.2009: 1f, 1tn; 8.-8.9.2009: 1f, 3tn; 2.-9.9.2009: 5m, 3f, 2tn; 30.9.-27.10.2009: 3m, 4f; 27.10.-25.11.2009: 2m; 25.11.2009-22.3.2010: 5m, 4f; SS: 8.9.2009: 1m, 4f, 2tn, 1dn; 426 m a.s.l.: PT: 8.7.-5.8.2009: 1tn; 5.-8.-2.9.2009: 2f, 1tn; 2.-9.-30.9.2009: 2f; 27.10.-25.11.2009: 4m, 3f, 1tn; 25.11.2009-22.3.2010: 5m, 4f; 22.3.-15.4.2010: 1f; SS: 5.5.2009: 1m, 1f, 8.9.2010: 3m, 2tn, 1dn, 1pn.


**FF3:** 374 m a.s.l.: PT: 13.5.-8.6.2009: 1m, 1f; 8.6.-8.7.2009: 1m; 8.7.-5.8.2009: 1m, 8.-2.9.2008: 1tn; 2.9.-30.9.2009: 1dn; 27.10.-25.11.2009: 2m; 25.11.2009-22.3.2010: 2m, 3f; SS: 5.5.2009: 1pn; 19.9.2010: 2m, 2f, 1tn; 405 m a.s.l.: PT: 13.5.-8.6.2009: 2m, 1f; 8.6.-8.7.2009: 1m; 8.7.-5.8.2009: 1f, 2tn; 5.8.-2.9.2009: 2tn; 30.9.-27.10.2009: 3m, 2f; 27.10.-25.11.2009: 2m; 25.11.2009-22.3.2010: 16m, 4f; SS: 5.5.2009: 1m, 3tn, 1dn; 410 m a.s.l.: PT: 25.5.-24.6.2010: 1m; 24.6.-19.7.2010: 1f; 15.9.-12.10.2010: 1m; 12.10.-9.11.2010: 2f; 9.11.2010-7.2.2011: 14m, 4f; 7.2.-7.3.2011: 3m, 3f; 7.3.-12.4.2011: 1m, SS: 4.5.2010: 1m, 1f, 1tn, 1dn, 1pn; 2.9.2010: 4m, 1tn; 414 m a.s.l.: PT: 8.6.-8.7.2009: 1dn; 8.7.-5.8.2009: 1f, 1tn; 8.-2.9.2009: 1tn; 2.9.-30.9.2009: 1tn; 30.9.-27.10.2009: 3m, 2f; 27.10.-25.11.2009: 1f; 25.11.2009-22.3.2010: 5m, 1f; SS: 5.5.2009: 2m, 2tn; 1.9.2010: 1m, 2f, 2tn; 422 m a.s.l.: PT: 13.5.-8.6.2009: 1m, 1f; 8.6.-8.7.2009: 1m; 8.7.-5.8.2009: 2tn, 1dn; 2.9.-

**Neobisium (Neobisium) erythrodroactylum (L. Koch, 1873)**


**Neobisium (Neobisium)fuscimanum (C.L. Koch, 1843)**

**FF6**: 352 m a.s.l.: PT: 12.10.-9.11.2010: 1f;
Neobiusium (Neobiusium) sylvaticum (C.L. Koch, 1835)

**FF1:** 375 m a.s.l.: PT: 7.3.-12.4.2011: 1m; 3.11.-29.11.2011: 1tn; 27.2.-27.3.2012: 1f;


**FF4:** 385 m a.s.l.: PT: 3.11.-29.11.2011: 1f, 1tn; 380 m a.s.l.: PT: 27.10.-25.11.2009: 1dn;

**FF6:** 347 m a.s.l.: PT: 18.3.-16.4.2009: 1m, 1tn; 27.10.-25.11.2009: 2f; date unknown: 1f;

**FF7:** 324 m a.s.l.: PT: 5.8.-2.9.2009: 4tn; 30.9.-27.10.2009: 4m, 8f, 1tn; 27.10.-25.11.2009: 1f, 1tn; 25.11.2009-22.3.2010: 2m, 1f, 2tn; date unknown: 1f; SS: 1.9.2009: 4tn;

**FF8:** 302 m a.s.l.: PT: 8.6.-8.7.2009: 1f; 27.10.-25.11.2009: 1m, 1f; 25.11.2009-22.3.2010: 1m, 1f;

**FF10:** 415 m a.s.l.: PT: 25.11.2009-22.3.2010: 1m;

**FF11:** 363 m a.s.l.: PT: 9.11.2010-7.2.2011: 1m; 7.2.-7.3.2011: 1m, 1tn; 414 m a.s.l.: PT: 7.3.-12.4.2011: 1m;


**Family Chernetidae Menge 1855**

*Allochernes peregrinus* Lohmander, 1939

**Published data:** (Krajčovičová et al., 2012)

**New data:**

**FF1:** 390 m a.s.l.: PT: 17.5.-14.6.2011: 1f; SS: 18.5.2011: 1f, 2tn; 9.9.2011: 1m, 7f, 1tn; 420 m a.s.l.: PT: 13.4.-17.5.2011: 2f; 17.5.-14.6.2011: 1idn; SS: 18.5.2011: 1m, 1f, 2tn; 9.9.2011: 2m, 1of, 4tn, 3dn;

**FF3:** 415 m a.s.l.: PT: 16.4.-13.5.2009: 1f; SS: 1.9.2009: 1f;


14.6.2011: 2f; SS: 4.5.2011: 4m, 10f, 1tn; 18.5.2011: 1m, 3f, 2tn; 1.9.2011: 3m, 12f, 5tn, 1dn; 2.9.2011: 1tn;
NOL 800: 390 m a.s.l.: SS: 11.5.2010: 1f; 10.9.2010: 3m, 3f; 1dn.

Pselaphochernes scorpioides (Hermann, 1804)
FF1: 401 m a.s.l.: SS: 8.9.2009: 3dn;
FF3: 375 m a.s.l.: PT: 8.7.-5.8.2009: 1f;
FF6: 352 m a.s.l.: PT: 8.6.-8.7.2009: 1m;
FF7: 324 m a.s.l.: SS: 5.5.2009: 1f;
FF10: 419 m a.s.l.: SS: 5.5.2009: 2dn;
FF15: 392 m a.s.l.: PT: 15.4.-25.5.2009: 1m; 24.6.-19.7.2009: 1f; 452 m a.s.l.: PT: 23.7.-19.8.2009: 1f;
FF18: 446 m a.s.l.: PT: 14.6.-11.7.2009: 1f.

DISCUSSION

A total of 3823 specimens were examined from the studied forest fragments (except the open non-forest localities). The pseudoscorpion N. carcinoides was eudominant and euconstant in the whole studied area of Český kras. In Central Europe, N. carcinoides is considered to be eurytopic, mainly epigeic species and often the most common species of the family of Neobisiidae (Beier, 1963; Krumpál, 1980; Mahnert, 1983; Ducháč, 1994; Šťáhlavský, 2001, 2006a, b, 2011; Šťáhlavský & Krášný, 2007; Christophoryová, 2009; Šťáhlavský & Tuf, 2009). C. tetrachelatus often belongs to the most numerous species of the family of Chthoniidae (Beier, 1963; Šťáhlavský, 2001, 2006a; Šťáhlavský & Krášný, 2007). Surprisingly, the research in Český kras revealed, that C. orthodactylus was the most numerous Chthoniidae species in this area. In all known localities of the Czech Republic, as well as in other countries, only isolated findings of the pseudoscorpion A. peregrinus were recorded (Rafalski, 1967; Droglá, 1983; Krumpálová & Krumpál, 1993; Ducháč, 1995; Droglá & Lippold, 2004; Christophoryová & Krumpál, 2007, 2010). Vice versa A. peregrinus occurred in all the studied forest fragments in Český kras and belonged to eudominant species. The only known locality of M. suecicum from the Czech Republic was the heathland around the villages Havraník and Popice (Šťáhlavský, 2006a). Český kras became the second known locality in the Czech Republic with the distribution of this quite rare species. Except the females, all its nymphal stages were found there. Altogether 36 specimens belonging to four species (C. orthodactylus, C. tetrachelatus, N. carcinoides, A. peregrinus) occurred in open non-forest localities.

ACKNOWLEDGEMENTS

We are grateful to Dr. Karel Tajovský and Aleš Tenčík for collecting the pseudoscorpion material. The study was financially supported by the projects VaV SP/2d3/139/07 (Limits of biodiversity protection in fragmented landscape) of the Ministry of Environment of the Czech Republic and VEGA 1/0176/09.
LITERATURE CITED


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</tr>
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<td>BOH, MOH</td>
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<td>MOH</td>
</tr>
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<td>3</td>
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<td>49°54'</td>
<td>MOH, NDP</td>
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<td>49°54'</td>
<td>SEA</td>
</tr>
<tr>
<td>NOL 801</td>
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<td>0.02</td>
<td>14°06'</td>
<td>49°54'</td>
<td>XSE</td>
</tr>
<tr>
<td>NOL 802</td>
<td>0.0025</td>
<td>0.02</td>
<td>14°06'</td>
<td>49°55'</td>
<td>MM</td>
</tr>
</tbody>
</table>


Table 2. The total number of all developmental stages of the recorded species in Český kras. Abbreviations: m – male, f – female, tn – tritonymph, dn – deutonymph, pn – protonymph. The data of A. peregrinus included the total number of the species recorded during the four-year research, including the published ones (Krajčovičová et al., 2012).

<table>
<thead>
<tr>
<th>Species</th>
<th>m</th>
<th>f</th>
<th>tn</th>
<th>dn</th>
<th>pn</th>
<th>Total</th>
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</thead>
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<td>C. orthodactylus</td>
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<tr>
<td>C. fuscimanus</td>
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<td>C. tetrachelatus</td>
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<td>M. suecicum</td>
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<td>A. peregrinus</td>
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<td>106</td>
<td>66</td>
<td>3</td>
<td>676</td>
</tr>
<tr>
<td>P. scorpioideos</td>
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<td>5</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>

Figure 1. Map of the Czech Republic with the marked position of the Protected Landscape Area of Český kras.
EFFECT OF VARIOUS ADDITIVES ON VERMICOMPOSTING OF PAPER WASTE USING EPIGEIC EARTHWORM, EUDRILUS EUGENIAE (ANNELIDA: CLITELLATA)

Muddasir Basheer*, Rajesh Kumar*, S. A. Ganai* and O. P. Agrawal*

* Vermibiotechnology Research Unit, School of Studies in Zoology, Jiwaji University, Gwalior. (M.P). INDIA – 474011. E-mails: Rahmuddasir69@gmail.com; op_agrawal51@rediffmail.com


ABSTRACT: Earthworms perform wonderful job to maintain nutrient balance in the soil by recycling of organic waste. Earthworms have been used in the degradation of various types of wastes from prehistoric times. This study examines the potential of the African night crawler, Eudrilus eugeniae in the vermicomposting of waste paper. The effect of some additives on the process of vermicomposting was also observed. A mixture of waste paper and cow dung in the ratio of 1:1 was found to be the best for the growth and survival of Eudrilus eugeniae. Trichoderma treated media was the most preferential medium (35%) followed by Vermiwash (28%) and Jaggery + Buttermilk (21%) and control (16%). An increase was noticed in various parameters like percent number, weight, percent population growth and biomass production of earthworms.

KEY WORDS: Eudrilus eugeniae, Paper waste, Trichoderma, Vermiwash, Gwalior.

A significant amount of paper waste is produced in day-to-day life, particularly in offices, business concerns, packaging industries and homes. Shredded paper is used for packaging and transport of fruits, vegetables, foods, breakable items etc. For confidential reasons, the paper waste is not sold in the market and usually torn into pieces and burnt. The paper and card board waste from market yard is also not sorted out for recycling. A huge amount of such waste along with other waste are disposed off by dumping, land-filling and burning. The paper and paper based wastes are rich in cellulose (carbon) and poor in nitrogen content. They have much higher C/N ratio. Shredded paper has low bulk density permitting enough aeration, but water soaked stuff becomes too dense and does not allow free aeration. The aerobic bacteria are unable to utilize complex cellulose of paper waste. Thus vermicomposting of paper waste is not an easy task. No sincere attempts have been made to recycle the paper waste so that pollution caused by its disposal be prevented and useful end product can be generated. Earthworms are important Vermiresources having simple, cylindrical, coelomate and segmented body characterized by presence of setae. Many organic by-products of agricultural production and processing industries are currently seen as ‘waste’ and thus become potential environmental hazards. A portion of this waste is currently reused, recycled or reprocessed. However, a majority of it is disposed off in Landfills (anaerobic composting), which is a matter of concern due to many factors including cost and environmental issue. During recent years, applied use of earthworms in the breakdown of a wide range of organic residues, including sewage sludge, animal wastes, crop residues, and industrial refuse to produce vermicompost, has been recommended (Mitchell et al., 1980; Reinecke & Venter, 1987; Edwards & Neuhauser, 1988; Hartenstein & Bisesi, 1988; Van Gestel et al., 1992; Dominguez & Edwards, 1997; Edwards, 1998; Kale, 1998; Garg
et al., 2006). Vermicompost is rich in microbial populations and diversity particularly fungi, bacteria and actinomycetes (Edwards, 1998). The importance of the earthworms in waste management, environmental conservation, organic farming and sustainable agriculture has been highlighted by several workers (Edwards & Neuhauser, 1988; Senapati, 1992; Mitchell, 1997; Ismail, 1997; Eijasackers, 1998; Talashikar & Powar, 1998; Tripathi, 2003). It has been observed that although paper sludge is a good source of organic carbon, this sludge cannot be applied directly to fields as it is deficient in other nutrients (Kaur et al., 2010). It is reported that paper sludge can be used as a good bulking agent or good source of carbon in composting (Suriyanayanam et al., 2010). It was reported that paper waste can be managed by earthworms (Sinha et al., 2008).

**MATERIALS AND METHODS**

The fresh cattle dung was procured from nearby buffalo dairy farm. The moisture content of the medium was maintained at about 50%-60% and the paper waste (A4 size sheets) was procured from office and research laboratories of the Department and they were converted into small pieces using paper shredder machine. Earthworms were procured from vermicomposting center, charak Udhyyan, Jiwaji University, Gwalior (India). For the present study, vermic-beds were made using ten days (10 days) old cattle dung for mass culture of *Eudrilus eugeniae*. The culture was constantly monitored throughout the period of study with time by time spraying of water. Mature worms for experimental purpose were taken from this stock culture. During preliminary studies, preference of earthworms towards cultured media was determined. A free choice experiment was conducted in ceramic tanks of 55x40x15 cm measurement (Fig. 1). This tank was divided into four equal size chambers with the help of thermocole sheets provided with some holes so that earthworms can pass through from one chamber to another, according to their preferential habits. In the first chamber, mixture of dung and shredded paper was filled, which was pre-decomposed by using water. Dung and shredded paper was filled in chamber B, which was pre-decomposed by sprinkling with a solution containing of Butter milk and Jaggery (450 ml + 250 gm in 5 litre of water). In the chamber (C), mixture of dung and shredded paper was filled which was pre-decomposed by adding vermiwash and in the chamber (D), mixture of dung and shredded paper was filled, which was pre-decomposed with a solution containing 5 gm of *Trichoderma harzianum* in five litres of water. The quantity of the medium in all the four chambers was kept constant (3 kgs.). 100 adult earthworms were released and the whole assembly was covered by garden mesh net. Free choice experiment was repeated three times and the results were recorded after 15 days by counting the number of earthworms.

Detailed composting experiments were carried out (in triplicates) using different additives as enhancers in plastic containers of 45 x 30 x 10 cm (Fig. 2) dimensions in all the experiments except the first one which was kept control. A mixture of waste paper and dung in the ratio of 1 : 1 treated with different additives i.e. *Trichoderma herzianum*, Vermiwash and Buttermilk + Jaggery used during the pre-decomposition period of 15 days. These additives enhance the process of decomposition of waste.

After 15 days, 25 mature weighed earthworms were taken from the stock culture and were uniformly released in all the containers. The culture containers were covered by mesh garden cloth for a period of 60 days. After 60 days, the contents of the culture containers were emptied on a white plastic sheet. It was then sieved to separate the vermicompost and earthworms. The cocoons and
juveniles were also separated for experimental observation. Degree of composting was obtained by weighing the vermicompost. Also percent increase in number, weight, population growth and biomass production were calculated. In order to determine the overall efficiency, percentile scoring was calculated for all the media. This was obtained by adding all the parameters. The medium giving maximum value was taken equivalent to 100 percent. The percent scores of other substrates was calculated. The percent scores of different media followed the sequence. Finally prepared vermicompost was analyzed for the following parameters: pH, Electrical conductivity, Total Nitrogen, Phosphorous and Potassium.

RESULTS

Results obtained during free choice experiment were depicted in figure 3. The maximum number (35%) of earthworm’s prefered the medium that was treated with Trichoderma for their settlement. Vermiwash treated medium was next with 28% preference. Next choice was shown for Jaggery and Buttermilk (21%). Least preference was shown for control (17%). Results obtained in main composting experiment revealed that a significant increase in number and weight of adult worms, number of cocoons and juveniles and a good amount of good quality compost was obtained during the 60 day period experiment time.

**Numbar & weight of adult worms:** A percent increase was observed in the number & weight of worms (Fig. 4) in media treated with different additives. Maximum increase was in number was noticed in Trichoderma treated media (101%) followed by Vermiwash (84%), Jaggery + Buttermilk (72%) and least increase was shown by control containers (61%), table 1. The trend of biomass (weight) was more or less similar to that of biomass (number). Maximum increase in biomass (weight) was recorded in containers treated with trichoderma (142%). This was followed by Jaggery + Buttermilk treated medium (117%), Vermiwash (108%) whereas minimum increase was shown by Control (90%) (Table 2).

**Worm population:** Percent population growth was also recorded in all the treated and control media. Maximum increase was shown by containers containing Trichoderma (937%), followed by Vermiwash (813%), and Jaggery + Buttermilk (746%). The minimum population growth was shown by control (680%) (Fig. 5).

**Biomass production:** Maximum biomass production was recorded in Trichoderma treated medium (182%) followed by Jaggery + Buttermilk (150%) and Vermiwash (140%). The minimum increase in percent biomass production was recorded in control containers (120%) (Fig. 5).

**Degree of composting:** Maximum degree of composting was observed in Trichoderma treated medium (59%), followed by vermiwash treated medium (50%), and Jaggery+ Buttermilk treated medium (45%). Lowest degree of composting was observed in control (42%) (Fig. 6).

Results obtained for percentile scoring are depicted in figure 7. The trend of percentile scorings was as follows: Trichoderma > vermiwash > Jaggery + Buttermilk > Control.

**Physico-chemical analysis:** The results of physico-chemical analysis of the vermicompost obtained from differentially treated substrates and control are given in table 3. The pH (7.6) was observed maximum in vermiwash treated media followed by Trichoderma (7.5) and Jaggery + Buttermilk (7.5), while least value for pH was recorded in control (7.3). The Electrical conductivity values obtained for the compost obtained from various treatments were 0.36 in
vermiwash, 0.50 in trichoderma, 0.70 in Jaggery+Buttermilk and 0.85 in control.

With regard to percent Nitrogen in compost obtained from different treatments, the values were 0.50%, 0.43%, 0.41% and 0.36% in Trichoderma, Vermiwash, Jaggery +Buttermilk and Control. Phosphorous and potassium content in the various treatments was also analyzed. The maximum phosphorous content was observed in Trichoderma (1.41%) followed by Vermiwash (1.30%), Jaggery + Buttermilk (1.28%) and Control (1.18%). The potassium content was also maximum in Trichoderma treated compost (0.34%). Vermiwash treated compost was having (0.30%) potassium content. Minimum potassium content was observed in Control group (0.19%) in which no any additive was added.

**DISCUSSION**

Results obtained for number, weight & biomass production are more or less similar to the findings of Kale et al. (1986) and Nagavallemma et al. (2004) who reported increase in number & weight of earthworms on the basis of quality and quantity of available food. The results obtained for vermicomposting performance were more or less similar to Pramanik & Chung (2011); Rasal et al. (1988); Buswell & Chang (1994); Milala et al. (2009) and Parray (2012), who reported that the composting can be enhanced by adding different additives like spirulina, vermiwash, sugarcane and Trichoderma. Also the time of predecomposition was reduced by adding different additives. The results were in agreement to the studies of Kumar et al. (2010) who demonstrated that overall time required for composting can be reduced to 20 days by adding different additives.

It can be concluded that vermicomposting is a feasible technology for the conversion of carbon rich waste paper after mixing with cow dung slurry and predigestion with different additives into a valuable product i.e. vermicompost.

**ACKNOWLEDGEMENT**

Authors are highly thankful to School of Studies in Zoology, Jiwaji University, Gwalior to provide facilities to carry out this research work.

**LITERATURE CITED**


Table 1. Showing number of adults, cocoons and juveniles in substrate treated with different additives.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatments</th>
<th>Initial No</th>
<th>Final number of adults</th>
<th>Numbe r of cocoons</th>
<th>Number of juveniles &amp; baby worms</th>
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<tr>
<td>1</td>
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<td>25</td>
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<td>2</td>
<td>Vermiwash</td>
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<td>3</td>
<td>J+BM</td>
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<td>92.33±1.75</td>
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<td>4</td>
<td>Control</td>
<td>25</td>
<td>40.33±0.88</td>
<td>71.66±1.45</td>
<td>83.33±1.20</td>
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</tbody>
</table>

Table 2. Showing weight of adults, cocoons and juveniles in substrate treated with different additives.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatments</th>
<th>Initial weight of adults</th>
<th>Final weight of adults</th>
<th>Weight of cocoons</th>
<th>Weight of juveniles</th>
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<td>J+BM</td>
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<td>9.32±0.05</td>
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Table 3. Showing the results of physico-chemical parameters of differentially treated vermicompost.

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<th>Treatment</th>
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<th>EC (dS/m)</th>
<th>N (%)</th>
<th>P (%)</th>
<th>K (%)</th>
</tr>
</thead>
<tbody>
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<td>0.85</td>
<td>0.36</td>
<td>1.18</td>
<td>0.22</td>
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Figure 1. Showing container used in free choice experiment.
Figure 2. Showing containers used for composting experiments.

Figure 3. Showing the relative preference of earthworms during free choice experiment.

Figure 4. Showing percent increase in adult number and weight in media treated with different additives.
Figure 5. Showing percent increase in population growth and biomass production in media treated with different additives.

Figure 6. Showing degree of composting in differentially treated media.

Figure 7. Showing the net percentile score differentially treated media.
A STUDY ON SAMPLING OF MOSQUITOS USING ECO-FRIENDLY MOSQUITO TRAP IN AND AROUND JIWAJI UNIVERSITY CAMPUS (INDIA)

Suheel Ahmad Ganai*, R. Kumar*, M. Basheer* and O. P. Agrawal*

Entomology Research Unit School of Studies in Zoology Jiwaji University, Gwalior-474011 (M.P.) India. E-mails: suhail_jalib@yahoo.com; op_agrawal51@rediffmail.com


ABSTRACT: Mosquitoes are the most important among all arthropod vectors that causes human disease in the tropical conditions. In order to reduce the mosquito nuisance and risk of diseases caused by them it is essential to reduce mosquito populations. All Inn Mosquito Trap/Killer was placed in four different outdoor locations. Out of total insects trapped, the percentage of mosquitoes was 36 %, 45 %, 35 % and 36 in case of Backyard of animal house, Backyard of Aryabhatt boys hostel, Front part and Fish pond area of School of Studies in Zoology, Jiwaji University, Gwalior respectively.

KEY WORDS: Gwalior, Mosquito, trap, sampling.

Mosquitoes are the most important among arthropod vectors of human disease in the tropics and are notoriously responsible for causing much greater misery to mankind than all other insects. Mosquitoes are considered “Public Enemy Number One” for humans owing to their biting and blood feeding habits. In order to reduce the mosquito nuisance and risk of diseases caused by them it is essential to reduce mosquito populations. Successful mosquito control requires detailed information about their diversity, distribution, seasonal variations etc. A large number of control programmes have been launched from time to time against mosquitoes such as chemical treatments, smoking, bio-pesticides and biological organisms. In addition to chemical insecticides other methods of mosquito control like window screens, mosquito nets, and mosquito repellents are being used. But all these control measures have got one or more drawbacks. Furthermore, mosquitoes are becoming resistant to different insecticides. So mosquito traps are much better option for controlling them, estimation of species abundance and composition. A large number of traps have been developed by Sudia & Chamberlain (1962), Odetoyinbo (1969), Service (1970), Davis et al. (1995), Mathenge et al. (2002), Hoel et al. (2007), Brown et al. (2008), Kaufman et al. (2008), Ritchie et al. (2008) and Kwela & Mahande (2009). But a significant success in mosquito control has yet to be achieved. In the present study, a new commercially available mosquito trap has been used. The device involves a number of attractive cues, UV light, heat, moisture (humidity) and carbon dioxide with creation of an atmosphere mimicking human skin, for female mosquitoes. The system does not involve any hazardous chemical and is perfectly eco-friendly. In India no studies have been conducted to demonstrate effectiveness of such mosquito traps, therefore the present study has been taken up with objectives of installing mosquito traps in different locations (outdoor) during different times (day, night) and different durations so as to observe the abundance of various mosquito species.
MATERIAL AND METHODS

Four pieces of All Inn Mosquito Trap/Killer, model Terminator – I were procured from market. The device works on the principle of attraction of mosquitoes, particularly the females, with creation of an atmosphere imitating / mimicking human skin. All Inn Terminator – I is fitted with small fluorescent (UV) tube and its inner walls are coated with titanium dioxide (TiO$_2$) - a natural oxide of the earth mineral that is non-toxic and is widely used in paints and to combat environment pollution worldwide.

Specifications of Device were as follow: Gross Weight: ~ 620 g/piece, UV fluorescent tubular lamp (200-400 nm), Air Blower (Exhaust Fan): Low noise, ultra-quiet fan, Transparent layer of TiO$_2$ is coated on the inner surface of the dome, Input Voltage: 220V AC, 50 Hz, Power Consumption: 6W, Approximate Monthly Power Consumption: 1.5 units.

A photo-catalytic reaction takes place when UV rays radiate TiO$_2$ resulting in generation of heat, moisture and CO$_2$, in the presence of organic carbon (bacteria). Thus hungry female mosquitoes are attracted towards Terminator – I through capture windows on upper part of the system. The attracted mosquitoes are sucked in a cage, at lower part, by vacuum created by a small exhaust fan. The trapped mosquitoes cannot fly upwards because of strong air flow of the ventilator. In few hours they die out due to dehydration under the influence of air blown onto them. The system does not involve any hazardous chemicals and is perfectly eco-friendly.

Mosquito traps were installed at various locations, as mentioned below, in Jiwaji University, campus. Outdoor locations selected for the study were, Backyard of animal house, Backyard of Aryabhatt Boys Hostel, Front part and Fish pond area of School of Studies in Zoology. Mostly they were installed for nocturnal survey for a period of 12 hours from 6 PM to 6 AM.

Trapped and killed insects were collected in Petri dishes. The Petri dishes were placed in an oven at 60$^\circ$C for 12 hours to remove moisture of the insects and then they were stored in air-tight plastic containers, for further study. The trapped insects were sorted out according to their orders. Identification of mosquitoes up to genus level was carried out. Data obtained was tabulated and subjected to statistical analysis (Mean ± S. E.).

RESULTS

The results of present study have been depicted in figure I - IV. The number of mosquitoes and other insects trapped in different locations were observed and recorded. The range of number of mosquitoes caught per day at the backyard of animal house (good place for breeding and hiding of mosquitoes) was 45-81. In total 5360 insects were caught in one month, the maximum number (1979) and percentage (37%) of insects caught at this point were of psycodids, while mosquitoes were the next with total number of 1936 and percentage share of 36%. Other dipteran insects of the catch included houseflies, sand flies and chironomids and some non-dipteran insects (small moths, bugs, beetles, grasshoppers) in small numbers (Fig. 1).

The results obtained from 2nd location, backyard of Aryabhat Hostel, were more or less similar with some difference in the total number, daily average and percentage share of over-all catch. At this location mosquitoes dominated the catch and psycodids were at second place. The number of mosquitoes caught per day at this location ranged from 45-81 (Fig. 2).
The results obtained from 3rd location, Front part of School of Studies in Zoology, were more or less similar with some difference in the total number, daily average and percentage share of over-all and differential catch (Fig. 3). At this location psycodids dominated the catch and mosquitoes were at second place. The total number of insects caught during this period was 4826 with daily average of 155.68 per day. The number of mosquitoes caught per day at this location ranged from 24-94. The range of number of insects caught per day at the Fish pond area of School of Studies in Zoology was 94-192. The range of number of mosquitoes caught per day at this location was 32-78 (Fig. 4).

Results of present studies are more or less similar to that of studies conducted by Moree et al. (2001) reported that UV light traps caught more mosquitoes than the traps with incandescent bulbs. Also, Hoel et al. (2009) reported maximum collection of Ae. Albopictus using commercial mosquito traps. Octenol trap is known to be an attractant for most Aedes and some Culex mosquitoes (Kline et al., 1991a,b; Kline, 1994; Kline & Mannm, 1998). Krockel et al. (2006), Maciel-de-Freitas et al. (2006) and Williams et al. (2006) compared the efficacy of BG-Sentinel™ mosquito trap (BGS) to other traps or active collection methods and reported the trap as an effective tool for capturing adult Ae. aegypti in the outdoor environment.

On the basis of observations of the present study it is concluded that trap used in the study acts as a good eco-friendly device for the control and sampling for the mosquitoes and the use of these traps do not cause any environmental pollution.

ACKNOWLEDGEMENT

Authors are thankful to School of Studies in Zoology for providing facilities to carry out this research work.

LITERATURE CITED


Figure 1. Showing percentage of insects trapped at backyard of animal house.
Figure 2. Showing percentage of insects trapped at backyard of Aryabhitt Boys Hostel.

Figure 3. Showing percentage of insects trapped at front part of S.O.S. in Zoology, Jiwaji University, Gwalior.

Figure 4. Showing percentage of insects trapped at fish pond area of S.O.S. in Zoology, Jiwaji University, Gwalior.
A NEW SPECIES OF TRICHOTROMBIDIUM KOBULEJ, 1951
(ACARI: PROSTIGMATA: MICROTROMBIDIIDAE)
FOR THE TURKISH FAUNA

İbrahim Karakurt* and Sevgi Sevsay**

* Institute of Natural and Applied Science, Atatürk University, Erzurum / TURKEY. E-mail: ikarakurto7@hotmail.com
** Department of Biology, Arts & Science Faculty, Erzincan University, Erzincan / TURKEY. E-mail: ssevsay@erzincan.edu.tr


ABSTRACT: In this study, larvae of Trichotrombidium rafieiae Saboori, 2002 which are new for Turkish fauna and obtained as an ectoparasite on adult Musca domestica (Diptera, Muscidae), are given the morphological characters and drawings of various organs, identification key and its zoogeographical distribution.

KEY WORDS: Acari, Microtrombidiidae, Trichotrombidium, larva, Erzincan, Turkey.

Microtrombidiidae is a large family that has 437 species registered in 126 genus (Mačkol & Wohltmann, 2012). The genus Trichotrombidium Kobulej, 1951 is known only from larvae and deutonymf forms. Trichotrombidium includes two species as Trichotrombidium hemistriatum (originally described as Trichotrombidium hemistriatum by Riley (1878) and redescribed as Trichotrombidium muscae by Kobulej (1951) and known from larvae and deutonymf forms) and Trichotrombidium rafieiae (Southcoot, 1994) (known only larval form). The latter species is an ectoparasite on adult Musca domestica (Diptera, Muscidae) (Saboori, 2002).

In this paper larvae of Trichotrombidium rafieiae is described and illustrated as an ectoparasite on adult Musca domestica (Diptera, Muscidae) from Erzincan, Turkey. A short key for larvae of the Trichotrombidium species is also proposed. The genus Trichotrombidium is recorded from Turkey for the first time.

MATERIAL AND METHODS

Larvae obtained as an ectoparasite on adult Musca domestica (Diptera, Muscidae) from Erzincan, Turkey. Examined material was preserved in 70% ethyl alcohol and cleared in 9% KOH. Specimens for light microscope studies (6 larvae) were fixed on slides in Hoyer’s medium (Krantz & Walter, 2009). Measurements were taken and drawings made under a Leica DM 4000 microscope with differential interference contrast and phase contrast. Mačkol (2007) and Southcoot (1994) followed for the morphological terminology in the text. All measurements are given in micrometers (μm).

RESULTS AND DISCUSSION

Family Microtrombidiidae Thor, 1935
Genus Trichotrombidium Kobulej, 1951
Type species Trichotrombidium muscae Kobulej, 1951
**Trichotrombidium rafieiae** Saboori, 2002

**Diagnosis.** Scutum and scutellum are available with longitudinal striations in its lateral parts. And larva with the following features: palpal formula: 0-0-0-NN-NNNNNζω; fD=28; IP=797  fCx formula: BB-B-B. Pretarsus of legs I–II with paired claws and claw-like empodium. Pretarsus of leg III with outer claw and empodium, inner claw deformed.

**Description.** Standart measurements in Table 2. Colour in life red. Gnathosoma with horseshoe-like mouth that bearing large denticled membranes outside (Fig. 1). Setae bs in the shape of stout calyx, distally seven finger-like. Adoral seta smooth. Cheliceral blade short and slightly curved. Seta absent on palp femur and genu. Palp tibia with two nude setae. Palp tarsus with five nude setae, an eupathidium and a solenidion; palpal formula: 0-0-0-NN-NNNNNζω (Figs. 2–3).

Scutum pentagonal; clearly convex at the mid of its anterior border and slightly concave at the mid of its posterior border with longitudinal striations in its lateral parts. The surface of scutum bears three pairs nonsensillary setae and one pair sensillary setae. AM (36 µm) seta smooth. AL (37 µm) seta with slightly setules. S (66 µm) seta thin and long. PL (61 µm) seta with distinctly setules has stem thicker than AM and AL setae. Two pairs of eyes at the level of S seta, each pair situated on the on the oval sclerite. Palpal length (lens: 20 µm) larger than posterior one (diameter: 15 µm). Scutellum more narrowed in cooperation with scutum but it with longitudinal striations in its lateral parts similar scutum and slightly convex at the mid of its anterior border. Surface of scutellum bears a pair of c1 (or SL=61 µm) seta. All dorsal setae situated on plates or platelets (the largest c1 and d1 plates) barbed and arranged in 5 rows. : fD formula: 6-6-6-4-4 (c1c3, d1r3, e1r3, f1r2, h1c2), (38-76 µm), (h2 setae observed in idiosoma ventrum). Number of all dorsal setae (fD) 28 (Fig. 4).

All coxae punctuated. Claparéde’s organs laterally between coxae I and coxae II. All coxal setae with setules. fCx formula: BB-B-B. One pair of barbed intercoxal setae 3a placed in between coxal plates III. Posteriorly following four barbed setae situated anterior and lateral to anal opening. fV formula: 2-2u-2. Ventral setae slightly thinner than dorsal setae. Anal opening without sclerite (Fig. 5).

Legs segmentation formula: 6-6-6, for leg chaetotaxy see Table 1. All normal setae on legs I–III setulose. Pretarsus of legs I–II with paired claws and claw-like empodium. Pretarsus of leg III with outer claw and empodium, inner claw deformed (shortened) (Figs. 6-10).

**Material examined.** 6 larvae were obtained as ectoparasites on adult *Musca domestica* L., 1758, vicinity of Terzibaba Mosque of Erzincan, Turkey, 39°44’41”N 39°30’14”E, 1195 m, 17. 09. 2010, leg. H. H. Özbek.

**Distribution.** Iran and Turkey.

**Discussion.** *Trichotrombidium rafieiae* easily separated from *Trichotrombidium hemistriatum* by the number of normal setae on femur I (4 vs. 5), on genu I (4 vs 3), on tibia I (6 vs. 5), fD (28 vs. 22), solenidion on genu I (4 vs. 3).

In fact, this species are similar to zoogeographical and morphological properties of Iranian specimens that were given by Saboori (2002). But Turkish specimens (656 length, 423 width) differs from Iranian specimens (388 length, 245 width) by large body. Also, setae AM and AL combined length subequal with distance between their insertion (AM + AL = MA) in Iranian specimens, but not equal in Turkish specimens.

In addition, morphological differences are available of these specimens (see Table 2).
Key to the species of *Trichotrombidium* (larva)

1. 3 solenidion on genu I, fD= 22 ....................... *Trichotrombidium hemistriatum*
   - 4 solenedion on genu I, fD= 28 ....................... *Trichotrombidium rafieiae*

LITERATURE CITED


Table 1. Leg chaetotaxy of larvae of *Trichotrombidium rafieiae*

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Table 2. Morphometric data on larvae of *Trichotrombidium rafieiae*.

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ASSESSMENT OF DEARTH PERIODS FOR HONEY BEES (APIS MELLIFERA) IN GWALIOR (M.P.), INDIA

Rajesh Kumar*, Gajendra Singh Rajput*, Suheel Ahmad Ganai*, Mudashir Basheer* and Om Prakash Agrawal*

* Entomology Research Unit, School of Studies in Zoology, Jiwaji University, Gwalior - 474011 (M.P.), INDIA. E-mail: krajeshentomology@gmail.com; op_agrawal51@rediffmail.com


ABSTRACT: Management of honeybees for the production of various value added products require complete knowledge & understanding of beekeeping practices. Honeybee colonies should be evaluated for their performance during dearth periods so that appropriate measures can be opted to successfully overcome dearth periods. In the present study, various colony parameters viz. egg laying area, brood area, honey and pollen storage area were observed and recorded. Values obtained for all the parameters viz. egg laying (1712 cm²), brood area (1302.7 cm²), pollen stores (1090.7 cm²) and honey stores (1476 cm²) were maximum in the April month when sufficient bee flora was available. The values decreased for all the parameters and reached minimum (0.0) in June month when the food sources were in scarce.

KEY WORDS: Honeybee, beekeeping, dearth periods, Gwalior, brood.

During summer season, natural food sources (pollen and nectar) of honeybee become scarce. In India, summer seasons are getting prolonged and so also the dearth period due to huge industrialization and global warming. Periodical dearth periods results into depletion of food stores & nutritional reserves inside the bee hives. Due to deficiency of protein rich food, egg laying frequency of queen bee decreases. Worker bees stops brood rearing resulting into weakening of colony performance & colony strength. Sometimes prolonged dearth of bee flora may lead to perishing of the bee colonies. Poor bee colonies may sometimes be attacked by bee enemies such as wasps, ants, bee eater birds, wax moth and robbing by wild bees. Therefore management of bee colonies is getting more and more difficult. Quite often beekeepers harvest excess amount of honey before dearth period so that colonies cannot sustain due to the shortage of food. All these reasons forces the beekeepers have to follow the concept of colony migration which involves a lot of labor, time and money. Several colonies may perish during transportation due to accidents, improper timing and improper site selection. In addition to colony migration, study related to colony parameters during dearth period may help in variety of ways in successful beekeeping management. Study of various colony parameters during dearth periods may help in calculating the severity and effect of dearth period and amount of pollen substitute to be provided to bee colonies during different time intervals of the dearth period. Mishra (1995) reported the dearth of bee flora from May to September and emphasized the necessity of feeding artificial diets to bee colonies during this period to strengthen their stores. The present study was conducted to assess the severity of dearth periods and their effect on bee colonies so that suitable arrangements can be done for proper bee management to help tide the colonies of Apis mellifera over the dearth periods.
MATERIAL AND METHODS

Required number of disease free *Apis mellifera* colonies of almost equal strength were procured from Navdarshnam Bee Farm and maintained at Jiwaji University Campus, Gwalior (M.P.) during summer 2010. Egg laying area, brood area, pollen and honey stores in the colonies was measured after every 21 days interval with the help of wire grid measuring frame consisting of squares of the size of one inch\(^2\) (Seeley & Mikheyev, 2003; Amir & Peveling, 2004) (Fig. 1). This value denotes the area in inch\(^2\) which was then converted into cm\(^2\) by multiplying with a factor of 6.45. Data thus obtained was tabulated and subjected to randomized block design (Gomez & Gomez, 1984).

RESULTS

Results obtained during the study were depicted in figures 2 & 3.

Egg laying area was observed to be 1712 cm\(^2\) per colony in April month which decreased to 317.4 cm\(^2\) per colony in May followed by 58 cm\(^2\) per colony in late May. No any egg laying was observed in the June month. Fresh egg laying (112.7 cm\(^2\)) was observed in July and after that it started increasing and recorded to be 357 cm\(^2\) and 486.3 cm\(^2\) on 5\(^{th}\) August & 26\(^{th}\) August respectively (Fig. 2).

Brood area was observed maximum 1302.7 cm\(^2\) per colony in beginning of study which decreased to 640 cm\(^2\) on 22\(^{nd}\) April. Brood area further decreased to 112.7 cm\(^2\) in the May month and no any brood was observed in June month. With the onset of monsoon season, brood reappeared as value recorded for brood area was 30 cm\(^2\) on 15\(^{th}\) July. Brood area further increased to 114 cm\(^2\) as on 5\(^{th}\) August and reached 266.3 cm\(^2\) at the end of August month (Fig. 2).

Reserved food stores in form of pollen and honey were also observed & recorded in the colonies to assess the severity of dearth period. The pollen stores were observed to be 1090.7 cm\(^2\) per colony on 1\(^{st}\) April followed by 805 & 389 cm\(^2\) per colony on 22\(^{nd}\) April and 13\(^{th}\) May. No any pollen stores were observed in June month as values recorded to be 0.0. After that with the fresh showers of monsoon, bee flora started reappearing and fresh pollen was observed in the bee hives as 67 cm\(^2\), 112.7 cm\(^2\) & 167.3 cm\(^2\) on 15\(^{th}\) July, 5\(^{th}\) August and 26\(^{th}\) August respectively (Fig. 3).

Similarly honey stores were also observed in the colonies. No sealed/unsealed honey was found in the colonies in the month of June. Fresh honey (45.0 cm\(^2\)) was observed in July month which increased to 82.7 cm\(^2\) on 5\(^{th}\) August. Honey storage area reached 110 cm\(^2\) at the end of study i.e. on 26\(^{th}\) August (Fig. 3).

DISCUSSION

The results obtained during the study were more or less similar to the observations of Standifer et al. (1973), Doull (1980), and Mishra (1995) who reported that dearth period for honeybees starts in May and end in September month. Also they emphasized the necessity of feeding protein rich artificial diets to bee colonies during this period to strengthen their stores. During the study, it was also observed that egg laying & brood area started recovering with the first showers of monsoon (July onwards). The inferences drawn from the study were in accordance with that of Singh (1943); Thakar & Shende (1962); Shah & Shah (1976) who reported an increase in the rate of egg laying by queen bee and brood rearing with the first income of pollen after dearth period. Thus the study on control colonies was of prime significance as it gives an idea about the severity of
dearth period for honey bees. Also, the study was helpful in determining the amount of artificial protein rich diet to be provided to bee colonies during different time intervals of the dearth period. At the end of study, it can be concluded that intensive care of bee colonies is required only during severity of dearth periods. Proper bee management practices must be followed to overcome dearth period successfully.

ACKNOWLEDGEMENTS

Authors are highly thankful to School of Studies in Zoology, J. U. Gwalior for providing research facilities & UGC New Delhi for providing research grant.

LITERATURE CITED


Figure 1. Frame sized wire grid used to measure various colony parameters.
Figure 2. Showing variation trend in egg laying & brood area during dearth period.

Figure 3. Showing variation trend in honey & pollen area during dearth period.
BIOLOGICAL STUDIES OF LYMANTRIA OBFUSCATA WALKER (LEPIDOPTERA: LYMANTRIDAE) ON APPLE PLANTATIONS (MALUS DOMESTICA BORKH.) IN JAMMU REGION OF J & K, INDIA

Ruchie Gupta* and J. S. Tara*

* Department of Zoology, University of Jammu, Jammu (Tawi) - 180006, J & K, INDIA. E-mail: ruchiegupta18@gmail.com


ABSTRACT: Lymantria obfuscata Walker is a polyphagous pest infesting a wide variety of fruit and forest trees. The objective of this work is to study the detailed life cycle of Indian gypsy moth (Lymantria obfuscata Walker) on apple plantations (Malus domestica Borkh.), which is a cherished and economically important fruit crop in Jammu region of J & K State, India and is severely attacked by the larvae off Indian gypsy moths. Larvae defoliate apple plants, reduce their vigour and sometimes the infestation is so severe that it leads to mass destruction of apple plants. Thus, an attempt was made to study the biology of this pest in Jammu as no earlier record of the pest has been obtained from the region so far. Incidence of the pest was determined by the defoliated leaves fallen from the trees which indicates an identification mark for locating the pest. Biological studies include morphometric measurements of different stages from egg to adult. Incubation period varies from 286.0 to 329.0 days (305.2±5.26 days) (mean±SE). Larval period varies from 37 to 60 days (49.8±2.43) days. Pupal period ranges from 12 to 14 days (13.4±0.27 days). Adult longevity of male and female is 3.5 to 6 days (4.45±0.25) and 7 to 9 days (7.60±0.0.20 days) respectively. Besides biology, host plants and distribution of the pest are also included in the paper.

KEY WORDS: Lymantria obfuscata Walker, Malus domestica Borkh, biology, new, morphometric.

Indian gypsy moth Lymantria obfuscata Walker (Lepidoptera: Lymantridae), also known as hairy caterpillar is one of the most destructive pest of fruit and forest plantations across the world. The pest has been recorded by the montane and sub -montane regions of south western Himalayas, West Pakistan (Hampson, 1892; Beeson, 1941; Browne, 1968) and USA (Fuester et al., 2008) and Canada (Gries et al., 2007) have been reported causing frequent and severe defoliation.

In India the pest has been recorded from Kashmir, Himachal Pradesh (Beeson, 1941; Pruthi & Batra, 1960; Nair, 1970; Malik et al., 1972; Mishra & Basu Choudhuri, 1974; Sheikh, 1975; Dar et al., 1976; Butani, 1979; Shrivastava & Masoodi, 1985; Rishi & Shah, 1985; Singh & Singh, 1986; Masoodi, 1991; Bhardwaj & Bhardwaj, 2005; Mir & Wani, 2005), Tamilnadu (Rahman, 1941; Nair, 1970; Gupta, 1976; Verma et al., 1979; Butani, 1979; Masoodi et al., 1986; Bhardwaj & Bhardwaj, 2005; Singh et al., 2007), Dehradun (Roonwal,1954), Uttar Pradesh (Gupta, 1976), Karnataka (Nair & Premkumar, 1974) and Varanasi (Raju et al., 1994; Raju et al., 1995) on different host plants.

The biological studies of this pest have not been conducted in detail on apple although, some preliminary observations were made by Beeson (1941), Rahman & Kalra (1944) and Roonwal (1977). Kumar (1974) while observing this pest in South India on cacao leaves made some observations about the hatching of eggs and feeding habits. Mishra & Basu Choudhuri (1974) while recording the occurrence of Lymantria obfuscata Walker on cashew in Tamil nadu described its
bionomics. Masoodi (1991) recorded its biology on willow leaves in Kashmir. These observations on its biology are either incomplete or were undertaken in different situations in India and no detailed and systematic information on its bionomics in Jammu province in India, where it has assumed serious dimensions, is available. The present work was therefore undertaken to study the detailed biology of *Lymantria obfuscata* Walker in Jammu, India which would be useful for development of management programme of the pest on the most important economic crop plant i.e. apple plantations of the area.

**MATERIALS AND METHODS**

Studies on the biology of *Lymantria obfuscata* were conducted under laboratory conditions in the field laboratory established at Bhaderwah area of Jammu Province from April to July during 2011-12. The insect larvae were collected from apple plantations of the area and reared in the laboratory. Adult moths were allowed to copulate separately in wire meshed cages. Each pair was observed for pre-mating, mating, pre-oviposition and oviposition behaviour and duration. Longevity of adult moths was also recorded. The egg masses were measured and eggs in each mass were dehaired, counted and their diameter measured by means of an ocular micrometer after calibration. Dehaired eggs were washed with distilled water; air dried and kept under laboratory conditions for incubation in Petri dishes.

Newly hatched larvae were then transferred to sterile paired petri dishes, lined with moist filter paper and provided with fresh apple leaves. The food and filter paper lining were changed after every third day during the first and second larval instars and later on food was changed daily and filter paper lining on alternate days. Larvae were observed daily and data was recorded with regards to molting, duration and size of each larval instar, pupation and pupal period. All life stages were recorded morphometrically. Male and female pupae were placed in separate petridishes lined with filter paper. Pupae were segregated on the basis of size as female pupae were larger than the males. Observations were recorded with regards to emergence and fecundity.

Morphometric measurements were recorded using standard graphic paper method. For the study of different instars, the head capsule width was measured with the help of an occulometer. Data gathered during the experiment was analyzed statistically for calculating mean, standard deviation and standard error.

**RESULTS**

**BIOLOGICAL STUDIES:**

**Emergence of the pest:**

In the field, adult gypsy moths appeared in late May and remains till June on apple plantations in study areas. Before copulation the male shows some signs of pre-copulatory behaviour indicated by twitching of antennae and shaking of the body. Simultaneously female moth responds by protracted and retracted last abdominal segment of their body. Mating occurs during day time and lasts for about one and a half hour.

**Oviposition:**

Immediately after copulation female starts egg laying in batches on the bark of apple trees and other adjoining places and forms an egg mass covered with golden brown hair. Egg laying continued for 2.0 to 5.0 days and an average of 270.83 eggs are laid by each female in the area of investigator on apple trees. Egg laying
behaviour of the pest under study has also been observed by some earlier workers like Rahman & Kalra (1944) and Masoodi (1991) who gave a brief account of the oviposition of female moths of *L. obfuscata* and recorded 200-400 and 462.13 eggs laid by each female.

Egg masses are laid by female moths in clusters on the surface of the bark or leaves of trees, each egg mass usually being covered externally with a layer of hairs believed to be derived from the anal tufts of the ovipositing females. Exceptionally eggs were also laid on leaves, dried fruits, and even on the surface of brick walls, ceilings on the houses and metal wire gauze nettings. The egg masses of *Lymantria obfuscata* on apple plantations in the present area of study are sub ovoid, oval to quadrate and semi linear and measures 26.0±9.72 (SE: 2.80) and 19.66±5.86 (SE: 1.69) mm in length and width respectively. The egg masses also assume a variety of other shapes. Freshly laid eggs were pale yellowish and rounded when seen from above, having a diameter of about 0.75±0.070 (SE: 0.02) mm that ranged from a minimum of 0.65mm to a maximum of 0.85 mm.

**Incubation Period:**

Incubation period of the eggs as observed by the present author in the area under investigation on apple plantations as host ranged from 9 to 10 months with an average of 305.2±16.63 days.

**Hatching**

From the incubated eggs of the previous season, young larvae start hatching from late March and continued till April in Jammu region of J&K State on apple plantations (*Malus domestica* Borkh.). Masoodi (1991) also recorded the same hatching period of the pest from 5.0 days to 24.0 days with an average of 9.8±5.37 days and occurs during day time. After hatching first instar larvae wander about and started feeding on upper surfaces of leaves forming small perforations. They remain hidden during the night where they do not feed.

**Larval Stages:**

The author has recorded five larval instars in the life cycle of the pest.

**First Instar**

First instar larvae of *Lymantria obfuscata* were darker measuring 4.03±0.80 (SE: 0.25) mm in length and 0.37±0.05 (SE: 0.01) mm in width. Body covered with tuft of hairs, bearing a pair of small dots on each segment running all along the back. Newly hatched larvae feed on upper surfaces of leaves forming small perforations. They remain hidden during the night when they do not feed.

This stage lasted for 7.0 to 10.0 days with an average of 8.55±0.92 (SE: 0.29) days while feeding on apple in the area of present investigator.

**Second instar**

Larvae brownish, with hairs covering the body and measured 8.43±1.30 (SE: 0.41) mm long and 1.78±0.27 (SE: 0.08) mm wide. Larva possess double row of small tubercles along the back. Feed usually in the morning hours by defoliating the leaves along their margins. During night or when not feeding, larvae rest under shade i.e. under leaves and cracks in the bark spaces of trees in the field and inside the filter paper of Petri dishes under lab conditions.

The second larval stage lasted for a period of 5.0 to 9.0 days with an average of 6.75±1.37 (SE: 0.43) days by the investigator during her studies in Jammu region.

**Third instar**

Third instar larvae are dark grey. Double rows of tubercles are prominent with first five pairs of bluish and last six pairs brick red in color. The dark brown head of the larva had yellow markings and body measured 17.12±3.17mm in length and 3.89±0.70 mm in width. Larvae usually feed during morning and cause massive
defoliation of the apple trees in study area of the present investigator. This stage lasted for 5.50 to 9.0 days with an average of 7.6±1.41 days. The duration of third larval instar in the study area on to range between 5.0 to 9.0 days with an average of 7.6 days.

**Fourth instar**

Body becomes more hairy, brownish and double row of tubercles become more prominent and measured 25.67±3.33 mm in length and 6.22±0.33 mm in width. A light strip between the tubercles and the spiracles runs on each side of larva all along the length.

The feeding behaviour of fourth instar larvae vary much from the previous ones as larvae now start feeding during night hours also but remains confined to leaf margins and during the day larvae rest under the shade of the leaves. This larval stage varies between 8.0 - 14.0 days with an average of 11.6±1.85 days.

**Fifth instar**

General appearance of the final instar larvae was similar to that of the fourth instar except variations in the length and width of the body that measured 39.94±4.41 mm (SE: 1.39) and 8.30±0.42 (SE: 0.13) mm respectively. It has short dorsal and long lateral tufts of hair. Duration of fifth instar lasted for a minimum period of 12.0 days to a maximum of 18.0 days with an average of 15.3±2.16 days.

Average larval duration of the pest as recorded by the author in the study area on apple tree as a host ranged between 37.5 - 60.0 days with an average of 49.8±7.71 (SE: 2.43) days.

**Pupae**

Fully fed and matured larvae stopped feeding, body start shrinking and thickening in size. It then spins some silken threads around its body and remains in this pre-pupal stage for about 3.35±0.88 days. Larvae do not spin any cocoon around its body. Pupae almost naked, reddish brown with only a few strands of silken threads attached loosely to its body. Female pupa characteristically larger than male pupa measured 22.0±1.58 mm and 6.20±0.78 mm respectively. Pupal period ranged from 12.0 to 14.5 days with an average of 13.4±0.87 days.

**Adults**

In adults of gypsy moth, sexual dimorphism is well distinct. Female moths larger in size and dirty creamish whereas males smaller than females and have brownish bodies. In males wings are well developed. Front and hind wings dissimilar in venation and in shape. \( R_1 \) in hindwing unbranched; jugum and fibula absent; front and hind wings united by a frenulum; mouthparts usually in the form of a coiled proboscis. Wings entire; scaled throughout. Hindwings much broader than their fringe and usually wider than front wings; hind wings with two anal veins; front wing with a single complete anal vein \( S_c \) and \( R_5 \) in hind wing not connected by a cross vein; \( M_2 \) in front wing arising closer to \( M_3 \) than to \( M_1 \); cubitus appear four branched; front wing with some branches of \( R \) and \( M \) fused beyond discal cell; hindwing without humeral veins; usually with a frenulum; \( Cu_2 \) in front wing arising in basal half; frenulum well developed; \( S_c \) in hindwing present and well developed; Hindwing with \( S_c \) and \( R_5 \) widely separate beyond discal cell and base of \( R_5 \) well developed; ocelli present; front wings smoothly scaled; Hindwing with a small basal areole and \( S_c \) and \( R_5 \) fused for only a short distance at end of areole.

Female moths apterous possessing feebly developed wings and bulky body and therefore are unable to fly. Male moths have functional wings and can perform its normal flight in a zig zag manner during the day. The average length and width of male and female moths are 14.2±1.64 (SE: 0.73) mm and 33.4±4.21 (SE: 1.88) mm and 20.6±2.96 (SE: 1.32) mm and 40.8±2.94 (SE: 1.31) mm respectively.
Male and female moths lived for a period of about 3.5 to 6.0 days and 7.0 to 9.0 days with an average of 4.45±0.79 (SE: 0.25) days and 7.60±0.65 (SE: 0.20) days respectively when fed with 5% honey solution in the field lab established at study station at Bhaderwah.

**Damage:**

Indian gypsy moth is an important defoliator and a destructive pest of deciduous, shade and fruit trees in parts of Asia, Africa, Europe and North America (Berozoa et al., 1973 and Kumar (1974). Although the insect has a wide range of host plants but some host species such as willows, poplars and apples are extensively defoliated and support large larval populations. Butani (1979) reported that the larvae of Indian gypsy moth defoliates the trees completely and results in failure of fruit formation.

Present investigations in Jammu division of J&K State on apple plantations (*Malus domestica* Borkh.) as a host found the caterpillars of this pest to defoliate the leaves and their feeding increases with the subsequent instars and the caterpillars feed voraciously on the entire tender leaves including the veins. In the field, the first instar larvae usually remains on the underside of leaves and are carried by wind from tree to tree, suspended by long threads that they spin. Caterpillars are nocturnal and gregarious in habit. They aggregate in large numbers on the ground under the fallen dry leaves near the base of the trees, crevices of bark or on lower parts of well shaded main branches. After dusk the larvae start crawling through tree trunks and feed there. In severe attack the caterpillars defoliate the host plants completely thereby retarding the growth of the trees.

On the basis of above observations recorded by the author in the field *Lymantria obfuscata* is recorded as an important pest of apples in Jammu province of J & K State. In the near future this pest may assume more serious and destructive position if adequate control measures were not undertaken immediately. This warrants attention of the orchardists of the region for its timely and proper control.

**ACKNOWLEDGEMENTS**

The authors are highly thankful to Head, Dept. of Zoology, University of Jammu for necessary help and Entomology Division of IARI New Delhi for the insect identification.

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Roonwal, M. L. 1954. Structure of egg masses and their hairs in some species of Lymantria of importance to forestry (Insecta: Lymantriidae). Forest entomologist, Forest Research Institute, Dehra Dun: 553-559.


Table 1. Morphometric measurements of various life stages.

<table>
<thead>
<tr>
<th>STAGE</th>
<th>BODY LENGTH (mm)</th>
<th>BODY WIDTH (mm)</th>
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</thead>
<tbody>
<tr>
<td>Mean±SD</td>
<td>(Min-Max)</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Egg mass</td>
<td>15.0-45.0</td>
<td>26.0±9.72</td>
</tr>
<tr>
<td>First instar</td>
<td>3.04-5.20</td>
<td>4.03±0.80</td>
</tr>
<tr>
<td>Second instar</td>
<td>6.00-9.80</td>
<td>8.43±1.30</td>
</tr>
<tr>
<td>Third instar</td>
<td>10.8-10.8</td>
<td>17.12±3.17</td>
</tr>
<tr>
<td>Fourth instar</td>
<td>25.0-30.0</td>
<td>25.67±3.33</td>
</tr>
<tr>
<td>Fifth instar</td>
<td>39.0-47.0</td>
<td>39.94±4.41</td>
</tr>
<tr>
<td>Pupa</td>
<td>20.0-25.0</td>
<td>22.0±1.58</td>
</tr>
<tr>
<td>Adult male</td>
<td>12.0-16.0</td>
<td>14.20±1.64</td>
</tr>
<tr>
<td>Adult female</td>
<td>18.0-25.0</td>
<td>2.06±2.96</td>
</tr>
</tbody>
</table>

Table 2. Duration of different stages in the life cycle of *Lymantria obfuscata* Walker on apple plantations.

<table>
<thead>
<tr>
<th>STAGE</th>
<th>DURATION OF DAYS</th>
<th>MEAN±SD</th>
<th>SEM</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>MIN.</td>
<td>MAX.</td>
<td></td>
</tr>
<tr>
<td>Incubation period</td>
<td>286.0</td>
<td>329.0</td>
<td>305.2±16.63</td>
</tr>
<tr>
<td>First Instar</td>
<td>7.0</td>
<td>10.0</td>
<td>8.55±0.92</td>
</tr>
<tr>
<td>Second Instar</td>
<td>5.0</td>
<td>9.0</td>
<td>6.75±1.37</td>
</tr>
<tr>
<td>Third Instar</td>
<td>5.5</td>
<td>9.0</td>
<td>7.6±1.41</td>
</tr>
<tr>
<td>Fourth Instar</td>
<td>8.0</td>
<td>14.0</td>
<td>11.6±1.85</td>
</tr>
<tr>
<td>Fifth Instar</td>
<td>12.0</td>
<td>18.0</td>
<td>15.3±2.16</td>
</tr>
<tr>
<td>Total Larval Period</td>
<td>37.5</td>
<td>60.0</td>
<td>66.5±7.71</td>
</tr>
<tr>
<td>Prepupation</td>
<td>2.0</td>
<td>4.0</td>
<td>3.35±0.88</td>
</tr>
<tr>
<td>Pupation</td>
<td>12.0</td>
<td>14.0</td>
<td>13.4±0.87</td>
</tr>
<tr>
<td>Life cycle(egg to adult emergence)</td>
<td>38.0</td>
<td>59.0</td>
<td>48.8±6.98</td>
</tr>
<tr>
<td>Adult Longevity (Male)</td>
<td>3.5</td>
<td>6.0</td>
<td>4.45±0.79</td>
</tr>
<tr>
<td>Adult Longevity (Female)</td>
<td>7.0</td>
<td>9.0</td>
<td>7.60±0.65</td>
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</tbody>
</table>
BIONOMICS OF AAK WEEVIL, PARAMECOPS FARINOSA (WIEDEMANN) (COLEOPTERA: CURCULIONIDAE), A PEST OF CALOTROPIS PROCERA (AIT.) R. BR. IN JAMMU DIVISION OF J & K STATE (INDIA)

Madhu Sudan*, J. S. Tara and Baldev Sharma

* Department of Zoology, Division Entomology, University of Jammu, Jammu (Tawi)-180006, J & K (INDIA). E-mail: dr.sudanmadhu.ju@gmail.com


ABSTRACT: The bionomics of Aak weevil Paramecops farinosa (Wiedemann) has been studied on Calotropis procera (Ait.) R. Br. in Jammu, Reasi and Rajouri Districts of Jammu region of J & K State. This is the first report from India as well as the world. P. farinosa has been observed as a major pest of C. procera, an important medicinal plant which is grown only in restricted patches in Jammu region of J & K State. Adults feed externally on the tender leaves and flowers whereas larvae feed internally with in the developing seed pods causing heavy damage. Mating usually occurs during night or early morning hours. Copulation lasts for 30 to 45 minutes and females oviposit in the pericarp of seed pods and lay 6 to 12 eggs per clutch. Eggs are oval with both ends rounded, creamish to dull yellow. Larvae are apodous, soft, and cylindrical with dark brown head and pass through five larval instars. Egg, larval and pupal periods is 6.20±0.66, 22.50±1.55 and 18.00±1.47 respectively. The total period from egg to adult takes about 46.70±3.75 days. Adults emerge from the infested seed pods from June to November without any interruption and remain actively feeding on host plants till the beginning of next fruiting stage. The pests breed throughout the year and do not undergo winter rest. At least two generations are observed from June to November.

KEY WORDS: Bionomics, Paramecops farinosa, Calotropis procera, Medicinal plant, Jammu, Reasi, Rajouri, India.

Paramecops farinosa (Wiedemann) has been observed as a major pest of Calotropis procera, an important medicinal plant in Jammu, Reasi and Rajouri Districts of Jammu region of J & K State. C. procera commonly known as Giant-milkweed, Swallow-wort, Apple-of-Sodom, or Rooster tree is an Asclepias genus that is distributed in tropical and subtropical areas such as India, Nepal, Pakistan, Africa, Australia, Egypt, Iran, and Arabic islands. In India, it is found wild, distributed throughout from Punjab and Rajasthan to Assam and Kanayakumari in comparatively drier and warmer areas up to an altitude of 1,050 m. C. procera has so important ecological roles because of its settlements in sandy soils, prevention of soil erosion, natural reproduction and its uses in the weavering, rubbering and medical industries (Golestaneh et al., 2009).

In India, C. procera is well known for its medicinal properties and holds a place of pride largely because of its other uses and economic values. This shrub has been widely used in the Sudanese, Unani, Arabic and Indian traditional medicinal system for the treatment of various diseases namely leprosy, ulcers, piles and diseases of the spleen, liver and abdomen. Different parts of this plant have been reported to exhibit analgesic, antitumor, anti-inflammatory, antihelminthic, antioxidant, hepatoprotective, antidiarrhoeal, anticonvulsant, antimicrobial, oestrogenic, antinociceptive, and antimalarial activity (Sharma et al., 2011). The flowers of the plant exhibit hepatoprotective activity, anti-inflammatory, antipyretic, analgesic, antimicrobial effects and larvicidal activity.
The latex of the plant is reported to possess analgesic and wound healing activity, as well as anti-inflammatory and antimicrobial activity while the roots are reported to have anti-fertility and anti-ulcer effects (Meena et al., 2011). The crude aqueous extract from the leaves of *C. procera* showed potent anti HIV-1 activity (Mohanraj et al., 2010).

Besides *Paramecops farinosa*, this medicinal plant is attacked by number of pests viz. *Spilostethus pandurus*, *Poekilocerus pictus*, *Anosia chrysippus*, *Aphis nerii*, *Corynodes peregrines*, *Phytoschapus* sp. and *Dacus longistylus*. Both adult and larvae feed on various parts of the host plant causing serious damage. But the present study is restricted to *Paramecops farinosa* only and provides details of its bionomics.

**MATERIALS AND METHODS**

Collections were made from Akhnoor (District Jammu), Dhanwa (District Reasi) and Solki (District Rajouri) of Jammu province, where the Aak plantations, *Calotropis procera* are in abundance. Studies were conducted during the period 2009-2011 when the occurrence of the pest was at peak. Rearings were made through culture on potted cage plants. Mating pairs were collected and kept in captivity in the laboratory in 20×20×20 cm rearing cages with wire gauge (5 meshes per cm) on the sides and on top. They were kept supplied with fresh and healthy twigs bearing flowers, fruits/seed pods and leaves of *Calotropis procera*. Copulatory behaviour was studied and each mating pair was observed for pre-mating, mating, pre-oviposition and oviposition behaviour and duration both in the field and under laboratory conditions. Eggs laid by each female within the fruit were counted and egg period was determined from freshly laid eggs. These eggs were placed in the niches and on moist filter paper in petridishes to prevent their desiccation before studying them for hatching.

In order to determine the individual larval periods cellular rearing was done. Freshly oviposited places on previously uninfected shoots were covered by thin wire mesh cages and examined regularly. From the collected data only the total larval period could be derived. For determining the instars, newly hatched larvae and the subsequent stages were subjected to Dyar’s law (Dyar, 1890). For determining the pupal period matured larvae collected from the infested plants were observed at intervals till the emergence of adults. Eggs were preserved in 5 per cent formalin with few drops of glycerine where as larvae, pupae and adults were preserved in 90 per cent ethyl alcohol. For studying number of generations, the time taken to complete adult stage in one generation in captivity was considered. For the morphological studies, the twenty numbers of each biological stage (eggs, larva, pupa, adults) were selected. All the stages were examined and photographed with Sony Cyber-Shot T10, Digital Still Camera, having 5x optical zoom with 7.2 effective megapixels and with inbuilt macro function for extreme close-ups.

**RESULTS AND DISCUSSION**

**Distribution:**

The results revealed the distribution in Jammu and Kashmir as: Poonch, Rajouri, Reasi, Jammu and Samba Districts of Jammu Province; and from literature throughout southern India all the year round (Fletcher, 1914); Rajasthan Desert (Parihar, 1983); throughout District Rajouri in Solki, Sial Sui (Kalakote); Chingus, Narian (Rajouri); Rajal, Lamberi (Nowshera) and Siot,
Host Plants:
P. farinosa is a monophagous pest of Milkweed plants (Asclepiadaceae) and has been found feeding on Calotropsis procera, Calotropsis gigantea and Asclepias syriaca. Both adults and larvae cause severe damage to these plants (Sudan, 2008).

Pest status:
Both adults and larvae make extensive damage to the host plants throughout the year. Adults leave a characteristic crescent-shaped hole in one half of leaves that have been eaten and the larvae go on boring inwards and feeding on all seeds until it was fully fed and the last instar larvae emptied the fruit from most of its seeds. Maximum of 10 adults and 20 larvae at different stages of development were recorded per twig and per fruit of C. procera respectively. The percentage incidence recorded during the month of June is as high as 85.00±1.41 per cent and this reveals its serious pest status.

Seasonal Incidence:
The pest is prevalent throughout the year, the peak of the incidence being attained during May-June. Adults are found to be most active from March to November, whereas, larval stages being internal feeders are quite active from April to October as the fruits or seed pods of Calotropsis procera are available from April in the field. Adults breed throughout the year, though activity slows down during winter months from December to February. Adult do not undergo hibernation or winter rest, although, during winter the adults remained confined in the basal portion of the plant or in the surrounding leaf litter at the base of plant.

Nature and Extent of Damage:
The most adapted and specialized insect occurring on C. procera is the Aak weevil, Paramecops farinosa. It is a small, cryptic, monophagous herbivore that feeds nocturnally on the leaves and flowers of C. Procera. Both adults and larvae of P. farinosa cause considerable damage to this milkweed plant. The adult weevils prefer to feed on the leaves, buds and flowers thus leaving number of characteristic crescent-shaped holes in leaves whereas, the larvae prefer to feed on the developing seeds thereby completely destroying all seeds inside the pods and thus check the reproduction and growth of this particular medicinal plant. With the increase in infestation and number of individuals at different stages of development, entire plants get defoliated and even the flowers are damaged, thereby resulting in complete drying of entire plant.
Similar observations were made by Parihar (1983) who recorded that the grubs bored into the soft tissues of pods and then fed on the developing fibers and young seeds and the adults after their emergence also fed on the leaves.

Life Cycle:

Mating behaviour (Fig. 1):
Field observations revealed that mating usually took place during night or early morning hours and sometimes they mate during a mid-day hours under cool and calm weather conditions but the frequency of mating was quite low in these
situations. A number of mating pairs were observed in the field and it was seen that a mating pair always tried to hide in leaf axils or branches of the host plants.

**Courtship and Copulation Behaviour:**
After about half an hour of courtship, the male weevil succeeds in riding over the female and holds it firmly with the help of its legs. During the process of copulation, the antennae remained directed upwards and forward and male also strokes the female with the help of its snout. It has been observed that the freshly emerged adults are not sexually mature and the pre-copulation and pre-oviposition periods are observed to be 1 to 2 days and 5 to 10 days respectively. Copulation lasted for 30 to 45 minutes but sometimes it continues for several hours.

**Site Selection and Oviposition Behaviour (Fig. 2):**
A *Paramecops* female has a very interesting ovipositional behaviour. Gravid female positioned herself on the upper side of the fruit (a follicarium), and uses her mandibles to cut a hole of approximately 1 mm diameter into the outer layer of the three layered fruit wall (pericarp). A copious amount of latex exudes during the process from the perforated laticifers present in the fruit wall. The female then turns by 180° and aligns her ovipositor structures with the hole. Eggs are laid into the fibrous middle layer of the fruit wall. The female turns again by 180° and spreads the plant latex on and around the hole, using her mandibles to seal it, presumably to prevent desiccation as well as predation of eggs by potential enemies, e.g. ants that inhabit the host plant in great numbers. Latex from the damaged pericarp forms a hard plug over the entrance to the hole, sealing the egg inside and protecting it as it develops. The female then engages herself in removing the partially coagulated latex from her mandibles and legs. Having freed herself from the latex, the female moved away from the fruit, but not before depositing her excrement near the sealed hole, presumably to deter oviposition by conspecific females. The entire process of oviposition typically lasted 20-30 minutes. Eggs are usually laid in a small group or a clutch and the number of eggs in a clutch varies from 6 to 12. The average number of eggs per clutch was approximately 10±2 (Amritphale & Sharma, 2006).

**Egg and Incubation Period (Fig. 3):**
Freshly laid eggs are oval with both ends rounded, surface smooth, shiny, soft and creamish or light yellow which frequently changes to dull yellow as development proceeds. The egg measures 1.25±0.12 mm ranging from 1.00 to 1.40 mm long and 0.80±0.11 mm broad ranging from 0.50 to 0.90 mm. Incubation period varies from minimum of 5.00 and maximum of 7.00 days with an average of 6.20±0.656 days.

**Hatching (Fig. 4):**
The eggs hatch into a small, apodous, creamish white grub in the space between a double-walled pericarp layers of fruits of *Calotropis procera*, sometimes wandering about before making a hole through the inner layer of the pericarp to enter the fruit or seed pod containing the seeds.

**Larval instars (Figs. 5-10):**
Since the larva is an internal feeder, Dyar’s law has been applied to determine the number of larval instar, and it was observed that the grub passes through five instars. Not much difference has been observed between the five different instars
in general characters and hence the detailed description of the first instar larva
and the final instar larva are taken into account.

Freshly hatched larva is elongate, smooth, soft, apodous, transparent white to
creamish white, narrow posteriorly and slightly curved with C-shaped body. Head
prominent, smooth, pale brown, shiny with yellowish tinge, comparatively larger
in size and with biting and chewing type of mouth parts. Mandibles prominent,
dark brown, pointed, triangular and bidentate. Body segments not clearly
discernible. Abdomen wrinkled, tapering posteriorly and curved ventrally forming
C-shaped structure. Head capsule of the first instar larva measured 0.20 to 0.35
mm averaging 0.25±0.043 mm in length and 0.30 to 0.45 mm averaging
0.40±0.046 mm in width. Body length ranged between 1.50 to 2.50 mm with a
mean of 2.00±0.291 mm and width ranged between 0.30 to 0.60 mm with a
mean of 0.52±0.085 mm. The width of the head capsule in the successive instars
increase in the geometrical progression.

Body of full grown larva stout, creamish white, apodous, elongate, cylindrical
and when taken out of the follicle shows typical curvature, becomes C-shaped
with posterior end slightly narrower. Head dark brown, fairly well sclerotized,
provided with mandibulate mouth parts. Mandibles strong, black, triangular and
bidentate. Thorax with three segments, each with a pair of cushion-like pedal
lobes on the ventral side, slightly broader than abdominal segments with
transverse rows of hairs dorsally one each in every segment on either side.
Abdomen large, prominent, nine segmented and narrow posteriorly; first seven
segments almost equal in size while eighth and ninth are quite narrow and
rounded; a row of long hairs in each segment present dorsally on either side.
Sparse hairs present all over the body. Laterally eight pairs of small spiracles with
pale brown margin are clearly visible; one pair in the segmental groove of
metathoracic segment and seven pairs each in first seven abdominal segments.
Head capsule measures 1.00±0.053 mm in length ranging between 0.80 to 1.02
mm and width between 1.50 to 2.00 mm averaging 1.80±0.144 mm. Fifth instar
larva measured on an average 15.20±0.808 mm in length ranging between 13.50
to 16.00 mm and 5.25±0.420 mm in width ranging between 4.50 to 6.00 mm.

**Larval Duration:**

The larval period of Indian Aak weevil on *Calotropis procera* in Jammu
region lasts for 20.00 to 25.00 days with an average of 22.50±1.547 days.

**Pupation (Figs. 11 & 12):**

After passing through a number of instars the full grown larva pupate inside a
“cocoon” made from the silk threads of the seed parachutes by cutting and
winding short pieces of fibrous material of the seed silk around its body, thus
enclosing itself with in the cocoon, where they transform into pupae after passing
through prepupal stage. The cocoon is pale white to creamish, elongate,
cylindrical which effectively plugs the exit hole apparently bitten in advance by
the mature larva. The average length of the cocoon measures 25.24±4.059 mm
ranging from 15.00 to 30.00 mm and width of 10.00 mm to 25.00 mm with an
average of 20.05±4.285 mm while the average length of the pupal chamber inside
the cocoon varies from 12.00 mm to 20.00 mm with an average of 18.12±2.615
mm and average width of 8.52±0.826 mm ranging from 7.00 mm to 10.00 mm.

**Pupa (Figs. 13a,b):**

Pupa is exarate, naked, with all the appendages distinctly visible and freely
projecting on the ventral surface. General colour is creamish white in the
beginning but gradually turn pale yellow to pale brown. Fine sparse hairs are present all over the body. Head is light brown with sparse hairs, small broader than long and ventrally prolonged in the form of elongate, cylindrical, well developed rostrum which touches coxae of first leg. Eyes are prominent, black, and present at the base of the rostrum. Mouth parts are prominent, located at the tip of rostrum, which reaches upto the middle of the abdomen ventrally; mandibles black, small, pointed and clearly visible. A pair of geniculate antennae present on either side of the rostrum and segmentation not clearly demarcated. Thorax is three segmented, creemish pale brown with two wing pads, and three legs sharply bent and folded on the ventral side. Abdomen prominent, narrow posteriorly, with clearly demarcated segments and bears sparse setae on either side. Pupa measures $12.00 \pm 0.968$ mm in length varying from $10.00$ mm to $13.00$ mm and $5.52 \pm 0.630$ mm in width varying from $4.00$ mm to $6.00$ mm. The pupal period including pre-emergence resting period of adult lasts for $15.00$ to $20.00$ days with an average of $18.00 \pm 1.468$ days.

**Adult Emergence (Fig. 15):**

The pupa ultimately transforms into adult and emerges out from the pupal chamber through the emergence hole made by the mature larva with its mouth parts at anterior end of the cocoon or sometimes at the middle of the cocoon. Emergence hole in cocoon varies between $5.00$ to $8.00$ mm in length with an average of $6.50 \pm 0.795$ mm and $4.50$ to $6.00$ mm in width with an average of $5.00 \pm 0.426$ mm while emergence hole in the pericarp layer of fruit or follicle varies from $5.00$ to $6.00$ mm with an average width of $5.50 \pm 0.331$ mm. Even after transforming into adult, the weevil remains in the cocoon for about 5 to 8 days, with an average of $6.50 \pm 0.842$ days, attained maturity and then finally emerged out.

**Adult (Fig. 16):**

Adult robust, usually reddish brown on emergence and turned light grey to greyish black on maturity. Integument glossy, often partially or largely covered with a consistent, moderately pruinose coating, not easily removable. Antennae and occasionally pronotum and tarsi are dark ferruginous. Head globose; interocular space on vertex, half as wide as the base of the rostrum. Rostrum nearly cylindrical, weakly broadened apically. Eyes flat, elongate elliptical, closer together at the bottom and rounded at their lower margin. Antennae strong; scape straight or barely curved forwards, moderately and regularly thickened from basal third to apex; funicle segment one approximately 2 times longer than broad; segment 2 slightly longer than broad; segments 3 to 5 nearly subquadrate; segments 6–7 conical, broadened and transverse; club elliptical, as long as the last five segments of the funicle. Pronotum distinctly granulose, often having deeper and more clearly delimited punctures, as long as it is broad; base strongly sinuate, broadly curved towards elytra at middle; maximum width at base, sides slightly convergent from base to near apex. Elytra with maximum width at humeri; metathoracic wings very large, macropterous. Fore femora scarcely broadened at middle, inner side with barely developed median teeth, hidden by the setae and the pruinose coating; tibiae short, straight, robust, inner side indistinctly sinuate; segment 3 of tarsi with lobes moderately developed.

Average length of adult from head to abdomen and from snout to abdomen measures $11.00 \pm 0.963$ mm ranging from $9.00$ to $12.00$ mm and $13.02 \pm 0.862$ mm ranging from $11.00$ to $14.00$ mm respectively; antennal length varies from $2.80$ to $3.20$ mm with an average of $3.00 \pm 0.106$ mm; snout varies from $2.50$ to $3.20$ mm.
in length with an average of 3.00±0.230 mm and 0.50 to 0.90 mm in width with an average of 0.80±0.120 mm; average length of head is 1.80±0.139 mm varying from 1.50 to 2.00 mm while head width varies from 1.80 to 2.20 mm averaging 2.00±0.114 mm; length of thorax varies from 5.00 to 7.00 mm with an average of 6.00±0.515 mm and width across pronotum averages 3.00±0.269 mm ranging from 2.50 to 3.50 mm; average abdominal length is observed as 5.00±0.553 mm with a range of 4.00 to 6.00 mm and average width of 3.50±0.317 mm ranging from 3.00 to 4.00 mm; elytral length and width are observed on an average of 7.02±0.281 varying from 6.50 to 7.50 mm and 3.25±0.147 varying from 3.00 to 3.50 mm.

**Total Life Cycle:**

The total life cycle of *Paramecops farinosa* i.e. from egg to adult emergence on *Calotropis procera* in Jammu region observed is of 46.70±3.746 days ranging from 40.00 to 52.00 days.

**Adult Feeding Behaviour (Figs. 17, 18, 19a,b):**

Adult weevils feed on *Calotropis* leaves and flowers and are mostly active at night, hiding during the day in the leaf axils on the lower side of leaves or in the leaf litter at the base of the plant. The adult weevils feed on milkweed leaves in a very distinctive way, first making characteristic feeding marks on leaves, puncturing or cutting the latex canal of the midrib, and then feeding distally to the cut. This is a form of “latex-canal sabotage behaviour”, a way of reducing the impact of the plant’s defensive reaction by preventing the milky alkaloid-laden exudates from reaching the feeding site and this form of feeding is also practised by many other milkweed herbivores. It leaves a characteristic crescent-shaped hole in one half of leaves that have been eaten.

**Larval Feeding Behaviour (Figs. 20a,b,c,d):**

Immediately after emergence from the egg in the space between double-walled pericarp layers of fruits of *C. procera*, the neonate larva begins to feed on the internal tissue for sometimes and then makes its way in the form of a hole through the inner pericarp layer. The larva moves by wriggling movements and penetrates fully to feed on the developing seeds, completely destroying all seeds within the seed pod. The larva goes on boring inwards and feeding on all seeds until it is full fed and the last instar larvae empties the fruit from most of its seeds and uses the fine filaments attached by them to construct its cocoon and pupate. The pupa develops into an adult. The adult found its way out of the cocoon and the fruit through a small hole to start a new life cycle.

**Management:**

Medicinal plants have great scope to achieve net higher returns and in international agribusiness which has an estimated growth rate of approximately 5-10%. However, they are facing danger of extinction due to the attack of some serious insect pests, diseases, deforestation, extensive exploitation and harvesting from natural sources and lack of proper knowledge on these problems among majority of the people. Report on insect pest’s management of medicinal plants is meagre and scattered. In the recent past the emphasis was given to the insect management measures which are scientifically sound, environmentally safe and economically feasible.

A wider range of useful botanicals or bio-extracts serve as natural repellent/pesticides and proved to be more effective in controlling many insect
pests and diseases. In this case, some preparations from botanicals i.e. leaf extracts of four plants viz. *Azadirachta indica* A. Juss (Meliaceae) commonly known as Neem, *Melia azedarach* Linnaeus (Meliaceae) commonly known as Chinaberry tree, *Mentha longifolia* (Linnaeus) (Lamiaceae) commonly known as Hourse mint and *Vitex negundo* Linnaeus (Verbenaceae) commonly known as 5-leaved Chaste tree at different concentrations (10%, 50%, 70% and 100%) were evaluated against important insect pests of *Calotropis procera* besides using kerosene oil and water (control) in Jammu Division of J & K State.

The results with botanical extracts @ 100% concentration revealed that *A. indica* caused 80.92%, 86.92% & 92.71% reduction in adult and 85.63%, 91.57% & 96.99% reduction in larval population of Aak weevil, *P. farinosa* at 3, 5 & 10 DAS respectively. On the other hand, *M. azedarach* @ 100% concentration being superior, caused as high as 92.35% reduction of adult and 95.86 % larval population of *P. farinosa* at 3 DAS which was further increased upto 95.64% & 98.36% and 100% control over adult and larval population at 5 and 10 DAS respectively as compared to control (water treatment). *M. longifolia* leaf extract resulted in 70.80%, 68.98% & 65.63% reduction of adult and 75.97%, 73.85% & 70.80% of larval population followed by *V. negundo* leaf extract which caused 50.64% 48.47% & 46.91% reduction in adult and 52.27%, 50.98% & 48.63% in larval population of *P. farinosa* at 3, 5 & 10 DAS respectively. None of the extracts were found to produce phytotoxicity in any form.

Among all the bio-pesticides tested on the basis of overall effectiveness, *Melia azedarach* (100%) suppressed more than 98.36% and 100% adult and larval population in the tenth day after spray (DAS) respectively and is thus a promising pesticide for the management of this pest.

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Plate II. Fig. 9: Fourth instar, Fig. 10: Fifth instar, Fig. 11: Final instar ready for pupation, Fig. 12: Cocoon, Fig. 13a: Early Pupa, Fig. 13b: Late Pupa, Fig. 14: Premature Adult, Fig. 15: Adult Emergence, Fig. 16: Newly emerged Adult.
Plate III. Fig. 17: Adult feeding on inflorescence, Fig. 18: Adults feeding on leaves, Fig. 19a & 19b: Damaged twigs of Calotropis procera, Fig. 20a-20d: Damaged fruits due to larval infestation.
IMPROVEMENT OF REARING PERFORMANCE IN MUGA SILKWORM ANThERAEA ASSAMENsIs WITH HORMONE TREATMENT

Palash Dutta*, P. Dutta**, A. K. Rai*** and K. Neog*

* Central Muga Eri Research & Training Institute, Lahoigarh, Jorhat-785700, Assam, INDIA. E-mail: pdutta_1@yahoo.com
** Regional Medical Research Centre (ICMR), Lahoal, Dibrugarh-786001, Assam, INDIA.
*** Department of Life Sciences, Dibrugarh University, Dibrugarh-786004, Assam, INDIA.


ABSTRACT: Reproductive efficiency of economic insects and its rearing performances are greatly affected by hormonal activities together with the environmental and cultural practices. Two different hormones were selected for tropical application on muga silkworm (Antheraea assamensis Helfer) to study their effect on the overall rearing performances. JH-III (Juvenile hormone) in three different concentrations and 20-Hydroxyecdysone i.e. 5, 10 and 15 µg/g body weight (w/w) were applied exogenously on head region of 5th instars 1st day larvae of muga silkworm. Larvae treated with higher concentration of 20-hydroxyecdysone (15 µg) and JH-III (10 µg) were significantly superior in terms of cocoon formation (86.2±3% and 78.4±2.97%), cocoon weight (6.174±0.34gm and 5.616±0.07gm), pupal weight (5.888±0.10gm and 5.078±0.04gm), shell weight (0.576±0.005gm and 0.532±0.01gm) compared to that of control. Similarly, the length of ovary (10.26±0.22 cm and 9.38±0.12cm) and fecundity (179.3±8.35 nos and 163.6±2.97 nos) in the treated larvae was also higher. Application of JH-III has resulted in the prolongation of larval period (8.0±0.44days) however, treatment with 20-hydroxyecdysone has shortened the larval period (5.8±0.37days) with higher silk ratio (8.346 ±0.29 %). Thus, JH-III and 20-hydroxyecdysone can successfully be applied for ovarian development which in turn can exhibit reproductive efficiency of muga silkworm.

KEY WORDS: Rearing, hormone, muga, silkworm.

Sericulture is an income generating agro-enterprise in the north-east region to alleviate poverty, through increasing rural women employment and their income, and thus, has been given due priority by Agriculture Perspective Plan (APP, 1995). In muga culture, the seed production is the most critical aspect that is considered as bottleneck in augmenting muga production. Large-scale production of muga silk is a daunting task due to insufficient yield of seed. The fecundity in muga silkworm is very poor for commercial rearing. Although the silkworm has the potential to lay a good number of eggs (250-280) realized fecundity (120-150) is comparatively poor even during the favorable seasons of Jethua and Kotia compared to eri (440-470) and mulberry (450-550). For reason unknown retention of eggs always occurs in this insect. Thus, the physiology of the insect itself can be attributed as the main factor that leads to the drawback in muga industry. There is a strong possibility that the neuroendocrine factor might come into play in controlling the physiology of the insect’s reproductive cycle. Works on endocrine control of reproduction by different workers in different insects have given insight that interplay of juvenile hormones and ecdysteroids are essential during vitellogenesis, oocyte maturation and ovarian development.

The shiny golden silk producer muga silkworm (Antherae assamensis Helfer) is a multivoltine and polyphagous lepidopteron insect highly endemic to North Eastern part of India, especially in Assam (Choudhury, 1970; Subba Rao,
1983). The silkworm is being reared six crop in a year including two crops each of pre seed, seed and commercial. Chotua and Bhodia are seed crops, Jethua and Kotia are commercial crops and while Jarua and Aherua are pre seed crops (Thangavalu et al., 1988). Due to it’s out door nature of rearing, the silkworm is exposed to various environmental factors such as temperature, humidity, rainfall etc. which eventually affect on reproductive behavior of muga silkworm (Das et al., 2006).

The two hormone 20 hydroxyecdydysone (20HE) and juvenile hormone (JH) are the major circulating hormones in insects which control majority of growth and developmental activities (Novak, 1975). Exogenous application of these two hormones could induce larval activities and create normal insect development. Plant-produced insect moulting hormones, termed phytococystosteroids (PEs), function as plant defenses against insects by acting as either feeding deterrents or through developmental disruption (Schmelz et al., 2002).

Rearing performance affects sharply in their ecological, biochemical, physiological and quantitative characters, which influence growth and development, and quantity and quality of silk they produce in different geographical locations, and thus, varies under different ecological conditions to make silkworm rearing cost effective and more productive (Hirobe, 1968; Shekharappa et al., 1993). Therefore, this study was conducted to evaluate the performance of muga silkworm growth, development and quality cocoon production which increase fecundity after application of Juvenil hormone III and 20 hydroxyecdyxon.

**MATERIAL AND METHODS**

The larvae of muga silkworm *Antheraea assamensis* were reared on som *Persia bombycina* plant as usual practices in Central Muga Eri Research and Training Institute. When the larvae attain in 5th inster just after molting apply hormone at appropriate doses. The two hormone namely Juvenil-III and 20 hydroxyecdyson (20E) with three different concentrations i.e. 5μl, 10 μl and 15 μl is formulated (Miranda et al., 2002). Exogenous application at 5th inster 1st day old larvae by tropically at doses within the normal physiological range with this three different concentration along dorsal midline using appropriate Micro Syringe (Mizoguchi et al., 2001). Untreated set of larvae consider as control.

Cocoons of different treatments were kept separately in rearing cage (30 cm x 30 cm x 40 cm) until emergence. In the first two hours after emergence, the insects were coupling both artificially and naturally. All the insects were maintained at 25 ± 2°C, 70 ± 5% RH and natural light. The potential fecundity (number of eggs deposited plus eggs remaining in ovaries after three day) of treated females was recorded by dissecting the female moths.

**RESULTS**

The impact on rearing performance in muga silkworm *Antheraea assamensis* the larval duration, % of cocoon formation, shell and pupal weight, fecundity, retained eggs, ovaries length, silk ratio and thickness of silk were considered. The results indicate that the two hormones after application significantly increased fecundity, larval, cocoon and pupal weights, silk ratio and thickness of silk with comparisons to control groups.
EFFECT OF JH-III HORMONE TREATMENTS:
The rearing performance among the three different concentration of JH-III, the 10 µg is most effective resulting (81.33±0.88 %) of cocoon formation, (4.990±0.04gm) single pupal weight, (0.450±0.02 gm) shell weight, (165±13.22 nos) fecundity, and prolong 5th inster larval duration to (8 ±0.57) days. The length of ovary is significantly longer when insects are treated with JH-III (10 µg) measuring (9.26±0.24cm) while it is (9±0.25cm) in control female. This situation suggests that the treatment of JH-III 10 µg promote ovarian development with more egg formation. Eggs are less retained in the abdomen when treated with JH-III10µg (9.66± 0.88nos) than control (33.33±3.28 nos). The thickness of silk is also more in JH-III 10µg (5.044±0.56 cm) and silk ratio (9.023 ±0.05 %) then the other treatments.(Figs. 1-4).

EFFECT OF 20 HE HORMONE TREATMENTS:
The rearing performance among the three concentration of 20 E the 15µg is most effective resulting (86.2±3.00 %) of cocoon formation, (5.638±0.28 gm) single pupal weight, (0.483±0.01gm) shell weight, (179.33 ±8.35 nos) fecundity, and shortened 5th inster larval duration to (6 ±0.57) days. The length of ovary is significantly longer when insects are treated with 20-HE (15 µg) measuring (11±0.40 cm) while in untreated normal female it is (9±0.25 cm). It is also suggests that the treatment of 20-HE (15µg) promote ovarian development with more egg formation. Eggs are less retained in the abdomen when treated with 20E 15µg (12±2.08) than control (33.33 ±3.28) nos. The thickness of silk is more in 20HE 15µg (5.188±0.10) and silk ratio (8.346 ±0.29) but in control (4.247±0.31) and (5.596 ±0.20) respectively. (Figs. 1-4).

DISCUSSION
In insects, virtually all life processes are regulating by neural and endocrine system. Basically brain hormone, molting hormone and juvenile hormone are involved in regulating insect development (Dhaliwal & Arora Ramesh, 2001). In this study revile that the 20 hydroxyecdysonse decreased shortly after application of JH-III would bounce back and reach the maximum peak on the seventh day which results longer the larval duration (first days old larvae after the treatment).The same phenomenon was reported by Trivedy et al. (2006) in which fifth instar of B. mori treated with a low dose of juvenile hormone R394 topically to stadium of 24 hours did not show any distinct effect to its ecdysteroid titer until the sixth day. On the seventh day, ecdysteroid titer dropped significantly until it began making a cocoon. Larvae treated with low dose at a stadium of 48, 72, and 96 hours showed a reduction in their ecdysteroid titer starting from the fifth day to the seventh day and would increase again on the eight day, when they began making cocoon.

In sericulture, Juvenile hormone analogues and also ecdysteroids have been tested in Bombyx mori as insect growth regulators in order to increase silk production (Baruah et al., 1998; Choudhury et al., 1998). The application of methoprene by spraying or immersion of the leaves into the products has been reported to increase fecundity in Antheraea yamamai (Gongin et al., 1999). Changamma et al. (2000) also observed increment of fecundity, weight of testis and ovaries when 5th instar larvae of B. mori were treated with methoprene.

In this studies the treatment of 20 hydroxyecdysonse (a moulting hormone) larvae become shortened their larval period (5.8±0.37) and give the good rearing performance of all the parameter may be because of suppressed to synthesis of
normal juvenile hormone which is present in a normal insect in low concentration with compared to untreated control larvae. Under normal conditions, the production of ecdysone by the corpora cardiaca in the fifth instars muga larvae is supposed to decrease or stop. But, because of the tropically application of 20 hydroxyecdysone inside the blood remained high. It led to a change on the normal condition of ecdysone hormone inside the insect body result the high weight of cocoon, more fecundity; length of ovary is long etc. The same work done by Levine et al. (1986) topical application of a juvenile hormone analog in M. sexta to the peripheral cell bodies of these sensory neurons during a critical period of development caused them to retain their larval commitment rather than undergo pupal development with the rest of the animal.

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LITERATURE CITED


Figures 1. Comparisons of fecundity, retain eggs and length of ovary 2. Comparisons of cocoon wt, pupal wt and shell wt 3. Comparisons of larval duration and cocoon formation 4. Comparisons of silk ratio and thickness of silk of treated and untreated muga silkworm. All the columns represent (averages ± SE) of the mean.

CONTRIBUTIONS TO THE KNOWLEDGE OF SCARABAEIDAE (COLEOPTERA) FAUNA OF THE MIDDLE AND EAST BLACK SEA REGION OF TURKEY

Yakup Şenyüz*, Kemal Dindar* and Ferhat Altunsoy**

* Dumlupınar University, Faculty of Arts and Science, Department of Biology, Kütahya, TURKEY. E-mail: yakupsenyuz@gmail.com
** Anadolu University, Faculty of Science, Department of Biology, Eskişehir, TURKEY.

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ABSTRACT: Additional notes on 40 species belonging to Scarabaeidae from Middle and East Black Sea Region are given. New distributions are given for the taxa.

KEY WORDS: Scarabaeidae, Aphodiinae, Melolonthinae, Scarabaeinae, Dynastinae, new record.

The superfamily Scarabaeoidea comprises worldwide more than 35,000 species (Ratcliffe & Paulsen, 2008). Historically, the superfamily Scarabaeoidea was divided into two generalized groups based on the position of the abdominal spiracles; the Laparosticti and Pleurosticti. Laparostict scarabs, on the other hand, were characterized by having most of the abdominal spiracles located on the pleural membrane between the tergites and sternites and included taxa whose adults and larvae feed on dung, carrion, hides, and feathers (Ritcher, 1969; Arnett et al., 2002; Anlaş et al., 2011b). The family Scarabaeidae includes about 91% of all scarabaeoids and includes about 27,800 species worldwide. Within the Scarabaeidae, the Aphodiinae and Scarabaeinae include approximately 6,850 species worldwide (about 22% of scarabaeoids and 25% of Scarabaeidae) (Arnett et al., 2002). Nearly 700 species are reported from Turkey, 350 of them being Laparosticti (Carpaneto et al., 2000; Löbl & Smetana, 2006; Anlaş et al., 2011b).

After the researches and the publications of Rudolf Petrovitz along all the fifty, sixty and seventy years, it could be reasonable to suppose that the knowledge of the Coleoptera Scarabaeoidea of Turkey is near to be sufficiently thorough. Notwithstanding, the only downright summary on the Turkish fauna can be considered the paper by Carpaneto (1977), that mainly referenced to unpublished data of the same Petrovitz, and, to some extent, the checklist with no localities by Carpaneto et al. (2000) (Ziani & Sama, 2013).

The Scarabaeidae fauna of Middle and East Black Sea Region have been studied poorly. Some important studies on the Scarabaeidae of study area have been established by Lodos et al. (1999), Rozner & Rozner (2009).

The main aim of this study is to contribute to the knowledge of the Scarabaeidae Fauna of Middle and East Black Sea Region in Turkey.

MATERIAL AND METHODS

The materials were collected from different localities of Middle and East Black Sea Region of Turkey. Forceps and sweeping nets were used to collect samples. The specimens were killed by using killing jar and pinned according to taxonomic
rules and regulations. The specimens are deposited in the first author’s private collection of Biology department at Dumlupınar University.


RESULTS

In this study totally 40 species belonging to Scarabaeidae were identified. And new distributions are given for the taxa. The taxa are presented alphabetically.

It is expected that the number of scarab species will increase significantly by the future investigations of Turkey Scarabaeidae fauna.

FAMILY SCARABAEIDAE Latreille, 1802

SUBFAMILY Aphodiinae Leach, 1815

TRIBE Aphodiini Leach, 1815

GENUS Aphodius Illiger, 1798

SUBGENUS Acanthobodilus G. Dellacasa, 1983

SPECIES Acanthobodilus immundus (Creutzer, 1799)

Material examined: Ordu, Fatsa, Çömlekli, 05.VII.2010, 10 exx.


Remark: New to Ordu province.

SUBGENUS Acrossus Mulsant, 1842

SPECIES Acrossus depressus (Kugelann, 1792)

Material examined: Ordu, Kabataş, 06.VII.2010, 6 exx.; Artvin, Kılıçkaya, 2388 m, 11.VII.2010, 1 ♂.


Remark: New to Ordu province and thereby Middle Black Sea Region.

SPECIES Acrossus luridus (Fabricius, 1775)

Material examined: Ordu, Nadirli, 05.VII.2010, 1 ♂; Rize, Tulumpinar, 1407 m, 12.VII.2010, 1 ♂; Artvin, Borçka, 587 m, 13.VII.2010, 1 ♂; Artvin, Yavuz village, 1789 m, 15.VII.2010, 2 ♂♂.


Remark: New to Artvin, Rize and Ordu provinces.

SUBGENUS Amidorus Mulsant & Rey, 1870

SPECIES Amidorus cribarius (Brullé, 1836)

Material examined: Samsun, Akgöl, 16.VII.2010, 1 ex; Giresun, Kükem Yaylası, 1784 m, 08.VII.2010, 4 exx.; Artvin, Kılıçkaya, 2388 m, 11.VII.2010, 1 ex.; Rize, Ovit mountain, 2292 m, 11.VII.2010, 14 exx.; Trabzon, Şekersu, 2237 m, 11.VII.2010, 12 exx.; Rize, Ovit Geçidi, 2561 m, 12.VII.2010, 15 exx.

Records in Turkey: Erzincan, Erzurum, Giresun, Iğdır, Sivas, Tarsus (Lodos et al., 1999; Rozner & Rozner, 2009).
Remark: New to Artvin, Giresun, Rize, Samsun and Trabzon provinces, and thereby Middle Black Sea Region.

**SPECIES Amidorus obscurus (Fabricius, 1792)**

**Material examined:** Samsun, Akgöl, 16.VII.2010, 1 ♂; Rize, Ovit mountain, 2292 m, 11.VII.2010, 5 exx.; Trabzon, Şekersu, 2237 m, 11.VII.2010, 4 exx.; Artvin, Yavuz village, 1789 m, 15.VII.2010, 1ex.

**Records in Turkey:** Adana, Artvin, Bartın, Erzincan, Erzurum, Içe, Kastamonu, Osmaniye, Rize (Lodos et al., 1999; Rozner & Rozner, 2009).

**Remark:** New to Samsun, Rize and Trabzon provinces and thereby Middle Black Sea Region.

**SUBGENUS Aphodius Illiger, 1798**

**SPECIES Aphodius fimetarius (Linnaeus, 1758)**

**Material examined:** Amasya, Ovasaray, 03.VII.2010, 1 ♂, 1 ♀; Ordu, Fatsa Çömlekli, 05.VII.2010, 1 ♀; Ordu, Kabataş, 06.VII.2010, 5 ♂♂, 4 ♀♀; Ordu, Gölköy, 07.VII.2010, 2 ♂♂, 3 ♀♀; Çorum, Çaybaşı, 16.VII.2010, 2 ♂♂; Giresun, Kümbet Yaylası, 1784 m, 08.VII.2010, 1 ♂; Artvin, Borçka, 587 m, 13.VII.2010, 1 ♂; Rize, Ayder Yaylası, 1670 m, 13.VII.2010, 3 ♂♂; Artvin, Yavuz village, 1789 m, 15.VII.2010, 1 ♂, 2 ♀♀.


**Remark:** New to Amasya, Ordu and Rize provinces.

**SPECIES Aphodius foetidus (Herbst, 1783)**

**Material examined:** Ordu, Fatsa, Çömlekli, 05.VII.2010, 1 ex.; Ordu, Kabataş, 06.VII.2010, 2 exx.; Ordu, Gölköy, 07.VII.2010, 2 exx.

**Records in Turkey:** Antalya, Aydın, Bursa, Çanakkale, Çorum, Edirne (Bellmann, 2007; Rozner & Rozner, 2009).

**Remark:** New to Ordu province and thereby Black Sea Region.

**SUBGENUS Colobopterus Mulsant, 1842**

**SPECIES Colobopterus erraticus (Linnaeus, 1758)**

**Material examined:** Çorum, Mecitözü, 03.VII.2010, 1 ♂; Amasya, Ovasaray, 03.VII.2010, 1 ♂; Amasya, Duracasu, 04.VII.2010, 1 ♂, 2 ♀♀; Tokat, Ustahasan, 04.VII.2010, 1 ♂; Ordu, Fatsa, Çömlekli, 05.VII.2010, 3 ♂♂, 2 ♀♀; Samsun, Akgöl, 16.VII.2010, 19 ♂♂, 16 ♀♀; Giresun, Kümbet Yaylası, 1784 m, 08.VII.2010, 1 ♂, 3 ♀♀; Rize, Ovit mountain, 2292 m, 11.VII.2010, 2 ♂♂, 1 ♀; Artvin, Yavuz village, 1789 m, 15.VII.2010, 1 ♂; Artvin, Şafşat, Karaköy, 2032 m, 15.VII.2010, 1 ♂; Rize, Ovit Geçidi, 2561 m, 12.VII.2010, 1 ♂, 6 ♀♀.

Tokat, Zonguldak (Tuatay et al., 1970, 1972; Carpaneto, 1973; Lodos et al., 1978, 1999; Dellacasa & Kırız, 2002; Şenyüz, 2004; Bellmann, 2007; Rozner & Rozner, 2009; Şenyüz & Şahin, 2009a; Anlaş et al., 2011b).

**Remark:** New to Artvin, Ordu and Trabzon provinces.

**SUBGENUS Coprimorphus Mulsant, 1842**

**SPECIES Coprimorphus scrutator (Herbst, 1789)**

**Material examined:** Giresun, Kümbet Yaylası, 1784 m, 08.VII.2010, 3 ♂, 2 ♀; Rize, Ovit mountain, 2292 m, 11.VII.2010, 1 ♀.

**Records in Turkey:** Edirne, Kırklareli, Kütahya (Dellacasa & Kırız, 2002; Şenyüz, 2004; Rozner & Rozner, 2009; Şenyüz & Şahin, 2009a).

**Remark:** New to Giresun and Rize provinces and thereby Black Sea Region.

**SUBGENUS Euheptaulacus G. Dellacasa, 1983**

**SPECIES Euheptaulacus sus (Herbst, 1783)**

**Material examined:** Giresun, Kümbet Yaylası, 1784 m, 08.VII.2010, 25 exx.; Trabzon, Zigana, 2018 m, 09.VII.2010, 3 exx.; Trabzon, Zigana Mountain, 2120 m, 09.VII.2010, 30 exx.; Rize, Ovit mountain, 2292 m, 11.VII.2010, 1 ex.; Rize, Ovit mountain Geçidi, 2561 m, 12.VII.2010, 7 exx.

**Records in Turkey:** Ankara, Çankırı, Çorum, Erzincan, Eskişehir, Kastamonu, Kayseri, Kırşehir, Niğde (Lodos et al., 1999; Rozner and Rozner, 2009).

**Remark:** New to Giresun, Rize and Trabzon provinces and thereby Eastern Black Sea Region.

**SUBGENUS Eupleurus Mulsant, 1842**

**SUBSPECIES Eupleurus subterraneus subterraneus (Linnaeus, 1758)**

**Material examined:** Ordu, Kabataş, 06.VII.2010, 1 ex, Artvin, Kafkasır, 1263 m, 14.VII.2010, 3 exx.


**Remark:** New to Artvin, Ordu provinces and thereby Eastern Black Sea Region.

**SUBGENUS Otophorus Mulsant, 1842**

**SPECIES Otophorus haemorrhoidalis (Linnaeus, 1758)**


**Remark:** New to Amasya, Artvin, Çorum, Ordu, Rize provinces and thereby Eastern Black Sea Region.

**SUBGENUS Teuchestes Mulsant, 1842**

**SPECIES Teuchestes fossor (Linnaeus, 1758)**

**Material examined:** Giresun, Kümbet Yaylası, 1784, 08.VII.2010, 12 ♂, 7 ♀; Artvin, KılıcKayası, 2388 m, 11.VII.2010, 1 ♀; Trabzon, Şekersu, 2237 m, 11.VII.2010, 2 ♂; Rize, Tulumpınar, 1407 m, 12.VII.2010, 3 ♂, 2 ♀; Artvin-Hopa, Koyuncular Mekvii, 460 m, 13.VII.2010, 3 ♂, 1 ♀; Rize, Ayder Yaylası, 1670 m, 13.VII.2010, 4 ♂, 2 ♀; Artvin Karaköy, 2032 m, 15.VII.2010, 1 ♂, 1 ♀; Artvin Yavuz village, 1789 m, 15.VII.2010, 5 ♂, 2 ♀.

**Records in Turkey:** Artvin, Balıkesir (Rozner & Rozner, 2009).

**Remark:** New to Giresun, Rize and Trabzon provinces.
SUBFAMILY Melolonthinae Samouelle, 1819
    TRIBE Melolonthini Samouelle, 1819
        GENUS Anoxia Laporte, 1833
            SUBGENUS Protanoxia S. I. Medvedev, 1951
                SPECIES Protanoxia orientalis (Krynicky, 1832)
        Records in Turkey: Adana, Adıyaman, Erzincan, Içel, Karaman, Kayseri, Konya (Lodos et al., 1999; Rozner & Rozner, 2009).
        Remark: New to Ordu province and thereby Black Sea Region.

        GENUS Polyphylla Harris, 1841
            SPECIES Polyphylla fullo (Linnaeus, 1758)
                SUBSPECIES Polyphylla fullo fullo (Linnaeus, 1758)
        Material examined: Ordu, Merkez, 06.VII.2010, 4 ♂♂; Artvin, Yavuz village, 1789 m, 15.VII.2010, 1 ♂.
        Remark: New to Ordu and Artvin provinces and thereby Middle and Eastern Black Sea Region.

SUBFAMILY Scarabaeinae Latreille, 1802
    TRIBE Coprini Leach, 1815
        GENUS Copris Geoffroy, 1762
            SPECIES Copris lunaris (Linnaeus, 1758)
        Material examined: Ordu, Fatsa, Çömlekli, 05.VII.2010, 1 ♂.
        Remark: New to fauna of Ordu province.

    TRIBE Gymnopleurini Lacordairei, 1856
        GENUS Gymnopleurus Illiger, 1803
            SPECIES Gymnopleurus geoffroyi geoffroyi (Fuessly, 1775)
                SUBSPECIES Gymnopleurus geoffroyi geoffroyi
        Material examined: Amasya, Ovasaray, 03.VII.2010, 4 exx.; Çorum, Mecitözü, 03.VII.2010, 1 ex.; Tokat, Ustahasan, 04.VII.2010, 8 exx.; Samsun, Ak göl, 16.VII.2010, 8 exx.
        Remark: New to Samsun and Tokat provinces.

            SPECIES Gymnopleurus mopsus (Pallas, 1781)
        Material examined: Tokat, Ustahasan, 04.VII.2010, 6 exx.
        Remark: New to Tokat province.

    TRIBE Oniticellini H.J. Kolbe, 1905
        GENUS Euoniticellus Janssens, 1953
            SPECIES Euoniticellus fulvus (Goeze, 1776)
Material examined: Amasya, Duracasu, 04.VII.2010, 2 ♂, 4 ♀; Amasya, Ovasaray, 03.VII.2010, 6 ♂; Çorum, Çayaş, 16.VII.2010, 2 ♂, 2 ♀; Çorum, Mecitözü, 03.VII.2010, 1 ♂; Ordu, Fatsa, Çömelkli, 05.VII.2010, 4 ♂, 1 ♀; Ordu, Kabataş, 06.VII.2010, 3 ♂, 4 ♀; Ordu, Darlı, 05.VII.2010, 1 ♂; Samsun, Akgöl, 16.VII.2010, 1 ♂; Tokat, Ustahasan, 04.VII.2010, 4 ♀; Rize, Ayder Yaylası, 1670 m, 13.VII.2010, 1 ♂; Artvin, Kafkasor, 1263 m, 14.VII.2010, 3 ♂, 4 ♀; Artvin, Yavuzköy mountain pasture, 1789 m, 15.VII.2010, 1 ♂, 2 ♀.


Remark: New to Amasya, Artvin, Ordu and Rize province.

SPECIES Euoniticellus pallipes (Fabricius, 1798)

Material examined: Amasya, Ovasaray, 03.VII.2010, 1 ♂.


Remark: New to Amasya province and thereby Middle Black Sea Region.

TRIBE Onthophagini Burmeister, 1846

GENUS Caccobius C.G. Thomson, 1859

SPECIES Caccobius histeroides (Ménétriés, 1832)

Material examined: Ordu, Fatsa, Çömelkli, 05.VII.2010, 2 ♂; Ordu, Esentepe, 04.VII.2010, 1 ♂; Ordu, Gölköy, 07.VII.2010, 2 ♂.


Remark: New to Ordu province and thereby Middle Black Sea Region and Black Sea Region.

SPECIES Caccobius schreberi (Linnaeus, 1767)

Material examined: Amasya, Duracasu, 04.VII.2010, 1 ♂, 1 ♀; Amasya, Ovasaray, 03.VII.2010, 1 ♂; Çorum, Çayaş, 16.VII.2010, 1 ♂, 5 ♀; Çorum, Mecitözü, 03.VII.2010, 2 ♂, 6 ♀; Ordu, Gölköy, 07.VII.2010, 1 ♂; Ordu, Kabataş, 06.VII.2010, 1 ♂, 2 ♀; Ordu, Darlı, 05.VII.2010, 1 ♂; Ordu, Fatsa, Çömelkli, 05.VII.2010, 2 ♂, 1 ♀; Artvin, Kafkasor, 1263 m, 14.VII.2010, 1 ♂; Artvin, Yavuz village, 1789 m, 15.VII.2010, 5 ♂.


Remark: New to Ordu province and thereby Middle Black Sea Region and Black Sea Region.

GENUS Onthophagus Latreille, 1802

SUBGENUS Euontheophagus Balthasar, 1959

SPECIES Euontheophagus gibbosus (Scriba, 1790)

Material examined: Artvin, Kılıçkaya, 2388 m, 11.VII.2010, 1 ♂; Rize, Otvet Geçidi, 2561 m, 12.VII.2010, 1 ♂.


Remark: New to Artvin, Artvin and Ordu provinces.

SUBGENUS Furconthophagus Zunino, 1979

SPECIES Furconthophagus furcatus (Fabricius, 1781)
Material examined: Tokat, Ustahasan, 04.VII.2010, 1 ♂, 2 ♀; Artvin, Kılıçkaya, 2388 m, 11.VII.2010, 1 ♀.


Remark: New to Artvin and Tokat provinces.

SUBGENUS Onthophagus Latreille, 1802

SPECIES Onthophagus illyricus (Scopoli, 1763)

Material examined: Artvin, Borçka, 587 m, 13.VII.2010, 4 ♂♂, 5 ♀; Artvin-Hopa, Koyuncular Mevkii, 460 m, 13.VII.2010, 5 ♂♂, 6 ♀; Rize, Ayder Yaylası, 1670 m, 13.VII.2010, 3 ♂♂, 4 ♀.


Remark: New to Artvin, Çorum, Ordu, Rize provinces and thereby Middle and Eastern Black Sea Region.

SPECIES Onthophagus tau (Schreber, 1759)

Material examined: Çorum, Mecitözü, 03.VII.2010, 1 ♂; Çorum, Çaybaşı, 16.VII.2010, 1 ♂, 1 ♀; Ordu, Kabataş, 06.VII.2010, 7 ♂♂, 6 ♀; Ordu, Gölköy, 07.VII.2010, 1 ♀; Ordu, Nadirli, 05.VII.2010, 1 ♂, 3 ♀; Tokat, Ustahasan, 04.VII.2010, 1 ♀; Artvin, Borçka, 587 m, 13.VII.2010, 4 ♀; Artvin-Hopa, Koyuncular Mevkii, 460 m, 13.VII.2010, 5 ♂♂, 6 ♀; Rize, Ayder Yaylası, 1700 m, 13.VII.2010, 3 ♀; Artvin, Kafkasör, 1263 m, 14.VII.2010, 3 ♂♂, 5 ♀; Artvin, Yavuz village, 1789 m, 15.VII.2010, 3 ♀.


Remark: New to Artvin, Ordu and Rize provinces.

SUBGENUS Palaeonthophagus Zunino, 1979

SPECIES Palaeonthophagus ceonobita (Herbst, 1783)

Material examined: Ordu, Kafkasör, 1263 m, 14.VII.2010, 3 ♀; Artvin, Kafkasör, 1263 m, 14.VII.2010, 3 ♀; Artvin, Yavuz village, 1789 m, 15.VII.2010, 3 ♀.

Records in Turkey: Erzurum (Rozner & Rozner, 2009).

Remark: New to Artvin, Ordu and Rize provinces and thereby Black Sea Region.

SPECIES Palaeonthophagus fissicornis (Steven, 1809)

Material examined: Artvin, Yavuz village Yaylaşı, 1789 m, 15.VII.2010, 1 ♀.


Remark: New to Artvin province.
SPECIES Palaeonthophagus tracticornis (Preyssler, 1790)
Material examined: Ordu, Nadirli, 05.VII.2010, 1 ♀; Ordu, Kabataş, 06.VII.2010, 1 ♀; Rize, Kılıç village, 11.VII.2010, 2 ♂♀, 4 ♀♀.
Remark: New to Ordu, Rize provinces and thereby Middle Black Sea Region and Black Sea Region.

SPECIES Palaeonthophagus gibbulus (Pallas, 1781)
Material examined: Artvin, Kılıçkaya, 2388 m, 11.VII.2010, 1 ♂, 2 ♀♀.
Records in Turkey: Giresun (Rozner & Rozner, 2009).
Remark: New to Artvin province.

SPECIES Palaeonthophagus medius (Kugelann, 1792)
Records in Turkey: Manisa (Anlaş et al., 2011b).
Remark: New to Çorum province and thereby Middle Black Sea Region and Black Sea Region.

SPECIES Palaeonthophagus opacicollis Reitter, 1893
Material examined: Tokat, Ustahasan, 04.VII.2010, 1 ♂; Ordu, Fatsa, Çümleli, 05.VII.2010, 2 ♀♀; Ordu, Nadirli, 05.VII.2010, 1 ♂, 1 ♀; Ordu, Kabataş, 06.VII.2010, 1 ♂, 1 ♀.
Records in Turkey: Adana, Antalya, Balikesir, Bolu, Eskişehir, Gaziantep, Hatay, İçel, Kahramanmaraş, Manisa, Niğde (Pehlivan, 1989; Lodos et al., 1999; Bellmann, 2007; Rozner & Rozner, 2009; Anlaş et al., 2011b).
Remark: New to Ordu, Tokat provinces and thereby Middle Black Sea Region.

SPECIES Palaeonthophagus ovatus (Linnaeus, 1767)
Material examined: Amasya, Duracasu, 04.VII.2010, 5 ♂♂; Çorum, Mecitözü, 03.VII.2010, Şenyüz Y. leg. and det. 1 ♂, 1 ♀; Ordu, Esentepe, 04.VII.2010, 1 ♂; Ordu, Kabataş, 06.VII.2010, 1 ♂; Ordu, Nadirli, 05.VII.2010, 1 ♂; Ordu, Fatsa, Çümleli, 05.VII.2010, 1 ♂; Samsun, Akgöl, 16.VII.2010, 8 ♂♂, 1 ♀♀; Giresun, Kümbet Yaylası, 1784 m, 08.VII.2010 1 ♀.
Remark: New to Amasya, Çorum, Giresun, Ordu, Samsun provinces and thereby Middle and Eastern Black Sea Region.

SPECIES Palaeonthophagus sericatus Reitter, 1893
Material examined: Çorum, Mecitözü, 03.VII.2010, 1 ♀.
Remark: New to Çorum province.

SPECIES Palaeonthophagus similis (Scriba, 1790)
Material examined: Rize, Ovit mountain, 2292 m, 11.VII.2010, 1 ♂.
Remark: New to Rize province, and thereby Eastern Black Sea Region and Black Sea Region.
SPECIES *Palaeonthophagus ruficapillus* Brullé, 1832

**Material examined:** Amasya, Duracasu, 04.VII.2010, 3 ♀♀; Amasya, Ovasaaray, 03.VII.2010, 1 ♂, 2 ♀♀; Çorum, Çaybaşı, 16.VII.2010, 6 ♂♂, 7 ♀♀; Çorum, Mecitözü, 03.VII.2010, 4 ♂♂, 3 ♀♀; Ordu, Esentepe, 04.VII.2010, 4 ♀♀; Ordu, Kabataş, 06.VII.2010, 1 ♂, 1 ♀; Ordu, Nadirli, 05.VII.2010, 3 ♂♂, 6 ♀♀; Ordu, Fatsa Çömlekli, 05.VII.2010, 6 ♂♂, 6 ♀♀; Samsun, Akgöl, 16.VII.2010, 12 ♂♂, 6 ♀♀; Tokat, Üstahasan, 04.VII.2010, 2 ♀♀.


**Remark:** New to Çorum, Ordu, Samsun, Tokat provinces.

SPECIES *Palaeonthophagus vacca* (Linnaeus, 1767)

**Material examined:** Amasya, Ovasaaray, 03.VII.2010, 1 ♀; Çorum, Çaybaşı, 16.VII.2010, 1 ♂.


**Remark:** New to Amasya province.

TRIBE Sisyphini Mulsant, 1842

GENUS *Sisyphus* Latrielle, 1807

SPECIES *Sisyphus schaefferi schaefferi* (Linnaeus, 1758)

**Material examined:** Rize, Ayder Yaylası, 1670 m, 13.VII.2010, 1 ex.

**Records in Turkey:** Adıyaman, Ankara, Antalya, Çorum, Erzurum, Eskişehir, Gümüşhane, Kars, Kırklareli, Kütahya, Manisa, Muğla, Muş, Osmaniye, Samsun, Sivas, Tekirdağ, Uşak, Van (Tuatay et al., 1970; Lodos et al., 1978, 1999; Bellmann, 2007; Rozner & Rozner, 2009; Anlaş et al., 2011a, b).

**Remark:** New to Rize province.

SUBFAMILY Dynastinae MacLeay, 1819

TRIBE Oryctini Mulsant, 1842

GENUS *Oryctes* Illiger, 1798

SPECIES *Oryctes nasicornis kuntzeni* (Minck, 1914)

**Material examined:** Ordu, Merkez, 06.VII.2010, 1 ♀.

**Records in Turkey:** Çorum (Lodos et al., 1999).

**Remark:** New to Ordu province.

LITERATURE CITED


ROOSTING BEHAVIOUR OF HOUSE SPARROW 
(*PASSER DOMESTICUS*, LINNAEUS 1758) IN SOME URBAN AND RURAL AREAS OF JAMMU DIVISION, J & K.

Rajan Singh*, Deep Noval Kour*, Fareed Ahmad* and D. N. Sahi*

* Department of Zoology, University of Jammu, Jammu, J & K (INDIA), 180006. E-mail: rsthakurlibra@gmail.com


ABSTRACT: 447 roosting groups of house sparrow were studied from February 2009 to April 2012 at 6 rural areas and 2 urban areas of Jammu division. The pre-roosting behaviour and roosting sequences like assembly time, time of arrival of birds at roost, sundown, duration of chirping, sunset, first call and departure time in morning in House Sparrow were studied which were found directly linked with light intensity, time of sundown, sunrise, weather condition and type of locality (urban / rural). House Sparrow were found to roost in pure (non-communal) and mixed groups (Communal). 58.84 % groups were mixed roosters with one species, 3.93% mixed roosting with more than one species and 41.16 % groups are pure rooster. House Sparrow was found to be more communal rooster (82 %) in urban areas because of less choices of vegetation and more risk of predation while in rural areas it prefer pure roosting (61%) because of availability of spiny shrubs and low risk of predation. House sparrow used spiny shrubs and trees less than 7 ft. height as favourite roosting vegetation. The spiny vegetation gives protection from predators. In mixed roosts of rural areas, the ratio of House Sparrow to other mixed roosters was found more in number because of less competition from other species due to availability of lot of choices for roosting sites. But in mixed roosts of urban areas, the ratio was found to be less because of less availability of roosting vegetation and more competition from other mixed roosters.

KEY WORDS: House sparrow, roosting, mixed roosters, pure roosters, vegetation, spiny.

The house sparrow (*Passer domesticus*) is a member of the family Passeridae. House sparrows are abundant near human habitations. The house sparrow has a historical commensal relationship with man and has followed his colonisation of the majority of the earth. It is the most widely distributed land birds in the world. The natural range of this subspecies runs from Saudi Arabia in the west to Myanmar (Burma) in the east, occupying the Indian subcontinent south of the Himalayas as well as Sri Lanka, a region throughout which it is a year-round resident. On the Arabian Peninsula, it occupies the western and southern coastal regions, including Yemen and Oman. It also occurs from extreme south-eastern Iran and southern Afghanistan south and eastward through most of Pakistan, India, Bangladesh, and Myanmar south to Rangoon (Summers-Smith, 1988). This race of the house sparrow has also been successfully introduced, both intentionally and unintentionally, to numerous places (Summers-Smith, 1988). Different species of birds assemble together to form diurnal or nocturnal mixed feeding flocks, breeding colonies and communal roosts by Zahavi (1971), Gadgil (1972), Ward & Zahavi (1973) and Gadgii & Ali (1975).

MATERIAL AND METHODS

To make a study on roosting behaviour, six rural sites namely Billawar, Doda, Chenani, Rajouri, Ramban and Ramnagar and two urban sites namely Jammu
and Udhampur were selected and 447 roosting groups of House sparrow are studied. The sites were the spaces where House Sparrow roosted. The parameters which we have considered during the study are Assembly time very near to roost, Arrival time on the roost, Sundown mean, chirping, last call after arrival, first call before departure and departure time. Observations were made from throughout the year from February 2009 to April 2012. Usually the observations were recorded during late evening (6 PM to 8:15 PM daily) and following morning (4:30 AM to 6:30 AM). Observation was made from the distance of about 20 to 30 meters. First, we identified the bird with the help of binocular (10×50).

**RESULTS**

The gamut of roosting sequences, viz. assembly time assembly time, time of arrival of birds at roost, sundown, duration of chirping, sunset, first call in morning and departure time in given in Fig. 1. As far as pre-roosting gathering is concerned, it was observed that the when the place roosting site is near (e.g. in rural areas Billawar, Doda, Chenani, Rajouri, Ramban and Ramnagar), the place of gathering is as near as 250 m. When the place of roosting is 1-2 km (e.g. in urban areas Jammu and Udhampur), the house sparrow inclined to roost, depart from assembly at an earlier time in groups of small numbers. Thus the original larger flock sheds off gradually towards the roosting groups in small sub-groups. Their time of arrival was found to be normally associated with the sunset and the day light. In cloudy weather they started roosting earlier than the normal days. The time period for assembly vary from 17 to 62 minutes (Av. 41 minutes) before sunset throughout the year. Mean arrival time at roosts varies from 1 to 9 minutes before sunset and 2 to 25 minutes after sunset. There is fighting and aggressive calls on roosting. Mean chirping time at roosting site after arrival varies from 32 to 50 minutes (Av. 40 min.). Last call after roosting varies from 51 to 75 after sunsets (Av. 62 mi). Mean first call in morning varies from 45 to 91 minutes (Av. 75 min) before sunrise. Mean departure time varies from 34 to 65 minutes (Av. 44 min) before sunrise.

Usually gathering started with the appearance of a few pairs on the gathering place and with the passage of time increasing number of house sparrows joined the gathering flocks. Both paired and unpaired house sparrow participated in gathering. The number of house sparrow in gathering flocks varied from 10-60 in urban areas and 20 to 200 in rural areas. The distance between individuals in gathering was 5-40 centimetres. In gathering individuals spent most of their time in foraging, preening, and social interaction and resting. The house sparrows made constant vocalization during gathering. The vocalizations reached the peak at the end of gathering. The time of arrival of birds in pre-roosting was early during the cloudy days than on clear days. The time of gathering in urban areas (Jammu and Udhampur) is late than the rural house sparrow. During non breeding season male and female of house sparrows roosted together but during breeding season/ summer, only one partner (male/ female) leave the nesting site for communal roosting and other partner roosts in the nest till the nestling was 10-14 days old. March onwards, as the breeding season progresses, roosts increased in size twice to three folds in August and September.

**Communal roosting**

House sparrow roosted both pure and mixed roosting groups (Fig. 2). Of the 447 groups studied, 58.84 % groups were mixed roosters and 41.16 % groups are pure rooster (Fig. 3). Common myna is most common communal rooster of House Sparrow accounting for 37.74 % of the mixed groups. The other communal
mixed roosting associates of house sparrow are Bank Myna, Jungle Babbler, Common Babbler, White-cheeked bulbul and Red-vented Bulbul. Sparrows were found to be more communal rooster (82 %) in urban areas (Jammu and Udhampur). While in rural areas (Billawar, Doda, Chenani, Rajouri, Ramban and Ramnagar) it preferred more pure roosting (61 %) because of availability of spiny shrubs and low risk of predation. The percentage of mixed roosting with more than one bird species is 3.93. The ratio of sparrow to Common myna in rural areas is found to be 70:30 while in mixed grouping in urban areas ratio was very small (2:10).

Selection of Roosting trees

The common trees used by house sparrow at eight different locations are given in Fig. 4. The dominant plants, type of vegetation and height of vegetation is given in Fig. 5. Shrubs and trees with height less than 7 ft. is most preferred type of vegetation (58.61%) used as roosting Fig. 6. Of the total roosting groups (292) in rural areas, 63.69 % of groups roosted on spiny vegetation. Relative percentage of type of vegetation and height used by roosting groups of house sparrow is shown in Fig. 6.

DISCUSSIONS

The roosting sites were found to use for roosting purposes during night and for foraging, preening, social interaction and resting during day. Anderson (2006) observed that sparrows form large communal roosts, which are used not only for nocturnal roosting but also as sites of social singing during the day, particularly in late afternoon and evening.

Mean arrival time at roosts varied from 1 to 9 minutes before sunset and 2 to 25 minutes after sunset. Anderson (2006) reported that sparrows begin arriving at communal roosts up to 2 h before sunset. Mean departure time varied from 34 to 65 minutes (Av. 44 min) before sunrise. North (1968) reported that in the morning, sparrows begin vocalizing about 30 min before sunrise, and they usually depart from the roost within 30 min after sunrise. This difference may be due to change regions, localities, feeding sites, weather condition etc. Summers-Smith (1963) also reported agitation calls frequently from communal roosts, however, suggesting that there are frequent aggressive encounters among birds at a roost.

Sparrows were found to be more communal roosters in urban areas the lack of choices of vegetation and more risk of predation. Communal roosting gave them protection. While in rural areas (Billawar, Doda, Chenani, Rajouri, Ramban and Ramnagar) it preferred more pure roosting (61 %) because of availability of spiny shrubs and low risk of predation. Heterospecific communal roosts have been observed with Spanish sparrows in Spain, Alonso, (1986), with European starlings in Poland (Gorska, 1975), with jungle babblers (Turdoides striatus) and common mynas (Acridotheres tristis) in India (Rana, 1989a), and with European starlings and Eurasian tree sparrows in North America (North, 1968). Mahabal & Bastawade (1985) also reported that house sparrows were among several species roosting communally near communal roosts of the common pariah kite (Milvus migrans govada) in India. Mahabal & Bastawade (1991) reported house sparrow as mixed roosting companions of India Myna.

The number of individuals in a group roosting observed range from 10 to 200. These were small groups as compared to 6000 sparrows roost observed by Leck (1973) at Lima Peru in August, 14000 sparrows winter roost (July) by Dawson (1967) in New Zealand, 19000 sparrows late summer roost by Summers-Smith
(1963) in London (UK), 100000 sparrows autumnal roost by Moreau (1931) in Egypt.

The number of sparrows roosting at a site changes seasonally, with larger numbers present during the nonbreeding season, but with smaller roosts persisting throughout the breeding season. Same observation has made by Summers-Smith (1963). The number of sparrows increased up to three folds in August and September. At a communal roost in Poland, for instance, Gorska (1990) observed the number of sparrows increased 3-4 folds between June and September by the addition of young of the year.

In the present study it was found that house sparrow shows preference for spiny shrubs and trees less than 7 ft. height as favourite roosting vegetation. The spiny vegetation gives protection from predators. In urban areas house sparrow used trees height between 7 to 15 ft as dominant roosting vegetation because of non availability of spiny shrubs and small trees due to extensive urbanisation. Anderson (2006) reported that communal roosting sites are usually located in trees, shrubs, or vines with dense foliage, and they change locally if deciduous sites lose their leaves. North (1968) reported that several tree species were utilized as communal roosting sites in Oklahoma (USA), with tree height (at least 6 m) and the density of the foliage (but not species) apparently being the principal criteria for selection.

In mixed roosts of rural areas, the house sparrow was found more in number because of less competition from other species due to availability of lot of choices for roosting sites. But in mixed roosts of urban areas, house sparrow number was found to be less because of less availability of roosting vegetation and more competition from other mixed roosters. Gupta & Goel (1994) reported Bank myna mixed roosting with the house sparrow in the ratio of 50:50.

**LITERATURE CITED**


<table>
<thead>
<tr>
<th>Months</th>
<th>Mean Assembly time very near to roost</th>
<th>Arrival time on roost</th>
<th>Mean time of arrival on roost</th>
<th>Sunset mean</th>
<th>Mean Clarping (Min.)</th>
<th>Last call after arrival (mean)</th>
<th>Mean 1st call Before</th>
<th>Departure Time mean</th>
<th>Mean sustris M</th>
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<tbody>
<tr>
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<td>4.23</td>
<td>5.16 to 5.32</td>
<td>5.24</td>
<td>5.25</td>
<td>43</td>
<td>6.24</td>
<td>5.30</td>
<td>6.15</td>
<td>7.01</td>
</tr>
<tr>
<td>December</td>
<td>4.32</td>
<td>5.18 to 5.34</td>
<td>5.29</td>
<td>5.25</td>
<td>35</td>
<td>6.29</td>
<td>6.00</td>
<td>6.20</td>
<td>7.24</td>
</tr>
<tr>
<td>January</td>
<td>5.05</td>
<td>6.00 to 6.20</td>
<td>6.10</td>
<td>5.45</td>
<td>44</td>
<td>6.48</td>
<td>6.05</td>
<td>6.25</td>
<td>7.30</td>
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<tr>
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<td>5.52 to 6.15</td>
<td>6.04</td>
<td>6.08</td>
<td>50</td>
<td>7.08</td>
<td>5.48</td>
<td>6.10</td>
<td>7.13</td>
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<tr>
<td>March</td>
<td>5.45</td>
<td>6.42 to 6.52</td>
<td>6.47</td>
<td>6.32</td>
<td>43</td>
<td>7.47</td>
<td>5.18</td>
<td>6.00</td>
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<td>April</td>
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<td>7.42 to 7.04</td>
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<td>6.50</td>
<td>37</td>
<td>7.53</td>
<td>4.40</td>
<td>5.30</td>
<td>6.02</td>
</tr>
<tr>
<td>May</td>
<td>6.54</td>
<td>7.02 to 7.26</td>
<td>7.14</td>
<td>7.11</td>
<td>41</td>
<td>8.14</td>
<td>4.38</td>
<td>5.01</td>
<td>5.32</td>
</tr>
<tr>
<td>June</td>
<td>6.56</td>
<td>7.18 to 7.48</td>
<td>7.33</td>
<td>7.26</td>
<td>32</td>
<td>8.33</td>
<td>4.30</td>
<td>4.48</td>
<td>5.24</td>
</tr>
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<td>July</td>
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<td>7.05 to 7.32</td>
<td>7.18</td>
<td>7.27</td>
<td>36</td>
<td>8.18</td>
<td>4.45</td>
<td>5.01</td>
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<td>August</td>
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<td>6.42 to 7.15</td>
<td>6.58</td>
<td>7.16</td>
<td>38</td>
<td>8.18</td>
<td>4.30</td>
<td>5.10</td>
<td>5.52</td>
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<td>September</td>
<td>6.00</td>
<td>6.25 to 6.44</td>
<td>6.34</td>
<td>6.38</td>
<td>38</td>
<td>7.14</td>
<td>4.53</td>
<td>5.65</td>
<td>6.12</td>
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<tr>
<td>October</td>
<td>5.15</td>
<td>5.42 to 5.52</td>
<td>5.47</td>
<td>5.45</td>
<td>41</td>
<td>6.47</td>
<td>5.05</td>
<td>5.48</td>
<td>6.35</td>
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</tbody>
</table>

Figure 1. Table showing the chronological sequence of various aspects related to roosting: assembly time, time of arrival of birds at roost, sundown, duration of chirping, sunset, first call in morning and departure time in House Sparrow at eight different locations of Jammu division.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Species of communal rooster</th>
<th>Scientific name</th>
<th>No. of House sparrow groups the species roosted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Common myna</td>
<td>Acridotheres gingiominus</td>
<td>184</td>
</tr>
<tr>
<td>2</td>
<td>Bank myna</td>
<td>Acridotheres tristis tristis</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Jungle Babbler</td>
<td>Turdoides striatus somervillae</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Red-vented Bulbul</td>
<td>Pycnonotus cafer cafer</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>White-checked Bulbul</td>
<td>Pycnonotus leucogenys leucogenys</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>Common Babbler</td>
<td>Turdoides caudatus caudatus</td>
<td>28</td>
</tr>
<tr>
<td>7</td>
<td>Pure groups</td>
<td></td>
<td>121</td>
</tr>
<tr>
<td>8</td>
<td>Mixed with babbler, common myna</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>Mixed with common myna and white checked bulbul</td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

**Figure 2.** Table showing name and no. of communal roosters of House sparrow for roosting at eight different locations of Jammu division. (n=447).

**Figure 3.** Pie diagram showing the relative percentage of communal roosters of House sparrow for roosting at eight different locations of Jammu division.
<table>
<thead>
<tr>
<th>S/N</th>
<th>Roosting sites</th>
<th>Roosting trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ramban 33.2500° N, 75.2500° E</td>
<td>Berberis artista, Astragalus candolleanus, Berberis lyceum, Coraria nepalensis, Indigofera atropurpurea, leycesteria Formosa, Melia azaedarach, Olea ferruginea, Rhamnus virgata, Robinia pseudocasia, Rubus elliptica, Salix alba, viburnum cotinifolium, Viburnum grandiflorum Ziziphus mauritiana, Pyrus pashia</td>
</tr>
<tr>
<td>2.</td>
<td>Ramnagar 32.4811 N 75.1844 E</td>
<td>Punica granatum, Artemisia nilagirica, Bambusa arundinacea, Berberis artista, Berberis lyceum, Coraria nepalensis, Cotoneaster bacillaris, Gymnosporia royleana, Lonicera quinquelocularis, Melia azaedarach, Populus ciliata, Robinia pseudocasia, Rubus elliptica, Ziziphus mauritiana Viburnum grandiflorum, woodfordia fruticosa, Pyrus pashia</td>
</tr>
<tr>
<td>3.</td>
<td>Billawar 32.6200° N 75.6200° E</td>
<td>Aegle marmelos, Asparagus adscendens, Bambusa arundinacea, Berberis artista, Coraria nepalensis, Dalbergia siso, Dodonaea viscosa, Dodonaea viscosa, Gymnosporia royleana, Hypericum oblongifolium, Lepidagathis cuspidata, Leptodermis lanceolata, Mallotus philippensis, Melia azaedarach, Murraya koenjii, Populus ciliata, spirae woodfordia fruticosa a canescens, Syzygium cumini, Viburnum grandiflorum, Ziziphus mauritiana, Pyrus pashia, Carissa opaca</td>
</tr>
<tr>
<td>4.</td>
<td>Udhampur 32.9300° N 75.1300° E</td>
<td>Capparis sepiaria, Carissa opaca Berberis artista, Aegle marmelos, Dalbergia siso, Eleaeagnus umbellate, Ficus bengalensis, Mangifera indica, Melia azaedarach, Populus ciliata, Salix alba, Syzygium cumini, Ziziphus mauritiana</td>
</tr>
<tr>
<td>5.</td>
<td>Jammu 32.7300° N 74.8700° E</td>
<td>Acacia catechu, Acacia farnesiana, Acacia gageana, Acacia modesta, Acacia nilotica, Aegle marmelos, Asparagus adscendens, Capparis sepiaria, Colebrookia oppositifolia, Dalbergia siso, Dodonaea viscosa, Ficus religiosa, Ficus bengalensis, Greviella robusta, Lepidagathis cuspidata, Madhuca indica, Mangifera indica Melia azaedarach, Murraya koenjii, Populus ciliata, Syzygium cumini, Tamariudias indica. Terminalia arjuna, Toona ciliate Pyrus pashia,</td>
</tr>
<tr>
<td>6.</td>
<td>Chenani 33.0219 N 75.1700 E</td>
<td>Punica granatum, Berberis artista, Aegle marmelos, Berberis lyceum, Carissa opaca, Lonicera Rubus elliptica quinquelocularis, Olea ferruginea, Populus ciliata, Salix alba, Spiraea canescens, Ziziphus mauritiana, Pyrus pashia, Carissa opaca</td>
</tr>
<tr>
<td>7.</td>
<td>Rajouri 33.3800° N 74.3000° E</td>
<td>Berberis artista, Berberis lyceum, Cocculus laurifolius Eleaeagnus umbellate, Leptodermis lanceolata, Oostegia limbata, woodfordia fruticosa, Pyrus pashia</td>
</tr>
<tr>
<td>8.</td>
<td>Doda 33.1300° N 75.5700° E</td>
<td>Astragalus candolleanus, Berberis artista, Berberis lyceum, Cocculus laurifolius, Coraria nepalensis, Cotoneaster bacillaris Eleaeagnus umbellate, Juniper communis, leucosteria Formosa, Lonicera quinquelocularis, Melia azaedarach, Olea ferruginea, Populus ciliata, Robinia pseudocasia, Rubus elliptica, Salix alba, spiraea canescens, Viburnum grandiflorum, Ziziphus mauritiana, Pyrus pashia</td>
</tr>
</tbody>
</table>

Figure 4. Table showing roost tree selection by House sparrow at eight different locations of Jammu division.
<table>
<thead>
<tr>
<th>Roosting site</th>
<th>No. of House sparrow roosting group studied</th>
<th>Dominant roosting vegetation</th>
<th>No. of House sparrow groups roosted</th>
<th>Type of roosting vegetation (Shrub/tree)</th>
<th>Av. Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramban</td>
<td>42</td>
<td><em>Berberis aristata</em></td>
<td>8</td>
<td>Spiny shrub</td>
<td>&lt;5 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Pyrus pashia</em></td>
<td>7</td>
<td>Spiny deciduous tree</td>
<td>&lt;15 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Rubus elliptica</em></td>
<td>5</td>
<td>Spiny shrub</td>
<td>&lt;7 ft</td>
</tr>
<tr>
<td>Rannagar</td>
<td>56</td>
<td><em>Berberis aristata</em></td>
<td>11</td>
<td>Spiny shrub</td>
<td>&lt;6 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Punica granatum</em></td>
<td>8</td>
<td>Spiny tree</td>
<td>&lt;7 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Pyrus pashia</em></td>
<td>7</td>
<td>Spiny deciduous tree</td>
<td>&gt;15 ft</td>
</tr>
<tr>
<td>Billawar</td>
<td>54</td>
<td><em>Pyrus pashia</em></td>
<td>21</td>
<td>Spiny deciduous tree</td>
<td>&gt;15 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Ziziphus mauritiana</em></td>
<td>12</td>
<td>Spiny shrub</td>
<td>&gt;7 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Carissa opaca</em></td>
<td>9</td>
<td>Spiny shrub</td>
<td>&gt;5 ft</td>
</tr>
<tr>
<td>Udhampur</td>
<td>58</td>
<td><em>Populus ciliata</em></td>
<td>12</td>
<td>Deciduous tree</td>
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</tr>
<tr>
<td></td>
<td></td>
<td><em>Aegle marmelos</em></td>
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<tr>
<td></td>
<td></td>
<td><em>Ficus bengalensis</em></td>
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<td>Evergreen tree</td>
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<tr>
<td>Jammu</td>
<td>48</td>
<td><em>Ficus bengalensis</em></td>
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<tr>
<td></td>
<td></td>
<td><em>Populus ciliata</em></td>
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<td>Deciduous tree</td>
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<td><em>Grevillea robusta</em></td>
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<td>Chenani</td>
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<td><em>Punica granatum</em></td>
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<td>15</td>
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<tr>
<td></td>
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<td><em>Others</em></td>
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<tr>
<td>Doda</td>
<td>55</td>
<td><em>Berberis aristata</em></td>
<td>12</td>
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</tr>
<tr>
<td></td>
<td></td>
<td><em>Pyrus pashia</em></td>
<td>9</td>
<td>Spiny deciduous tree</td>
<td>&gt;15 ft</td>
</tr>
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</table>

Figure 5. Table showing dominant roosting vegetation, type of vegetation and average height of vegetation used by roosting house sparrow groups (n=447) at eight different locations of Jammu division.

![Figure 5](image)

Figure 6. Pie diagram showing relative percentage of type of vegetation and height used by roosting groups of House sparrow for roosting at eight different locations of Jammu division.

![Figure 6](image)
LIFE CYCLE AND LABORATORY REARING OF
LACCOTREPHES MACULATES (HEMIPTERA:NEPIDAE)
FROM JAMMU (J & K, INDIA)

Ramnik Kour*, J. S. Tara, Sheetal Sharma and Shivani Kotwal

* Department of Zoology, University of Jammu (J & K), 180006, INDIA. E-mail: ramnikento@gmail.com

ABSTRACT: The life cycle of Laccotrephes maculates was studied by rearing from egg to adult in laboratory conditions at a temperature of 28.9± 1.08°C with description of immature stages. Individuals were reared on nymphs of Anisops sp. (Hemiptera: Notonectidae) and mosquito larvae. The incubation period averaged 12.6 days. Durations of five subsequent instars averaged 8.1, 10.0, 10.3, 11.3 and 9.1 days respectively. Total life cycle averaged 61.4 days.

KEY WORDS: Anisops, Laccotrephes maculates, laboratory rearing, Hemiptera, Nepidae.

Aquatic hemipterans play a significant role as the major predator of aquatic fauna (Blaustein, 1998). The members belonging to family nepidae feed on a variety of aquatic organisms such as aquatic insects and tadpoles (Menke, 1979). Laccotrephes maculates Fabr. commonly known as water scorpion belongs to family Nepidae of order Hemiptera is carnivorous and air breather. Though most of the time they live in water but sometimes emerge out of water on the ground or under stones in damp beds of recently dried streams. All legs are employed in swimming but they are not good swimmers. Fore legs are moved up and down and middle is used for kicking motion, each pair operates simultaneously as a unit. In crawling on objects under water, normal alterations of legs occur. Abdominal appendages thrust up to the surface as the insect crawls or move slowly. They feed on various types of small aquatic animals after capturing them with front raptorial legs. Water scorpions inflict painful bite when handled. Though they have well developed wings but they seldom fly.

The information relating to life cycle of Laccotrephes maculates is lacking in Jammu and Kashmir State of India but a limited aspect of life cycle studies has been reported in India. Rao (1976) carried out bioecological studies of Laccotrephes robustus and Laccotrephes griseus in Madras, India. The life cycle of Laccotrephes japonensis in Japanese rice fields and a pond was studied by Ohba and Goodwyn (2010). This paper presents information on the life cycle and laboratory rearing of Laccotrephes maculates and includes description of the immature stages.

MATERIALS AND METHODS

The study was started with adults of Laccotrephes maculates which were collected during mid July from pond, taken to laboratory and placed in glass troughs containing mud, water and aquatic vegetation and mosquito larvae and nymphs of Anisops sp. (Hemiptera: Notonectidae) as food at a temperature of 28.9±1.08°C. The glass troughs or aquaria were cleaned weekly and examined daily for eggs. Extracted eggs were placed on moistened petri dishes. Eggs were checked daily. Upon hatching, first instars were removed to other glass troughs.
As individuals moulted, they were transferred to new troughs. Each day, first and second instars were fed on mosquito larvae and subsequent instars on Anisops nymphs.

For morphological studies nymphs and adults were preserved in 70% ethyl alcohol. Eggs were preserved in 5% formalin with a few drops of glycerine. The description of immature stages is based on 5 individuals. Measurements were made with the help of an oculometer calibrated against stage micrometer, which includes total body length and breadth, egg and nymph. Standard graphic paper method wherever necessary was also applied. Descriptions of instars follow the protocol of McPherson & Packauskas (1987); i.e., the first instar is described in detail, but for subsequent instars only major differences from previous instars are described. Length is measured from the tip of clypeus to the tip of abdomen, and width across the mesonotum.

**OBSERVATION AND DISCUSSION**

**Laboratory Rearing**

**Oviposition**

Oviposition or egg laying started after 24 hours of copulation and approximately 15-20 eggs are laid singly. Similarly McPherson & Packauskas (1987) in Nepa apiculata (Hemiptera: Nepidae) reported that few eggs were laid singly in mud away from the shoreline. On the contrary Rao (1976) reported 18 eggs in Laccotrephes robustus which are laid in groups of five and six. Oviposition period lasted 4-20 days.

Egg was white at oviposition but later turns pale white and reddish at the time of hatching. The incubation period averaged 12.6 days (Table 1). The first instar emerged through a circular opening in the cephalic end of the egg. It was reddish at this time but soon darkened to black. It fed on mosquito larvae within 1 day. The first, second, third, fourth and fifth instars averaged 8.1, 10.0, 10.3, 11.3 and 9.1 days respectively. The total life cycle averaged 61.4 days (Table 1).

**Description of immature stages**

The description of each stage is based on average of five individuals.

**Egg** (Fig. 1)

Length (excluding the length of filament): 2.06±0.04 (range, 2.0–2.1 mm); Width: 0.94±0.04 (range, 0.9–1 mm). Egg is oval and cylindrical and provided with 8 apical filaments; whereas in Laccotrephes griseus there are 6 apical filaments and in Laccotrephes robustus there are 10 filaments (Rao, 1976). Whereas Keffer et al. (1994) observed 12-17 apical filaments in the egg of Curicta scorpio (Hemiptera: Nepidae). Egg is whitish at oviposition but later turns pale white and reddish at the time of hatching. Similar observations regarding the morphology of egg of Nepa apiculata (Hemiptera: Nepidae) has also been observed by McPherson & Packauskas (1987). Incubation period averaged 12.6 days. Earlier similar incubation period of 12-13 days was observed by Wiley (1924) in closely relatrd genus Curicta drakei (Hemiptera: Nepidae). But Rao (1976) observed an incubation period of 9 days in Laccotrephes griseus in Madras. On the contrary Packauskas & McPherson (1986) observed an incubation period of 11.3 days in Ranatra fusca (Hemiptera: Nepidae) and McPherson & Packauskas (1987) reported an incubation period of 14.1 days in Nepa apiculata (Hemiptera: Nepidae). Whereas Keffer et al. (1994) in Curicta scorpio (Hemiptera: Nepidae) observed an incubation period of 11.4 days.
Instars

There are five instars in the life cycle of L. maculates. But McPherson & Packauskas (1987) reported four instars in the life history of Nepa apiculata (Hemiptera: Nepidae). Overall characters between instars remain same throughout the instars with minor differences such as lengths of body, abdomen, respiratory siphon and increasing wing pad length which are diagnostic features among instars.

First instar (Fig. 2)

Duration: 8.1 days Length: 4.2± 0.19 (mean±SD) Rostrum: 0.3± 0.1. Respiratory siphon: 1.18±0.13. Body elongate oval, dorsoventrally flattened, pale yellowish at the time of hatching, turning brown to reddish brown later on. Head moderately declivent anterior to eyes, broader than long; eyes black. Antennae brownish, short, 3-segmented. Rostrum three segmented. Pronotum wider than long with two ridges lying posteriorly. Mesonotum and metanotum slightly convex. Wing pads seen slightly posterolaterally on both meso and metanota. Prothoracic legs raptorial, uniformly brown; coxa elongate, shorter than femur; trochanter shorter than coxa; tibia lighter proximally and distally, bordered by row of spines on either sides; femur with yellow stripe on anterior surface; tarsus one segmented with single claw, bordered each side by row of short spine. Middle and hind legs light brown with lighter areas; bearing paired claws. Abdomen flattened dorsoventrally, last segment terminating in siphon like tube that open along its ventral length.

Second instar (Fig. 3)

Duration: 10.0 days Length: 7.2± 0.83 (mean±SD) Rostrum: 0.42±0.08. Respiratory siphon: 1.84±0.20. Body more elongate, varying from brown and reddish brown to brownish yellow. Antennae two segmented varying from yellow to brown. Pronotum with median depression. Mesonotum with posterior margin slightly produced posteromedially. Wing pads more pronounced. Prothoracic legs yellowish brown to brown having protarsus with row of tiny, dark tubercles replacing hairs of first instar and more pronounced yellow markings on femur. Meso and metathoracic legs yellowish brown to brown.

Third instar (Fig. 4)

Duration: 10.3 days Length: 9.4 ±0.65 (mean±SD) Rostrum: 0.68±0.13. Respiratory siphon: 2.34±0.20. Antennal segments two. Lateral light brown spots more pronounced on thoracic region. Wing pads more pronounced, particularly on mesonotum.

Fourth instar (Fig. 5)

Duration: 11.3 days Length: 19.0 ±0.79 (mean±SD) Rostrum: 2.16±0.27. Respiratory siphon: 5.78±0.19. Head posterior to eyes. Antennal segments two. Mesonotal wing pad completely overlapping metanotal wing pad laterally. Pronotum more wider than long.

Fifth instar (Fig. 6)

Duration: 9.1 days Length: 20.0 0±.44 (mean±SD) Rostrum: 2.82±0.21. Respiratory siphon: 6.78±0.21. Antennae two segmented Pronotum with lateral length subequal to posterior width. Mesonotal wing pads covering those of metanotum. Males slightly smaller than females.

Adult (Fig. 7)

Total body length: 28.6±0.72 (mean±SD) Rostrum: 3.6±0.48 Thorax length: 12.4±0.48 Thorax width: 6.6±0.48 Abdomen length: 12.2±1.36 Abdomen width:
6.6±0.48 Respiratory siphon: 30.8±0.64. Head small, triangular, broadest in the middle, produced in front forming rostrum. Eyes oval, prominent antero laterally present in the middle of head. Antennae not visible dorsally, placed ventrally near the inner edge of each eye; 3 segmented, lamellate type. Pronotum slightly broader than long; scutellum triangular broader at base, pointed at apex. Hemielytra well developed; veins and membrane distinct. Forelegs raptorial; coxae long and trochanter short, femora flattened dorsoventrally; thick with a strong tooth. Tibia short, slender, dentate at the inner edge, tarsi one segmented, claw single. Middle and hind legs are moderately slender. Row of thin long hairs present on tibial and tarsal segments of middle and hind legs. Tarsi in both legs single segmented but with two sharp pointed claws. Abdominal appendages shorter than the body length. Apically respiratory siphons are present for breathing purpose formed by the cerci.

Duration of Life cycle of *Laccotrephes maculates*:

The duration of individual instar is given in Table 1 and a perusal of the table revealed that the total life cycle of *Laccotrephes maculates* to be completed in 50-70 days with an average of 61.4±8.11 days. The life cycle in laboratory conditions started in mid July and adults emerged in late September. First instar appeared in early August marked by overlapping of subsequent instars and active adults last observed in late September.

Though earlier Rao (1976) recorded total life cycle of 45-53 days in case of *Laccotrephes griseus* (Hemiptera: Nepidae) and 39-46 days in *Laccotrephes robustus* (Hemiptera: Nepidae) in Madras. Whereas McPherson & Packauskas (1987) recorded total duration of 59.8 days in *Nepa apiculata* (Hemiptera: Nepidae) and Packauskas & McPherson (1986) observed total duration of 47.0 days in *Ranatra fusca* (Hemiptera: Nepidae). On the contrary Keffer et al. (1994) recorded total duration of 79.87 days in *Curicta scorpio* (Hemiptera: Nepidae) and Kumari & Nair (1984) observed the total duration of 58 days in *Ranatra filiformis* (Hemiptera: Nepidae) in Kerala.

ACKNOWLEDGEMENT

The authors are highly indebted to Prof. K. K. Sharma, Head Dept. of Zoology, University of Jammu, Jammu for his constant interest and encouragement.

LITERATURE CITED


Table 1. Duration (in days) of each immature stage of *Laccotrephes maculates* under laboratory conditions.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Range</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>10-14</td>
<td>12.6± 1.67</td>
</tr>
<tr>
<td>1st instar</td>
<td>7-9</td>
<td>8.1±0.89</td>
</tr>
<tr>
<td>2nd instar</td>
<td>8-12</td>
<td>10±1.69</td>
</tr>
<tr>
<td>3rd instar</td>
<td>8-12</td>
<td>10.3±1.52</td>
</tr>
<tr>
<td>4th instar</td>
<td>10-12</td>
<td>11.3±0.83</td>
</tr>
<tr>
<td>5th instar</td>
<td>7-11</td>
<td>9.1±1.51</td>
</tr>
</tbody>
</table>

Table 2. Measurements (Mean±SD) of various organs of the different stages of *Laccotrephes maculates* Fab. (based on 5 individuals of each instar).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Body Length (mm)</th>
<th>Head Length (mm)</th>
<th>Head Width (mm)</th>
<th>Thorax Length (mm)</th>
<th>Thorax Width (mm)</th>
<th>Abdomen Length (mm)</th>
<th>Abdomen Width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st instar</td>
<td>4.2±0.19</td>
<td>0.6±0.1</td>
<td>0.32±0.16</td>
<td>1.92±0.08</td>
<td>0.72±0.08</td>
<td>1.96±0.13</td>
<td>0.92±0.07</td>
</tr>
<tr>
<td>2nd instar</td>
<td>7.2±0.83</td>
<td>0.7±0.07</td>
<td>0.6±0.07</td>
<td>2.48±0.30</td>
<td>1.0±0.15</td>
<td>2.16±0.11</td>
<td>2.82±0.19</td>
</tr>
<tr>
<td>3rd instar</td>
<td>9.4±0.65</td>
<td>0.8±0.1</td>
<td>0.78±0.13</td>
<td>3.5±0.31</td>
<td>2.76±0.20</td>
<td>2.38±0.13</td>
<td>2.86±0.11</td>
</tr>
<tr>
<td>4th instar</td>
<td>19.0±0.79</td>
<td>1.1±0.15</td>
<td>0.9±0.15</td>
<td>4.66±0.23</td>
<td>3.96±0.11</td>
<td>5.26±0.18</td>
<td>5.02±0.08</td>
</tr>
<tr>
<td>5th instar</td>
<td>20.0±1.44</td>
<td>1.66±0.28</td>
<td>2.70±2.3</td>
<td>5.70±2.56</td>
<td>5.66±0.40</td>
<td>6.78±0.49</td>
<td>5.36±0.16</td>
</tr>
<tr>
<td>Adult</td>
<td>28.6±0.72</td>
<td>3.4±0.48</td>
<td>3.6±0.48</td>
<td>12.41±0.18</td>
<td>6.6±0.48</td>
<td>12.2±1.36</td>
<td>6.6±0.48</td>
</tr>
</tbody>
</table>

Table 2 (Cont.)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Rostrum Length (mm)</th>
<th>Respiratory siphon Length (mm)</th>
<th>Fore leg (mm)</th>
<th>Mid leg (mm)</th>
<th>Hind leg (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st instar</td>
<td>0.3±0.1</td>
<td>1.18±0.13</td>
<td>2.4±0.1</td>
<td>2.2±0.08</td>
<td>3.12±0.08</td>
</tr>
<tr>
<td>2nd instar</td>
<td>0.4±0.08</td>
<td>1.84±0.20</td>
<td>3.14±0.38</td>
<td>2.98±0.13</td>
<td>3.94±0.27</td>
</tr>
<tr>
<td>3rd instar</td>
<td>0.68±0.33</td>
<td>2.34±0.20</td>
<td>4.12±0.13</td>
<td>4.02±0.08</td>
<td>5.08±0.13</td>
</tr>
<tr>
<td>4th instar</td>
<td>2.16±0.27</td>
<td>5.78±0.39</td>
<td>7.5±0.25</td>
<td>6.78±0.11</td>
<td>7.36±0.16</td>
</tr>
<tr>
<td>5th instar</td>
<td>2.82±0.21</td>
<td>6.78±0.21</td>
<td>11.20±0.20</td>
<td>6.8±0.19</td>
<td>7.84±0.18</td>
</tr>
<tr>
<td>Adult</td>
<td>3.8±0.48</td>
<td>30.8±0.64</td>
<td>23.8±1.04</td>
<td>13.2±0.64</td>
<td>21.8±1.04</td>
</tr>
</tbody>
</table>
FIRST RECORD OF THE SPIDER GENUS EPISINUS (ARANAEAE: THERIDIIDAE: SPHINTHARINAE) FROM INDIA WITH DESCRIPTION OF A NEW SPECIES

Sumit Chakrabarti*

* Himalayan Forest Research Institute, Conifer Campus, Panthaghati, Shimla, INDIA, 171009. E-mail: chakrabartis@icfre.org

ABSTRACT: Spiders of the family Theridiidae is represented in India by 57 valid species. A Theridiid female of the genus Episinus was found from Shimla, Western Himalayan hills of India and E. pentagonalis is described as a new species. A comparison with other closely related species of Episinus is also deliberated in the present communication.

KEY WORDS: Episinus pentagonalis, Western Himalaya, India.

Indian Theridiidae is represented by 57 valid species which includes 49 species from Indian mainland, 5 species from Andaman Is., and 3 species from Nikobar Is. (Platnick, 2012). However as the geographic locations of the spiders collected by Stolickza during Yarkand Mission (Cambridge, 1885) are not clear, 12 species of Theridiid spiders are not considered to be as Indian species. Genus Episinus Walckenaer, 1809, is a very well studied taxa (Kulczynski, 1905; Becker, 1896; Bosenburg, 1903; Simon, 1895; Walckenaer, 1841; Walckenaer & Gervais, 1847), which contains 58 species worldwide, none from India. Most of the Episinus spiders are similar in having long pyramidal or triangular abdomen with abdominal humps or small beaks and a few bear no tooth on the chericeral fang-furrow (Levi & Levi, 1962; Levi, 1964; Okuma, 1994).

It would be erroneous to mention that genus Episinus was not recorded from India. During Yarkand Mission, Stolickza collected a spider from Muree, now in Pakistan, which was mentioned as Episinus algiricus by Cambridge (1885). Though he analyzed the characters of the species with E. truncatus, but his text was not supported by any distinctive drawings, neither of habitus of the spider nor genitalia. Probably that is why in the geographic location of E. algiricus, India, Yarkand or Pakistan were not included in Platnick’s world spider catalogue. Genus Episinus is well represented from Asian countries like, China (Zhu, 1998), Japan and Taiwan (Bosenburg & Strand, 1906; Yoshida, 1983, 1991; Okuma, 1994), Singapore, Korea, Myanmar, (Simon, 1894) totaling 13 Asian species.

The present spider was collected from Himachal Pradesh and its morphological characters, colouration and especially female genitalia were compared with all Asian as well as Mediterranean species. As this spider from Western Himalaya differs from all valid species, a new one, viz. E. pentagonalis, has been erected, which happens to be the first Indian record the genus Episinus too.

MATERIAL AND METHODS

Spiders collected from the forest were preserved in 75% Ethyl Alcohol and kept in glass vial with plastic screw-cap (Borosil) of 20 ml. capacity. Photographs were taken with a Nikon D80 digital SLR camera having a 60mm AF Micro-
Nikkor 1:2.8 D Lens. For geo-referencing a GPS instrument (GPSmap 76CSx, Garmin) was used.

Preserved spider was studied under a Stereozoom Microscope (RSM-9) having a CCTV Camera (Calton) connected with a desktop computer. All measurements in millimeter (mm) were done through an image analyzing software (USB Digital Scale 1.1.0, Scaler Corp.) Microscopic photographs were taken with a digital camera (Nikon D80, Japan) attached with the trinocular tube of the microscope.

Female genetalia were cut, soft tissues removed and kept in Clove Oil overnight for clearing. As the internal genetalia was highly chitinized, compact and looping patterns of copulatory ducts were not clearly visible, the genital was further cleared in 5% aqueous solution of KOH. Thus the internal genetalia became dilated and inflated exhibiting all parts clearly.

Temporary microscopic slide was prepared with the female genetalia submerged in glycerol on a cavity slide and studied under Nikon Eclipse 400 research microscope. Camera Lucida drawings were made with a Drawing Tube.


**TAXONOMY**

*Episinus pentagonalis*, sp. nov.

**General morphology.** Small web-building spider with light yellowish grey colour having darker spots and lines on long and pentagonal flat abdomen (Fig.10). Legs long, slender but stout, faint yellowish appeared as semi transparent. Two pairs of front legs projected forward with each lateral pair close together and hind pair of legs are similarly positioned when on rent on leaf-surface or on substratum. A pair of oblong mid-dorsal abdominal sigila and a pair of roundish black patch is prominent.

**Measurements.** Body length: 3.313, CP length 1.078, CP width: 1.148, CL length: 0.539, CL width: 0.381, ABD length: 2.235, ABD width ant. end: 0.518, ABD. width across mid-lateral humps: 1.469, ABD. width at below humps: 0.743, AME-ALE distance: 0.137, PME-PLE distance: 0.149, distance between AME: 0.168, distance between PME: 0.187, clypeus length: 0.204, clypeus width: 0.383, chelecera length: 0.355, chelecera width 0.156, labium length: 0.140, labium width: 0.238, maxilla length: 0.328, maxilla width: 0.134, sternum length: 0.739, sternum width: 0.594. width of epigynal atrium: 0.191.

**Cephalothorax.** Yellowish brown, almost circular, slightly broader than long, tapered apically. Cephalic region prominent, elevated and roundish, posteriorly slopes down and meet carapace. Immediately after the depression the thoracic part raises up and suddenly drops down at the posterior end. The central top of the raised thoracic part bears a deep ‘V’ shaped fovea. Several light brown irregular reticulate patches originate from periphery of cephalothorax (Fig. 1). Eyes clustered on elevated cephalic region, encircled by black ring, and black patches mark the ocular quad. ALE and PLE are close, PME are largest and close to PLE, OQ almost square, cephalic region darker than thoracic region (Fig. 5). Clypeus flat, wider than long, projected forward, appears as a semi-circular beak (Figs. 1 and 5). Chelicera cylindrical, glossy yellowish, smooth, few hairs crowd the apex. Grey coloured patches present at the inner side of the base of chelicera (Fig. 5). Cheliceral fang small, sharp, dark coloured, and curved without any
serration, anterior and posterior margin of fang furrow without any tooth (Fig.
3c). Labium wider than long, semicircular, with broad flat base. Maxilla quadrangular, longer than wide, apically provided with tuft of hairs. Sternum yellowish without any mid dorsal line, pear shaped, broader at proximal end, tapered at distal end, grey patches encircle the periphery (Fig. 2). Pedipalp normal, light brownish and remain folded on vertical plane, with one serrated palpal claw (Fig. 3b). Legs light brownish, appears almost transparent, joints of each leg segment is darker, distal half of 4th tibia dark brown, light brownish broken patches irregularly distributed on legs, covered with very fine hairs and few dark spines are present. Each tarsa having three dark brown minute claws, upper pair is slightly curved and serrated, the lower claw smooth without any serration, curved at the base and straight afterwards, without tuft of hairs (Fig.
3a).

**Abdomen.** Darker than prosoma, numerous chalk white granules spread all over dorsally and ventrally. Longer than wide, pentagonal, truncated, broader at the posterior end. Abdomen covered with fine pubescence and decorated with black and grey spots and patches (Fig. 1). A longitudinal mid-dorsal thick semitransparent line over the abdomen indicates presence of heart beneath. Two lateral line originate from it and ends obliquely down just above the lateral hump. In continuation of the above mid line a black thin line runs down caudal part of abdomen and ends above anal tubercle. At the mid length of abdomen a pair of prominent elliptical sigila present laterally along the mid dorsal line. A mid dorsal depression at the anterior end gives rise a pair of small shoulder humps. Numerous long dark brown and hyaline thin hairs are present on the ventro-lateral side of the proximal end of abdomen. Distal end of abdomen provided with a pair of prominent lateral conical humps, slightly bent down. The ventro-lateral surface of the humps are striated. Each lateral humps are having 3-4 dark hairs, flat on the surface. A prominent ridge of dark wavy line and white patch along runs across the humps over the abdomen and immediately below that a pair of dark circular lateral spots marks the distal half of abdomen. Below the humps the abdomen narrows down ending as a conical cauda. Ventrally abdomen is lighter and chalk white granules of different sizes are numerous laterally, giving an appearance of ‘U’ shaped design between epigastric furrow and spinner (Fig. 2). Spinners normal, colulus absent, area covering spinner is darker, having a pair of lateral white spots and few white spots present at the bottom (Fig. 4).

**Measurement of legs.**

<table>
<thead>
<tr>
<th>Legs</th>
<th>Coxa</th>
<th>Trochanter</th>
<th>Femur</th>
<th>Patella</th>
<th>Tibia</th>
<th>Metatarsus</th>
<th>Tarsus</th>
<th>Total Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.386</td>
<td>0.193</td>
<td>1.920</td>
<td>0.491</td>
<td>1.370</td>
<td>2.005</td>
<td>0.552</td>
<td>6.917</td>
</tr>
<tr>
<td>II</td>
<td>0.356</td>
<td>0.189</td>
<td>1.445</td>
<td>0.282</td>
<td>0.889</td>
<td>1.219</td>
<td>0.540</td>
<td>4.920</td>
</tr>
<tr>
<td>III</td>
<td>0.350</td>
<td>0.180</td>
<td>1.001</td>
<td>0.278</td>
<td>0.857</td>
<td>1.020</td>
<td>0.547</td>
<td>4.233</td>
</tr>
<tr>
<td>IV</td>
<td>0.391</td>
<td>0.201</td>
<td>1.947</td>
<td>0.500</td>
<td>1.399</td>
<td>2.114</td>
<td>0.552</td>
<td>7.104</td>
</tr>
</tbody>
</table>

Leg-Formula: 4:1:2:3

**Female genetalia.** Epigynum appears as a dirk semi-circular area wider than long, several long dark hairs present around epigynum (Fig. 6). The cleared epygynal plate shows spacious atrium and no septum is found (Fig. 7). Internal genetalia including the copulatory ducts highly chitinized (Fig. 8). Spermatheca pear-shaped, two in number, the epical ends corrugated. Thick, broad, long and dark copulatory tubes originate from the apical half of spermatheca, bends down
and turns up forming a loop. After reaching the top end of spermatheca laterally, the loop bend down posteriorly and ends near the vulva (Fig. 9).


**Etymology.** The specific name of the present *Episinus* was assigned as *pentagonalis* referring to its two shoulder humps at apex of abdomen, two abdominal humps at the distal part and the conical abdominal extremity, which altogether gives a pentagonal appearance of the abdomen.

**Diagnosis.** The present spider, *Episinus pentagonalis*, erected as a new species, is very much similar to *E. algiricus*, *E. maculipes* and *E. truncatus* described by various authors, by external appearance but differs by distinct shoulder humps, lateral abdominal hump which is slightly bent down and prominent conical abdominal end. Cambridge’s description of *E. algiricus* resembles with the present spider by the absence of short & distinct yellow longitudinal line on carapace, colour of legs, distribution of chalk-white granules on the ventral side of the abdomen, more conical abdominal extremity, roundish dark epigyne etc. But detail structures of internal genetalia of the present spiders differ a lot with *E. algiricus*. Knoflach’s recent studies on the Mediterranean *Episinus* disclosed the distinctness among closely related species. Now it is evident that *E. algiricus* have the epigynum longer than wide and internal genetalia shows that the fertilization tubes are thicker, robust and having more loops. *E. pentagonalis* has got copulatory ducts which are highly sclerotised than others. The size and shape of spermatheca similar with *E. maculipes* to some extent but looping pattern of copulatory ducts are different. The epigynal cavity of *E. pentagonalis* is spacious but narrower than other species as evident from measurements.

**ACKNOWLEDGEMENTS**

I thank Dr. Barbara Knoflatch of University of Innsbruck, Austria, for supplying her reprints on Mediterranean Theridiidae and for some valuable comments on the present species.

**LITERATURE CITED**


Figures 3a. Tarsal claws of the female, 3b. Palpal claw of the female, 3c. Cheleceral fang of the female. 4. Abdominal area covering spinners. 5. Frontal view of ocular area, clypeus, and chelecera.


Figure 10. Dorsal habitus of adult female in situ.
THE CAUSES OF DECLINE OF HOUSE SPARROW
(PASSER DOMESTICUS, LINNAEUS 1758) IN URBAN AND SUBURBAN AREAS OF JAMMU REGION, J & K.

Rajan Singh*, Deep Noval Kour*, Fareed Ahmed* and D. N. Sahi*  

* Department of Zoology, University of Jammu, Jammu, J & K (INDIA), 180006. E-mail: rsthakurlibra@gmail.com


ABSTRACT: The house sparrow (Passer domesticus) belonging to the family Passeridae is the most widely distributed land bird in the world. In India, it is distributed all over up to 4000 m in the Himalayas. In the recent times, its population had declined drastically in Europe and other countries of the world. In India its number has also reported decreased in many cities of Andhra Pradesh, Kerala, West Bengal and coastal areas. In urban and suburban areas of Jammu, its population has been found to decrease drastically in the past 10 years. The study is carried from March 2009 to March 2013 to find out the cause of decline in these areas. The lack of nesting sites in the modern concrete houses and decrease in number of mud houses was found to be the main cause of decline. The lacking of spiny shrubs and trees less than 7 ft. height most preferred by House Sparrow as roosting sites, lack of animal diet in early stage of nestling diet and intense competition for nesting sites from birds like Common Myna, Red-rumped swallow etc. were other major causes of decline reported. Other probable causes reported are electromagnetic radiations from mobile towers, predation and lack of water sites.

KEY WORDS: House sparrow, Passeridae, drastically, decline, competition.

The house sparrow (Passer domesticus) is a member of the family Passeridae. House sparrows are abundant near human habitations. The house sparrow has a historical commensal relationship with man and has followed his colonisation of the majority of the earth. It is the most widely distributed land birds in the world, Summers & Smith (1988). It is associated with human habitations e.g. agricultural land, villages and urban areas. It is primarily a seed eater but requires insects and their larvae in the breeding seasons, Lowther & Clink (1992). Despite this historical success, the species has been declining since the early 1980s at several parts of the globe, including many countries across Europe reported by Crick et al. (2002), Prowse (2002), Vincent et al. (2002), Kelcey & Rheinwald (2005), Murgui & Macias (2010), Kekkonen et al. (2011), in North America by Erskine (2006), Lowther (2006), in Australia by Olsen et al. (2003). Robinson et al. (2005) and De Laet & Summers-Smith (2007) reported that this phenomenon is especially well documented in Britain where the most drastic declines have been detected, particularly in urbanized areas. As a result, according to Baillie et al. (2010), the house sparrow is now listed as a species of conservation concern in Europe (SPEC category 3) and of special conservation concern (Red List) in Britain. Chamberlain et al. 2009, Robinson et al. (2005) and Erskine (2006) reported that the timing and rate of decline was found to differ between rural and urbanized populations, De Laet & Summers-Smith (2007) and Shaw et al. (2008) suggested that different mechanisms are driving population trends in different habitats with respect to urbanization.
According to Dandapat et al. (2010), in India, the number of house sparrows has decreased dramatically in several parts of the country especially across Bangalore, Mumbai, Hyderabad and other cities. Ornithologist Survey conducted by Indian Council of Agricultural Research has reported that the sparrow population in Andhra Pradesh alone has dropped by 80% and in other states like Kerala, Gujarat and Rajasthan, it has dipped by 20%, while the decline in coastal areas was as sharp as 70% to 80%. According to the survey at different places of India on the occurrences of house sparrow, it was reported by Rajashekar & Venkatesha (2008), Daniels (2008), Khera et al. (2010), Bhattacharya et al. (2010), Ghosh et al. (2010) that their population has decreased considerably at present. Gulati (2005) reported that once widely distributed species in most parts of Europe and Asia slowly disappearing from urban areas.

In urban and suburban regions of Jammu region, there has been observed a drastic decline of house sparrow. The house sparrow which was once was commonly seen, it has become difficult to locate this bird in the region.

The present communication aims to establish the reasons for the dramatic decline in the population of house sparrows in some urban areas of Jammu division so that in the future, appropriate management strategies could be planned out to conserve this significant bird which is a useful scavenger.

**MATERIAL AND METHODS**

**Study Area:** The study was carried out in urban, suburban and rural areas of Jammu region. Geographically, Jammu lies between 32° 27’ and 33° 50” North latitudes and 74° 19’ and 75° 20” East longitudes. Attitudinally, it extends from 250 meters to 410 meters above the mean sea level. The climatic conditions in and around the study area are dry sub-humid to arid. There are four well marked seasons in a year, winter, summer, Monsoon and autumn. January is generally the coldest month while May and June are the hottest ones. Jammu city is the main urban area in Jammu district. The flora of urban areas is dominated by natural as well as exotic species. Predominant native plant species in the study area are *Ficus bengalensis, Ficus religiosa* (Peepal), *Dalbergia sisoo, Mangifera indica, Acacia modesta, Acacia arabica, Zizyphus species, Gravillea robusta* (Pallavi), *Cannabis sativa* (Bhang), *Dedonia viscose*, etc.

**Methodology:** The study was conducted over a period of two years (March 2009 to March 2013). Regular field trips were made throughout this period at regular intervals of one or two days. The status of house sparrows was determined by comparing the population pattern in different localities. Line Transect and Point Count Method were applied for enumerating the population of house sparrows. The birds were observed with naked eye and through binoculars (Bushnell 7X 50 U.S.A. made) whenever found necessary to record the data from quite a long distance in order to avoid any interference to birds due to the presence of observer. Photographs were taken with the aid of Canon EOS camera fitted with 300 mm zoom lens, digital camera and video camera.

**Statistical Analysis:** Pearson Co-relation co-efficient (R) was used to find positive and negative relationship between variables.

**RESULTS**

Urbanisation has complex direct and indirect effects on native flora and fauna. The number of house sparrows in urban areas of Jammu region has declined dramatically. The reasons for decline of population are as under-
1. Lack of nesting sites in modern houses:

To study effect of new modern buildings on nesting sites of house sparrow, census of houses and number of nests was done in Jekhane of Udhampur town for a period of five years from March 2009 to March 2013 (Fig. 1). The number of mud houses decreased during the period was 44.44% and decrease in nest count is 64.33%. The increase in concrete houses during the study period was 60.55%. The value of Pearson Coefficient (R) found were R = 0.97 (co-relation between no. of mud houses and nest counts) and R = -0.98 (co-relation between no. of concrete houses and nest count).

2. Increasing competition for nesting sites:

Five locations were selected to study the impact of completion for nesting sites with other birds of the region. The number of cases where house sparrow was forced to leave its nesting site by other birds was counted (Fig. 3). Common Myna is the biggest competitor (48%, n=489) of house sparrow for nesting sites in urban areas as shown in (Fig. 4).

3. Lack of Roosting sites:

During the study period, survey was carried on 447 roosting groups of house sparrow in rural and some suburban regions of Jammu to find the vegetation type preference for roosting. House sparrow used shrubs and trees less than 7 ft. height as dominant vegetation for roosting (Figs. 5 & 6). The roosting trees used by house sparrow in rural regions of Jammu are Punica granatum, Berberis aristata, Aegle marmelos, Berberis lyceum, Carissa opaca, Rubus elliptica, Populus cilata, Salix alba, Spiraea canescens, Ziziphus mauritiana, Pyrus pashia, Morus alba. The common vegetation used in urban regions are Ficus bengalensis, Ficus religiosa, Dalbergia sisoo, Mangifera indica, Acacia modesta, Acacia arabica, Zizyphus species, Berberis artiata, Punica granatum, Populus ciliate etc.

4. Effect of mobile towers on density of house sparrow:

To study the effect of mobile towers on house sparrow behaviour, six rural sites at Tehsil Chenani District Udhampur were selected where newly mobile towers were constructed. The no. of houses, nests and mobile tower were counted in March 2009 (Fig. 7). The number of houses, nests and mobile tower are again counted in the following breeding seasons and tabulated (Fig. 8). There is 17.61% decrease in number of of total nests.

5. Increase of predation:

Due to lack of nesting sites, sparrow is forced to form nests in tree holes and outside human habitations where it fell easy prey to predator birds like owl, crow and reptiles like snakes. During this period, two cases were noticed where Rat snake eat the chicks of house sparrow.

6. Shortage of food:

A study was carried on diet of nestling in rural and urban areas. The nestling of urban areas was found to eat less animal diet as compared to rural nestling and increase in mass was found to be far less. The number of nestling fledged successfully was less in urban areas than rural areas.

7. Lack of Water sites:

The urban areas of Jammu face acute shortage of water during summer season when temperature touches 45° C. During this period, water is not easily available to house sparrow. The modern houses lack water containing wooden boxes, mud boxes and earthen pots.
DISCUSSIONS

The house sparrow has undergone a drastic decline in the last 25 years across the world. It is included in the red list that means high conservation concern. The present decline in house sparrow number appears to be widespread all over the world. Many reasons have been suggested including the widespread use of garden pesticides resulting in the absence of insects needed by newborn sparrows. Joshi (2009) reported changes in agricultural practices, in particular the shift to monoculture crop planting have been suggested as the main cause of decline.

The major cause of decline is the lack of nesting sites. The modern houses are cemented and lack holes. The count of mud houses and nests of house sparrow was found positively co-related during the study period (R=0.97). A strong positive co-relation between mud houses and nests count is found since the value is near 1. The count of concrete houses and nests of house sparrow was found negatively co-related during the study period (R=-0.98). A strong negative co-relation between mud houses and nests count is found since the value is near 1. Due to lack of nesting sites, house sparrow is forced to make nest on trees and tree holes. During the study period, two nests of sparrow were found on trees Salix Alba. Dandapat et al. (2010) reported that decline is due to lack of holes for nesting in modern houses. Raghavendra Rao (2000), Denis Summer-Smith (2003), Cramp et al. (1985) reported that among all, one of the prime reasons is declining nesting sites in urban and suburban region.

Due to lack of nesting sites, house sparrow is facing a tough challenge in urban areas from other birds like Indian Myna, Bank myna, Brahminy Myna, Red-rumped swallow Indian Blue Rock Pigeon etc. for the available nesting sites. House sparrow being small in size and less aggressive always has to sacrifice its nesting sites to other birds.

Due to extensive urbanisation and development in urban and suburban regions of Jammu, the vegetation which was used by house sparrow for roosting have now been replaced by concrete buildings, walls, playgrounds, wire fences etc. These vegetation are important sites for sparrow as they use it for roosting, resting, preening their feathers and protection from predators. Thus sparrow is declining and shifting from urban regions.

To study the impact of electromagnetic radiation (mobile towers), rural sites were selected where the availability of nesting sites, food, roosting sites, water is available in plenty. The competition for nesting sites, food and risk of predation is also less. So in such places, the population should increase. But the population found to decrease. The maximum decrease in nests found in Motorshed (30%) where maximum number of mobile towers i.e. 5 were operational. The reduction in mud houses at this station was only 9%. The lack of nesting sites and electromagnetic radiations were possible cause of maximum decline of House sparrow at this station. Joris Everaert & Dirk Bauwens (2007) showed that fewer house sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of house sparrows in the wild.

The lack of the insect food is one of the main causes of decline of house sparrow on which the young ones of sparrow exclusively feed for first 15 days. The lack of insects is due to the lack of vegetation in urban areas. The food providing plants are replaced by human settlements. There is. The house sparrow has to travel long distance to get food. Kate Vincent (2005) reported the high rate of starvation of chick and low body masses at fledgings in suburban regions of
Britain as main causes of decline of house sparrow. He also reported that scarcity in the larvae which feed on leaves of plants reason as one of the main cause of population decline of *Passer domesticus*.

Crick et al. (2002) reported that suburban sparrows were found to experience higher nest failure rates and Peach et al. (2008) explained that it mostly due to reduced nestling survival compared to their rural counterparts in Britain, thus decreased reproductive success has been suggested to account for the decline of urbanized populations. Several reasons have been proposed for the reproductive failure of urban sparrows. First, nestlings require an arthropod diet, and parents may be unable to find nestling food of sufficient quantity and/or quality due to the scarcity of native vegetation. According to Shaw et al. (2008) recent development of cities often results in losses of green space such as gardens being replaced by paved parking lots. Southwood (1961) reported even existing vegetation may harbor poor insect fauna if it consists mainly of exotic or evergreen plants. Supporting this view, Peach et al. (2008) carried a study in and around the city of Leicester, Britain found that the survival of sparrow nestlings correlated negatively with high amounts of vegetable material in their diet and positively with high abundance of aphids around the nest. Second, according to Summers-Smith (2007), arthropod density may be reduced in cities by environmental pollution, especially traffic emissions. Raupp et al. (2010), Zvereva & Kozlov (2010) reported although the effects of traffic related air pollutants on animals are not well understood, they may affect invertebrates. Eeva et al. (2003), Swaileh & Sansur (2006) reported they might also have direct adverse impact on vertebrates such as the nestlings and adult birds.

Dandapat et al. (2010) reported introduction of unleaded petrol, use of chemically treated seeds, flow of electromagnetic waves from cellphone towers, reducing areas of free growing weeds or reducing numbers of badly maintained buildings, competition for food by other species etc. are possible reasons for this disappearance. Thus present study gives firm evidences to some of these causes. He also observed that other birds like pigeons, crows, mynas eat seed and are in direct competition with sparrow. Moreover, he is of the view that the availability of grains in pre- cleaned and packed packets has lead to the disappearance of larvae thereby depriving the sparrow of food.

Thus a single reason is not responsible for cause of the decline of House sparrow in urban and suburban region of Jammu. A combination of several factors is responsible for the urban declines of house sparrows.

**LITERATURE CITED**


<table>
<thead>
<tr>
<th>Year</th>
<th>No. of mud houses</th>
<th>No. of concrete houses</th>
<th>Total Houses</th>
<th>Nest count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-2009</td>
<td>90</td>
<td>180</td>
<td>270</td>
<td>157</td>
</tr>
<tr>
<td>Mar-2010</td>
<td>81</td>
<td>201</td>
<td>282</td>
<td>151</td>
</tr>
<tr>
<td>Mar-2011</td>
<td>72</td>
<td>235</td>
<td>307</td>
<td>120</td>
</tr>
<tr>
<td>Mar-2012</td>
<td>52</td>
<td>280</td>
<td>332</td>
<td>82</td>
</tr>
<tr>
<td>Mar-2013</td>
<td>50</td>
<td>289</td>
<td>339</td>
<td>56</td>
</tr>
<tr>
<td>TOTAL</td>
<td>345</td>
<td>1185</td>
<td>1530</td>
<td>566</td>
</tr>
</tbody>
</table>

R (no. of mud houses v/s nest counts) = 0.97
R (no. of concrete houses v/s nest count) = -0.98

Figure 1. Table showing the year wise data of mud houses, concrete houses and Jekhane area of Udhampur Town.
Figure 2. The graph shows the relation between number of nests, mud houses and concrete houses during the study period.

<table>
<thead>
<tr>
<th>Location</th>
<th>Name of Birds competitor for nesting sites</th>
<th>No. of nests studied</th>
<th>No. of case House Sparrow was thrashed out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jewel</td>
<td>Indian Myna <em>Acridotheres tristis tristis</em></td>
<td>123</td>
<td>12</td>
</tr>
<tr>
<td>Bag-e- Bahu</td>
<td>Bank myna <em>Acridotheres ginginianus</em></td>
<td>80</td>
<td>4</td>
</tr>
<tr>
<td>Chenani</td>
<td>Brahminy Myna <em>Sturnus pagodarum</em></td>
<td>123</td>
<td>2</td>
</tr>
<tr>
<td>Udhampur</td>
<td>Red-rumped swallow <em>Hirundo daurica</em></td>
<td>76</td>
<td>5</td>
</tr>
<tr>
<td>ReharChungi</td>
<td>Indian Blue Rock Pigeon <em>Columbia livia</em></td>
<td>87</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>489</td>
<td>25</td>
</tr>
</tbody>
</table>

Figure 3. Table showing the main competitors for nesting sites of House Sparrow at different locations.

Figure 4. Pie diagram showing % competitor for nesting sites of House Sparrow in different locations of Jammu division.
<table>
<thead>
<tr>
<th>Height of vegetation</th>
<th>No. of House Sparrow groups roosted</th>
</tr>
</thead>
<tbody>
<tr>
<td>shrubs and trees &lt; 7 ft.</td>
<td>262</td>
</tr>
<tr>
<td>trees between 7-15 ft</td>
<td>89</td>
</tr>
<tr>
<td>Trees &gt;15 ft</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>447</td>
</tr>
</tbody>
</table>

Figure 5. Table showing type of vegetation used by House Sparrow roosting groups in some rural and urban regions of Jammu.

![Pie diagram showing relative percentage of type of vegetation and height used by roosting groups of House sparrow for roosting locations of Jammu division.](image)

Figure 6. Pie diagram showing relative percentage of type of vegetation and height used by roosting groups of House sparrow for roosting locations of Jammu division.

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Houses within 500 m approx.</th>
<th>No. of nests</th>
<th>No. of towers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mud</td>
<td>Cemented</td>
<td>Total</td>
</tr>
<tr>
<td>Sewna</td>
<td>49</td>
<td>3</td>
<td>52</td>
</tr>
<tr>
<td>Motorshed</td>
<td>40</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>Mandal</td>
<td>32</td>
<td>4</td>
<td>36</td>
</tr>
<tr>
<td>Mantalai</td>
<td>38</td>
<td>5</td>
<td>43</td>
</tr>
<tr>
<td>Sudhmahadev</td>
<td>53</td>
<td>12</td>
<td>65</td>
</tr>
<tr>
<td>Karlaw</td>
<td>16</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>228</td>
<td>38</td>
<td>266</td>
</tr>
</tbody>
</table>

Figure 7. Table showing census of houses, nests/breeding pairs of House Sparrow and mobile towers of five sites at Tehsil Chenani in March 2009.

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Houses within 500 m approx.</th>
<th>No. of nests</th>
<th>No. of towers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mud</td>
<td>Cemented</td>
<td>Total</td>
</tr>
<tr>
<td>Sewna</td>
<td>47</td>
<td>12</td>
<td>59</td>
</tr>
<tr>
<td>Motorshed</td>
<td>36</td>
<td>9</td>
<td>45</td>
</tr>
<tr>
<td>Mandal</td>
<td>38</td>
<td>11</td>
<td>49</td>
</tr>
<tr>
<td>Mantalai</td>
<td>42</td>
<td>10</td>
<td>52</td>
</tr>
<tr>
<td>Sudhmahadev</td>
<td>50</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>Karlaw</td>
<td>25</td>
<td>13</td>
<td>38</td>
</tr>
<tr>
<td>Total</td>
<td>228</td>
<td>85</td>
<td>322</td>
</tr>
</tbody>
</table>

Figure 8. Table showing census of houses, nests/breeding pairs of House Sparrow and mobile towers of five sites at Tehsil Chenani in March 2013.
HYPOPYGIA OF THE HERCyna SPECIES GROUP OF ENTedON DALMAN (HYMENOPTERA: EULOPHIDAE), WITH DESCRIPTIONS OF NEW SPECIES

Mikdat Doğanlar* and Oğuzhan Doğanlar**

* Mustafa Kemal Üniversity, Faculty of Agriculture, Department of Plant Protection, TR-31034, Hatay, TURKEY. E-mail: doganlar@mku.edu.tr
** Trakya University, Medical school, Department of Medical Biology, 22030, Edirne, TURKEY. E-mail: doganlaro@yahoo.com.tr


ABSTRACT: Seven species of the hercyna species group of genus Entedon Dalman (Hymenoptera: Eulophidae: Entedoninae) were collected in Turkey: E. ergias Walker, E. procioni Erdős, E. calcicola Graham, E. hercyna Walker, E. diotimus Walker, and the new species, E. akdagic and E. nevsehiric. Hypopygia of the species, except E. calcicola and E. nevsehiric, were studied. Identification key to the Turkish species of the hercyna species group of Entedon were provided.

KEY WORDS: Hymenoptera (Eulophidae), hercyna species group of Entedon, Turkey.

The hercyna species group of Entedon was proposed by Graham (1971) for the association of Entedon hercyna Walker, 1839, Entedon ulicis (Perris, 1840), Entedon heyeri (Ratzeburg, 1848), E. gracilior Graham, 1971, E. calcicola Graham, 1971, and Entedon diotimus Walker, Entedon ?loti Erdős and ?Entedon molybdaenus Erdős in the diotimus species group, as a separate group. Graham (1971) revised the species of the group, and stated that the species sharing the characters as follow: frons without or with short impressed lines; oral fossa relatively small, 1.8-2.4 times malar space; anterior margin of clypeus truncate or slightly curved; fore tibia with two white longitudinal stripes; forewing immaculate, speculum open below, marginal vein not, or not much thickened; head relatively less transverse in dorsal view, at most 2.35 times as broad as long.


Gumovsky(1997) revised the species of hercyna species group, and gave the diagnostic characters as follow: anterior margin of clypeus truncate, fore tibiae with two white strips or wholly darkened, occipital margin mostly sharp, forming more or less raising crest with pronounced, rounded off peaks, male metasoma sometimes with pale basal spot, stated that this group includes E. hercyna, E. apionis Erdős, E. procioni Erdős, E. gracilarion Graham, E. reticulatus Erdős, E. calcicola Graham, 1971, E. ulicis Perris, E. heyeri (Ratzeburg), E. abdera Walker,1839, E. ukranicus Gumovsky, E. ergias Walker, E. diotimus Walker, E. alveolatus Gumovsky; E. pini Yang, E. broussonetiae Yang, E. pumilae Yang, E. tumiditempli Yang, E. wilsonii Yang, Nearctic E. ashmeadi Schauff, E. bigeloviae Ashmead, E. columbianus Ashmead, E. genei Schauff, E. leucopus (Ashmead), E.
pecki Schau, E. procerus Schau, E. robustus (Crawford), E. tachypterelli Gahan and E. teedoe Schau.


Gumovsky & Boyadzhiev (2003) gave the diagnostic characters of the hercyna group by adding the species with fore tibiae darkened completely, the characters are: both sexes. Frontal sulcus absent (or weakly traced as short smooth stripes), clypeus truncate; occipital margin somewhat sharpened, gena evenly curved, propodeal spiracular elevation delimited only laterally (lateral sulcus incomplete), submedian areas not convex, median propodeal carina weakly raised, with more or less expressed furrows along; petiole reduced to narrow band; fore tibia with two pale stripes (most species), or (E. diotimus, E. abdera and some allied species) completely darkened; trochanters darkened; subcosta of submarginal vein bearing normally 2, but occasionally 3 (E. apionis Erdős) setae on its dorsal surface; speculum closed or open and may be a subject for sexual dimorphism. Males. Funicle 4- or 3-segmented, often last two flagellar segments fused, but with deep constriction, metasoma occasionally with pale subbasal spot, they recorded 6 species of the hercyna group, E. hercyna, E. proconi, E. gracilior, E. heyeri, E. abdera, E. diotimus and E. Ergias in species complex squamosus of perturbatus group from Bulgaria.

In Turkey, Doğanlar (1985) recorded E. calcicola, E. hercyna, and E. molybdaenus from the hercyna species group and some other species of Entedon in Erzurum, the Eastern Anatolia.


In this work the morphology of hypopygia and some other morphological characters of the species in the hercyna species group of Entedon were treated as diagnostic characters for the systematic of the species from Turkey, and the new species were described. Aids of some morphological characters a new identification key was created for the species of the hercyna species group of Entedon in Turkey.

**MATERIAL AND METHOD**

This study is based upon examination and identification of the specimens collected from several parts of Turkey. The examined specimens were deposited in Insect Museum of Plant Protection Department, Agriculture Faculty, Mustafa
Kemal University, Antakya, Hatay, Turkey (MKUI). Specimens were collected by sweeping and putting the whole contents of the swept materials directly in 96% ethanol. After sorting the material, individuals were mounted on cards for further morphological studies. The species were identified by following the keys of Graham (1971), Gumovsky (1999) and Gumovsky & Boyadzhiev (2003). The hypopygia were separated from metasoma by dissecting and slide mounted in Canada balsam, the other parts of the metasoma were replaced on its own card near its mesosoma. Wings and antennae of some paratypes were slide-mounted in Canada balsam. Photographs of diagnostic characters of the genera were taken by using of Leica DM 5500 B microscopes with a digital Leica DFC 295 camera attached to it.

Terminology and abbreviations

Morphological terminology follows Graham (1969) and Doğanlar & Doğanlar (2012) in hypopygia as in Fig. 1, Gibson (1997) and Gumovsky & Boyadzhiev (2003). Abbreviations used in the key and descriptions are: OOL= shorter distance between ocello-ocular line, POL= distance between posterior ocelli, F1-4 = funicular segments C1-C2 claval segments. The name of some parts of hypopygium given in Fig. 1.

RESULTS AND DISCUSSION

Key to female of the species of the hercyna species group of Entedon

1- Fore tibia wholly darkened; speculum closed..............................................................2
-- Fore tibia with two distinct longitudinal pale stripes; the other characters variable......3

2- Antenna (Fig. 5a) with F1 of female as long as pedicel; scape 5.6 times as long as broad;
clava 2.6 times as long as broad, C1 2.14 times as long as C2. Hypopygium (Figs. 5d, e)
with anterior median incision broadly C-shaped, antero-lateral angle straight; anterior
lobe narrow, distally angular, posterior lobe almost circular, hypopygium 5.7 times as
broad as median length; median sclerotized line complete, median sclerotized area
almost circular; posterior median incision as in Fig. 5e. Flagellum of male (Fig. 5f) with
3-segmented funicle and 2-segmented clava; Smaller species, 1.6-2.2 mm........................
..................................................................................................................E. diotimus Walker

- Antenna (Fig. 6a) with F1 of female longer than pedicel, scape 4.22 times as long as broad;
clava 1.67 times as long as broad; C1 1.2 times as long as C2. Hypopygium (Figs. 6d, e)
with anterior median incision straight, antero-lateral angle circular; anterior lobe
narrow, distally circular, posterior lobe almost straight apically, hypopygium almost 4
times as broad as median length; median sclerotized line reaching only posterior 2/5 of
hypopygium, median sclerotized area almost V-shaped; posterior median incision as in
Fig. 6e..................................................................................................................E. nevsehiricus n. sp.

3- At most proximal 1/2 of hind and mid tibiae darkened (Figs. 2c, d)............................4
- Hind and mid tibiae broadly darkened, sometimes just their extreme tips pale (Figs. 3b,
c)......................................................................................................................................6

4- Hind (posterior) ocellus equidistant from both, inner eye margin and occipital margin;
hypopygium (Figs. 2e, f) with anterior median incision broadly W-shaped, antero-lateral
angle broadly circular; anterior lobe broad, distally circular, posterior lobe almost
circular, apically narrowing; hypopygium almost 5.6 times as broad as median length;
median sclerotized line complete, median sclerotized area almost triangular; posterior
median incision as in Fig. 2f. Female antenna with scape 5.5x, pedicel twice, F1 3x, F2
1.5x, F3 1.36x, clava 2.14x as long as broad, C1 twice C2. Flagellum of male antenna with
5 separate segments, scape 3x, pedicel 1.4x, F1 3.36x, F2 2x, F3 1.9, F4 1.84x, clava 3.3x
as long as broad; male metasoma with broad pale subbasal spot, metasoma with petiole conical, about as long as broad ............................... \textit{E. ergias} Walker

Distance between hind (posterior) ocellus and occipital margin shorter than distance between the ocellus and inner eye margin.......................................................... 5

5- Metasoma (Fig. 7d) as long as head plus mesosoma, 1.6 times as long as broad; Female antenna (Fig. 7a) with scape 3.9x, pedicel 2.1x, F1 1.6x, F2 1.5x, F3 1.2x, clava 2.1x as long as broad, C1 1.33x C2. Propodeum reticulate, especially near median carina.............

.................................................................................. \textit{E. calcicola} Graham

- Metasoma (Fig. 8d) about 1.3 times as long as head plus mesosoma, 2.67 times as long as broad. Female antenna (Fig. 8a) with scape 5.14x, pedicel 1.9x, F1 1.8x, F2 1.67x, F3 1.67x, clava 2.1x as long as broad, C1 1.22x C2. Propodeum smooth.................................................. \textit{E. akdagicus} n. sp.

6- Female metasoma elongate, 2.7-3.0 times as long as broad, Female antenna (Fig. 3a) with scape 5.7x, pedicel 2.14x, F1 2x, F2 1.9x, F3 1.55x, clava 2.1x as long as broad, C1 1.44x C2. Hypopygium (Figs. 3d, e) with anterior median incision shallow, broadly C-shaped, antero-lateral angle almost straight; anterior lobe broad, distally narrow, posterior lobe almost circular, hypopygium almost 3.4 times as broad as median length; median sclerotized line complete, median sclerotized area distinctly longer than broad; posterior median incision as in Fig. 3e........................................ .............................. \textit{E. hercyna} Walker

- Female metasoma at most 2.5 times as long as broad; Female antenna (Fig. 4 a) with scape 5x, pedicel 1.87x, F1 2.25x, F2 1.87x, F3 1.4x, clava 1.6x as long as broad, C1 equal to C2. Hypopygium (Figs. 4d, e) with anterior median incision broadly V-shaped, antero-lateral angle straight; anterior lobe narrow, distally circular, posterior lobe circular, hypopygium almost 3 times as broad as median length; median sclerotized line reaching only posterior half of hypopygium, median sclerotized area almost V-shaped; posterior median incision as in Fig. 4 e. antennal flagellum of male (Fig. 4f) with two apical segments fused (3-segmented funicle and 2-segmented clava), antenna with scape 1.94x, pedicel 1.67x, F1 2.4x, F2 1.7x, F3 1.36x, clava 2.5x as long as broad, C1 equal to C2.; larger species. 2.3-3.1 mm.............................................................. \textit{E. proconi} Erdös

\textbf{Entedon ergias} Walker, 1839  
(Figs. 2a-f)

\textit{Entedon tenuitaris} Thomson, Giritz, 1959a: 211.
\textit{Entedon tenuitaris} Thomson, Giritz, 1959b: 52.
\textit{Entedon leucogramma} Ratzeburg, 1844: 170.
\textit{Entedon leucogramma} Ratzeburg (misspelling of \textit{leucogramma}), Erdös, 1944: 42.
\textit{Eulophus albipes} Ratzeburg, 1844: 165.
\textit{Entedon albipes} Ratzeburg, 1848: 166.

\textbf{Diagnosis:} At most proximal 1/2 of hind and mid tibiae darkened (Figs. 2c, d); Hind (posterior) ocellus equidistant from both, inner eye margin and occipital margin; hypopygium (Figs. 2e, f) with anterior median incision broadly W-shaped, antero-lateral angle broadly circular; anterior lobe broad, distally circular, posterior lobe almost circular, apically narrowing; hypopygium almost 5.6 times as broad as median length; median sclerotized line complete, median sclerotized area almost triangular; posterior median incision as in Fig. 2f. Female antenna (Fig. 2a) with scape 5.5x, pedicel twice, F1 3x, F2 1.5x, F3 1.36x, clava 2.14x as long as broad, C1 twice C2. Flagellum of male antenna (Fig. 2b) with 5 separate segments, scape 3x, pedicel 1.4x, F1 3.36x, F2 2x, F3 1.9, F4 1.84x, clava 3.3x as long as broad; male metasoma with broad pale subbasal spot, metasoma...
with petiole conical, about as long as broad. Male: Antennae with funicle four-segmented, scape 3.2 times as long as broad, pedicel almost quadrate, 2.75 times as long as F1; the latter 1.9 times as long as broad, F2 and F3 distally petiolate, twice as long as broad, F4 ellipsoidal, 2.14 times as long as broad; clava including spicula thrice as long as broad; basal 1/5 of mid tibiae and basal 1/2 of hind tibiae dark.

**Material examined:** Turkey: Hatay, Belen., 1♀, 24. iv. 2008, swept from pasture (M. Doğanlar); Erzurum, 1♀, 05.vii. 1984, reared from branch of *Pyrus communis* (M. Doğanlar); Aktaş, 1♀, 25.vii. 1982, swept from pasture (M. Doğanlar); Antalya, 2♀♂, 1♀♂, 00.vi. 1984, reared from branch of *Olea europaea* (A. Yayla); Germany, Bad Soden, Salmünster, 4♀♂, 27.vii.1983 (R. Schopf). 5♀♂, 5♀♂, 14. Vi-26.viii. 1983, reared from branch of *Quercus* sp. (M. Doğanlar); Reinhausen, 2♀♂, 1♀♂, 12.vi.1983, reared from branch of *Quercus* sp. (M. Doğanlar).


**Distribution:** Western and Central Europe, Far East Russia, Japan, Korea (Boucek & Askew, 1968; Gumovsky, 1998; Gumovsky & Boyadzhiev, 2003); Turkey (New record).

**Hosts.** Xylophagous beetles, mainly from Scolytinae (Curculionidae) (Bouček & Askew, 1968).

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**Entedon hercyna Walker 1839**

(Figs. 3a-e)

*Entedon hercyna* Walker, 1839: 104.
*Entedon elongates* Thomson, 1878: 246.

**Diagnosis:** Hind and mid tibiae broadly darkened, sometimes just their extreme tips pale (Figs. 3b, c); Female metasoma elongate, 2.7-3.0 times as long as broad, female antenna (Fig. 3a) with scape 5.7x, pedicel 2.14x, F1 2x, F2 1.9x, F3 1.55x, clava 2.1x as long as broad, C1 1.44x C2. first funicular segment of female at most 2.5 times as long as broad, hypopygium (Figs. 3d, e) with anterior median incision shallow, broadly C-shaped, antero-lateral angle almost straight; anterior lobe broad, distally narrow, posterior lobe almost circular, hypopygium almost 3.4 times as broad as median length; median sclerotized line complete, median sclerotized area distinctly longer than broad; posterior median incision as in Fig. 3e.

**Material examined:** Turkey: Erzurum, 1♀, 25.vi. 1988, swept from pasture (M. Doğanlar); 2♀♂, 26.vi. 1979, swept from pasture (M. Doğanlar); 1♀, 08. ix. 1989, swept from pasture (H. Özbek).

**Host:** Unknown.

**Distribution.** Europe (Graham, 1971; Bouček & Askew, 1968; Trjapitzin, 1978); Turkey, Erzurum, (Doğanlar, 1985).

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**Entedon procioni Erdős, 1944**

(Figs. 4a-f)

*Entedon procioni* Erdős, 1944: 33.
*Entedon molybdaenus* Erdős, 1944: 59.
*Entedon urticarii* Erdős, 1951: 216.
*Entedon meliloti* Askew, 1992: 123.
Entedon (Entedon) procioni Erdős, Gumovsky, 1999: 32.

**Diagnosis:** Hind and mid tibiae broadly darkened, sometimes just their extreme tips pale (Figs. 4b, c); Female metasoma at most 2.5 times as long as broad; Female antenna (Fig. 4a) with scape 5x, pedicel 1.87x, F1 2.25x, F2 1.87x, F3 1.4x, clava 1.9x as long as broad, C1 equal to C2. Female metasoma 1.5-2.5 times as long as broad; hypopygium (Figs. 4d, e) with anterior median incision broadly V-shaped, antero-lateral angle straight; anterior lobe narrow, distally circular, posterior lobe circular, hypopygium almost 3 times as broad as median length; median sclerotized line reaching only posterior half of hypopygium, median sclerotized area almost V-shaped; posterior median incision as in Fig. 4e. Antennal flagellum of male (Fig. 4f) with two apical segments fused (3-segmented funicle and 2-segmented clava), antenna with scape 1.94x, pedicel 1.67x, F1 2.4x, F2 1.7x, F3 1.36x, clava 2.5x as long as broad, C1 equal to C2.

**Material examined:** Turkey: Erzurum, 21♀♀, 1♂, 26. vi. 1979, swept from pasture (M. Doğanlar); Horasan, 1♂, 20. v. 1989, swept from pasture (M. Doğanlar); Erzincan, 1♂, 09.v. 1982, swept from pasture (M. Doğanlar).

**Hosts.** Apion–species (Apionidae) inhabiting stems of Urtica, Melilotus and some other plants (Gumovsky, 1999a).


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Entedon diotimus Walker, 1839

(Figs. 5 a-f)

**Entedon loti** Erdős, 1944: 41-42.
**Entedon transversalis** Erdős, 1944: 55.
**Entedon (Entedon) diotimus** Walker, Gumovsky, 1999: 29.

**Diagnosis:** Tibiae wholly darkened (Fig. 5b, c); speculum closed; Antennae (Fig. 5a) with F1 as long as pedicel; scape 5.6 times as long as broad; clava 2.6 times as long as broad, C1 2.14 times as long as C2. hypopygium (Figs. 5 d, e) with anterior median incision broadly C-shaped, antero-lateral angle straight; anterior lobe narrow, distally angular, posterior lobe almost circular, hypopygium 5.7 times as broad as median length; median sclerotized line complete, median sclerotized area almost circular; posterior median incision as in Fig. 5e. Flagellum of male (Fig. 5f) with 3-segmented funicle and 2-segmented clava.

**Material examined:** Turkey: Erzurum, 3♀♀, 26. vi. 1979, swept from Onobrycis sativa field (M. Doğanlar); Tortum, 1♂, 2♀♀, 26.v. 1982, swept from pasture (M. Doğanlar); Erzincan, Ekşisu, 1♀, 22.v. 1982, swept from pasture (M. Doğanlar); Niğde, Gümüş, 1♀, 16. vi. 2006, (M. Doğanlar); Çankırı, İlgaz Mt., Kadın Çayırı, 2♀♀, 02.viii.1987, swept from Onobrycis sativa field (M. Doğanlar).

**Hosts.** Reared from pods of Trifolium sp. and Lotus corniculatus L. (Graham, 1971). The Trifolium spp. and L. corniculatus are very common ruderal plants, so that the insects associated with these plants (e. g. E. diotimus) are very common in material collected in many areas. This species is likely a parasitoid of various Apion species, in particular with Apion loti (Kirby) in pods of Lotus corniculatus (Graham, 1971; Gumovsky, 1999).

**Distribution.** Widespread in the Palaearctic (Bouček & Askew, 1968; Gumovsky, 1999).
**Diagnosis:** Tibiae wholly darkened (Figs. 6b, c); speculum closed; antenna (Fig. 6a) with F1 longer than pedicel, scape 4.22 times as long as broad; clava 1.67 times as long as broad; C1 1.2 times as long as C2. Hypopygium (Figs. 6d, e) with anterior median incision straight, antero-lateral angle circular; anterior lobe narrow, distally circular, posterior lobe almost straight apically, hypopygium almost 4 times as broad as median length; median sclerotized line reaching only posterior 2/5 of hypopygium, median sclerotized area almost V-shaped; posterior median incision as in Fig. 6e.

**Description:** Female. Body length 1.8 mm. Color of body metallic dark greenish-blue. Entire antennae dark. Legs (Figs. 6b, c) dark, except knees, and first tarsomer of fore legs and first two tarsomer of mid and hind legs, which are pale.

Head in dorsal view 2.32 times as broad as long; POL 2.6 OOL. Occipital margin moderately sharp. Eye with short sparse setae, eye height 3.4 times as long as malar space. Head in front view 1.33 times as broad as long. Interocular distance 2.66 times as long as eye breadth. Malar sulcus indicated by a line. Breadth of mouth opening twice as long as malar space. Clypeus reticulate, its anterior margin truncate. Antennae inserted slightly above the level of ventral eye margin. Antenna (Fig. 6a) with F1 longer than pedicel, scape 4.22 times as long as broad; clava 1.67 times as long as broad; C1 1.2 times as long as C2.

Mesosoma 1.25 times as long as broad. Pronotal collar hardly traceable, posterolateral corners of pronotum evenly rounded. Mesoscutum 2.3 times as broad as long, notauli traceable anteriorly as very fine sutures, posteriorly as shallow depressions; scutellum as long as broad and 1.2 times as long as mesoscutum. Propodeal surface finely reticulate, median carina complete, lateral sulcus incomplete; supracoxal flange moderate; spiracular elevation with blunt projection below, propodeal callus with 3 long setae. Hind coxa reticulate dorsally. Fore femur about 5.4 times as long as broad, fore tibia 8.25 times as long as broad, and almost as long as its femur; mid femur 4.4 times as long as broad; mid tibia 7.0 times as long as broad, spur of mid tibia 1.5 times as long as breadth of tibia, 0.8 as long as dorsal margin of mid basitarsus; hind femur about 3.1 times as long as broad, hind tibia about 7.5 times as long as broad, spur of hind tibia about as long as breadth of its tibia, 0.75 times as long as dorsal margin of hind basitarsus. Hind tarsus 0.74 times as long as its tibia, mid tarsus 0.8 times as long as its tibia. Fore wing 1.95 times as long as broad; costal cell bare, comparatively wide, 6.6 times as long as broad, 0.82 times as long as marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein slightly shorter than stigmatic; speculum closed below; apical margin with very short fringe, setae of which half as long as width of marginal vein at its narrowest part. Hind wing 2.8 times as long as broad. Petiole reduced, strongly transverse. Metasoma as long as almost mesosoma, about 1.4 times as long as broad; penultimate tergite 0.33 times as long as basal broad, about one-sixth of length of the metasoma, last tergite about as long as broad. Hypopygium (Figs. 6d, e) with anterior median incision straight, antero-lateral angle circular; anterior lobe narrow, distally circular, posterior lobe almost straight apically, hypopygium almost 4 times as broad as median length; median sclerotized line reaching only posterior 2/5 of hypopygium, median sclerotized area almost V-shaped; posterior median incision as in Fig. 6e.
Male: unknown.

**Type material.** Holotype, ♀, Turkey: Nevşehir, 19. v. 2005, swept from pasture (M.& O. Doğanlar). (MKUI).

**Host:** unknown.

**Discussion:** Entedon nevsehiricus n. sp. is similar to *E. diotimus* in having fore tibiae wholly black, but it differs in having F1 of female longer than pedicel, scape 4.22 times as long as broad; clava 1.67 times as long as broad; C1 1.2 times as long as C2 (in *E. diotimus* F1 of female as long as pedicel; scape 5.6 times as long as broad; clava 2.6 times as long as broad, C1 2.14 times as long as C2); hypopygium (Figs. 2b, c) with anterior median incision straight, antero-lateral angle circular; anterior lobe narrow, distally circular, posterior lobe almost straight apically, hypopygium almost 4 times as broad as median length; median sclerotized line reaching only posterior 2/5 of hypopygium, median sclerotized area almost V-shaped; posterior median incision as in Fig. 6e (in *E. diotimus* hypopygium (Figs. 2b, c) with anterior median incision broadly C-shaped, antero-lateral angle straight; anterior lobe narrow, distally angular, posterior lobe almost circular, hypopygium 5.7 times as broad as median length; median sclerotized line complete, median sclerotized area almost circular; posterior median incision as in Fig. 2c).

**Entedon calcicola** Graham, 1971  
(Figs. 7a-d)


**Diagnosis:** Metasoma (Fig. 7d) as long as head plus mesosoma, 1.6 times as long as broad; antenna (Fig. 7a) with scape 3.9x, pedicel 2.1x, F1 1.6x, F2 1.5x, F3 1.2x, clava 2.1x as long as broad, C1 1.33x C2. Propodeum reticulate, especially near median carina; Distance between hind (posterior) ocellus and occipital margin shorter than distance between the ocellus and inner eye margin; Fore tibia with two distinct longitudinal pale stripes; at most proximal 1/2 of hind and mid tibiae darkened (Figs. 7b, c).

**Material examined:** Turkey: Adıyaman, from Pazarcık to Gölbaşı highway, connection to Araban Road, 1♀, 0♂, v. 2008, swept from pasture (M. Doğanlar).

**Hosts.** Unknown.

**Distribution.** England, Yugoslavia (Former) (Graham, 1971); Turkey (misidentification of *E. biroi* Erdős) (Doğanlar, 1985).

**Entedon akdagicus** n. sp.  
(Figs. 8a-d)

**Diagnosis:** Fore tibia with two distinct longitudinal pale stripes; at most proximal 1/2 of mid tibiae darkened (Fig. 8c); distance between hind (posterior) ocellus and occipital margin shorter than distance between the ocellus and inner eye margin; Metasoma (Fig. 8d) about 1.3 times as long as head plus mesosoma, 2.67 times as long as broad. Female antenna (Fig. 8a) with scape 5.14x, pedicel 1.9x, F1 1.8x, F2 1.67x, F3 1.67x, clava 2.1x as long as broad, C1 1.22x C2. Propodeum smooth.

**Description:** Female. Body (Fig. 8b) length 1.9 mm. Color of body metallic dark blue, Entire antennae dark. Legs (Fig. 8c) dark, except knees, apical 1/3 of tibiae of mid and hind legs, and first three tarsomeres of tarsi which are pale; pretarsi
pale brown. Dorsal and ventral pale longitudinal stripes on fore tibia discernible along entire tibia.

Head in dorsal view 2.25 times as broad as long; POL 2.5 OOL; occipital margin moderately sharp; distance between hind (posterior) ocellus and occipital margin shorter than distance between the ocellus and inner eye margin. Eye with short sparse setae, eye height 2.6 times as long as malar space. Head in front view 1.35 times as broad as long. Interocular distance 3.1 times as long as eye breadth. Malar sulcus indicated by a line. Breadth of mouth opening 1.7 times as long as malar space. Clypeus reticulate, its anterior margin truncate. Antennae inserted slightly above the level of ventral eye margin. Antenna (Fig. 8 a) with scape 5.14x, pedicel 1.9x, F1 1.8x, F2 1.67x, F3 1.67x, clava 2.1x as long as broad, C1 1.22x C2.

Mesosoma 1.6 times as long as broad. Pronotal collar hardly traceable, postero-lateral corners of pronotum evenly rounded. Mesoscutum 2.1 times as broad as long, notauli traceable anteriorly as very fine sutures, posteriorly as shallow depressions; scutellum slightly longer than broad and 1.5 times longer than mesoscutum. Propodeal surface almost smooth, median carina complete, lateral sulcus incomplete; supracoxal flange moderate; spiracular elevation with distinct projection below, propodeal callus with 2 long setae. Hind coxa reticulate dorsally. Fore femur about 4.3 times as long as broad, fore tibia 6 times as long as broad, and as long as its femur; mid femur 7 times as long as broad; mid tibia about 8 times as long as broad, spur of mid tibia about 1.4 times as long as breadth of its tibia, 0.7 times as long as dorsal margin of hind basitarsus; mind tarsus 0.83 times as long as its tibia. Fore wing 2.1 times as long as broad; costal cell bare, wide, 8 times as long as broad, 0.8 times marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein slightly soroter than stigmal; speculum open below; apical margin with very short fringe, setae of which half as long as width of marginal vein at its narrowest part. Hind wing 4.8 times as long as broad.

Petiole reduced, strongly transverse. Metasoma (Fig. 8d) 1.3 times as long as head plus mesosoma, about 2.67 times as long as broad; penultimate tergite 0.66 times as long as basal broad, about one-fifth of length of the metasoma, last tergite about 1.5 times as long as broad.

Male: unknown.

**Type material.** Holotype, ♀, Turkey: Erzurum, Akgdağ, 25. vi. 1980, swept from pasture (M.& O. Doğanlar). (MKUI).

**Host:** unknown.

**Discussion:** *Entedon akdagicus* n. sp. is similar to *E. calcicola* and *E. ergias* in having fore tibia with two distinct longitudinal pale stripes and at most proximal 1/2 of mid tibiae darkened, but it differs from *E. ergias* in having distance between hind (posterior) ocellus and occipital margin shorter than distance between the ocellus and inner eye margin (in *E. ergias* distance between hind (posterior) ocellus and occipital margin as long as distance between the ocellus and inner eye margin); It differs from *E. calcicola* in having metasoma (Fig. 8d) about 1.3 times as long as head plus mesosoma, 2.67 times as long as broad (in *E. calcicola* metasoma as long as head plus mesosoma, 1.6 times as long as broad); female antenna (Fig. 8a) with scape 5.14x, F1 1.8x, F2 1.67x, F3 1.67x (in *E. calcicola* female antenna with scape 3.9x, F1 1.6x, F2 1.5x, F3 1.2x).

**LITERATURE CITED**


Figure 1. Hypopygium of Entedon hercyna Walker.

Figure 2. Entedon ergias Walker. a-b. antenna; a. female; b. male; c. mid leg; d. hind leg; e. hypopygium; f. median part of hypopygium.
Figure 3. *Entedon hercyna* Walker. Female a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median part of hypopygium.

Figure 4. *Entedon procioni* Erdős. a-e. Female a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median part of hypopygium; f. male antenna.

Figure 5. *Entedon diotimus* Walker. a-e. Female a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median part of hypopygium; f. male antenna.
Figure 6. *Entedon nevsehiricus* n. sp. a-e. Female a. antenna; b. mid leg; c. hind leg; d. hypopygium; e. median part of hypopygium.

Figure 7. *Entedon calcicola* Graham. a-d. Female a. antenna; b. mid leg; c. hind leg; d. metasoma.

Figure 8. *Entedon akdagicus* n. sp. a-d. Female a. antenna; b. body, in lateral view; c. mid leg; d. metasoma.
EFFECT OF WHEAT CULTIVARS AND SOWN DATES ON APHID INFESTATION IN EGYPT

Ashraf Helmi* and Rania Rashwan*

* Plant Protection Department, Faculty of Agriculture, Ain Shams University, Cairo, EGYPT.

[Helmi, A. & Rashwan, R. 2013. Effect of wheat cultivars and sown dates on aphid infestation in Egypt. Munis Entomology & Zoology, 8 (2): 825-830]

ABSTRACT: The current study was conducted to determine the influence of wheat cultivars and wheat sown dates on aphids populations. Three cultivars of wheat (Gemiza-9; Giza-168 and Sakha-93) were sown on five sown dates (1st October, 16th October, 31st October, 15th November and 1st December) throughout two successive seasons 2011 and 2011 at Qalyubiya Governorate, Egypt. Three aphids species; Rhopalosiphum maidis, Rhopalosiphum padi and Sitobion avenae were found infesting wheat plants. R. maidis was the most abundant species followed by R. padi and S. avenae. Plants that sown on early December were significantly infested by aphids. The Gemiza-9 appeared to be the most resistant cultivar, while Giza-168 appeared to be the most susceptible one for aphid infestations. It is concluded from the study that suitable wheat sown date is from early October until mid November and the Gemiza-9 cultivar is resistant to the attack of aphid’s population, this cultivar should be promoted in the areas of high aphid infestation. The selection of suitable wheat cultivar and wheat sown date can be important tool for IPM program in this area ecosystem.

KEY WORDS: Aphids, wheat cultivars, sown dates, Rhopalosiphum maidis, Rhopalosiphum padi, Sitobion avenae.

Wheat (Triticum aestivum L.) is a nutritious, convenient, economical source, and a source of the basic dietary product – breads which is consumed by more than 70 % of the human population. This cereal is grown on 23 % of global cultivated area and is of the great importance in bread, diet, pharmaceutics and other industry, but also important product of international trade on worldwide market (Wiese, 1987; Anwar et al., 2009). In 2001, the leading wheat producing countries were India, China, Russian Federation, U.S.A., Australia, Canada, Turkey, and Pakistan (Anonymous, 2001). Wheat is mainly grown in Egypt, as it is one of world’s leading crops, and can affect the economy. Wheat is susceptible to various kinds of pests that feed on the underground and aboveground parts of the plant including roots, stems, leaves and ears. Among the sap sucking arthropods, aphids are the most widely distributed group. Aphids cause direct damage by feeding deeply within the leaf whorl and inject a toxin in the plant which destroy the chloroplast membrane and indirect damage by transmission of several plant viruses (barley yellow dwarf Luteo virus) and by developing molds on their honey dews. BYDV-PAV is spread worldwide and its most significant transmitter is the aphid (Gill, 1980; Kieckhefer & Kantack, 1980, 1988; Gair et al., 1983; Pike & Schaffner, 1985; Johnston & Bishop, 1987; Voss et al., 1997; Rossing et al., 1994; Jensen & D’Arcy, 1995; Marzocchi & Nicoli; 1991; Aslam et al., 2005; Bukvayova et al., 2006). The aphid infestations significant affect wheat cultivars (Ahmad & Nasir, 2001; Khattak et al., 2007; Khan et al., 2011; Zeb et al., 2011; Zhou et al., 2011). Host plant resistance is an important part of IPM for aphids (Khattak et al., 2007, Khan et al., 2011; Zhou et al., 2011) This work aims at determining the suitable wheat cultivar as well as the suitable sown dates to manage aphids infesting wheat at Qalyubiya ecosystem.
MATERIALS AND METHODS

Experimental locality:
In order to evaluate the response of three different wheat genotypes (*Triticum aestivum*) to different wheat aphid species as well as to investigate the effect of sown date on the population density of aphids species. An experiment was conducted at the Experimental Farm, the Faculty of Agriculture, Ain Shams University at Shalakan, Qalyubiya Governorate. Field trials were conducted throughout two successive seasons 2011 and 2012. An area of about one Fadden was sown with three commercial wheat cultivars; Sakha 93, Giza 168 and Gemiza 9. Each cultivar was grown in three plots (replicates). Each plot was 40 m² in space. These three cultivars were sown on five different sown dates; 1st October, 16th October, 31st October, 15th November and 1st December in the two successive seasons. No chemical treatments were done during the period of this experiment.

Aphids Population Density counting:
Regularly weekly interval excursions were made to this experimental region for two successive seasons, from 13th of January 2011 to 5th of May 2011 for the first season, and from 15th of January 2012 to 6th of May 2012 for the second season. For recording the aphid’s population density ten wheat plants were randomly selected from each cultivar replicate (30 plants/ cultivar). Population density of different aphid species was determined by counting all individuals of each aphid species per plant on leaves, stem and in later stage also on spike using 10x lenses in the field.

Identification of different aphids on wheat:
Wheat aphid species which collected during this experimental period were brought to the laboratory for identification. Mounted microscopic slides of for different aphid species alate form were prepared. Available taxonomic keys were used to identify different collected aphid species according to Blackman (2000) and Helmi (2010).

Statistical Analysis:
The average number of aphids/plant for each cultivar was calculated. GLM procedure was used to test the significant effect of wheat cultivars and sown dates on aphid populations as well as analysis of variance between different aphids population density. These tests followed by using Duncan’s test at 0.05 probability level (Duncan, 1955) to compare the significant differences in the mean numbers using SAS Package.

RESULTS AND DISCUSSION

Seasonal abundance of different wheat Aphid species:
Three different aphid species found infesting the three different wheat cultivars during the two successive seasons 2011 and 2012. These species were identified according to available identification keys; Corn leaf aphid, *Rhopalosiphum maidis* (Fitch), Bird cherry-oat aphid, *Rhopalosiphum padi* (Linnaeus) and English grain aphid, *Sitobion avenae* (Fabricius). Analysis of variance among mean numbers of population density of the three aphids showed significant differences during the two successive seasons (F= 12.04 and 20.42). The data of relative abundance of different aphid species (average of all wheat cultivars and sown dates) throughout 2011 and 2012 seasons (Fig. 1) showed that *R. maidis* was the most abundant species (86.2 & 132.3 individuals / season) followed by *R. padi* (4.3 & 11.4 individuals / season) then *S. avenae* (2.1 & 2.3 individuals / season) throughout the two successive seasons, respectively. The
seasonal abundance of aphids in the second season (2012) was higher than this recorded in the first season (2011) with seasonal mean number of population densities; 30.9 and 48.7 individuals/plant for the first and second seasons, respectively. No aphids infestation was observed on wheat plants until first week of March then population density increased gradually until mid of April whereas the highest population density then decreased until end of April and early May throughout the two studied seasons. Corn leaf aphid, R. maidis was found to be the earliest species appearing on wheat plants during first week of March followed by R. padi that appeared during second week of March while S. avenae appeared during last week of March throughout the two successive seasons.

**Effect of Sown Dates on wheat aphids infestation:**
Statistical analysis of variance indicated significant effect of different sown dates on the aphid population densities throughout the two successive seasons 2011 and 2012 whereas F values were 4.8 and 2.8, respectively. Wheat that was sowed in the late sown date (1st December) was the most infested with the three aphid species (100.6 & 103.7 individuals / season for the two successive seasons, respectively,) followed by the other four sown dates those showed insignificant differences in the first season. While in the second season the fourth sown date (15th November) followed the late sown date in infestation showing significant differences with the other three sown dates (Fig. 2).

From the above results it could concluded that the preferred wheat sown date under field conditions in this region of Egypt ranged from early October to mid November to avoid high aphids infestation. This results in agreement with those obtained by Acreman & Dixon (1985) and Aslam et al. (2005) reported that potential for aphid infestation can be reduced by sown wheat early in the season. Also Aheer et al. (1993) cited that aphid infestation increases on late plantings of wheat and reduces the yield as compared to normal planting.

**Effect of wheat cultivars on wheat aphids infestation:**
Statistical analysis of variance among mean numbers of aphids population on different studied wheat cultivars showed highly significant differences throughout the two successive seasons (F= 12.02 & 20.42). Giza 168 cultivar had the highest mean numbers of aphids per plant (59.6 & 87.6) followed by Sakha 93 cultivar (20.6 & 39.3) while Gemiza 9 cultivar had the lowest mean numbers of aphids per plant (12.5 & 19.1) for the two successive seasons, respectively (Fig. 3).

The current results reveal that there were significant differences in the number of aphids among the wheat cultivars. Numbers of aphids per plant were high in Geiza 168 cultivar and low in Gemiza 9 cultivar. Thus, Geiza 168 seems to be more susceptible while Gemiza 9 more resistant. Variations in the aphid populations among the different cultivars has been reported by several researchers like Zhang et al. (1989), Kindler et al. (1992), Aheer et al. (1993), Havlickova (1993), Zia et al. (1999), Bosque & Schotzko (2000), Ahmed & Nasir (2001), Aslam et al. (2005) and Aheer et al. (2007).

**LITERATURE CITED**


Figure 1. Seasonal mean numbers of three wheat aphid species on wheat plants at Shalakan, Qalyubiya Governorate throughout two successive seasons 2011 and 2012.
Figure 2. Seasonal mean numbers of aphid population density in five different sown dates of wheat at Shalakan, Qalyubiya Governorate throughout two successive seasons 2011 and 2012.

Figure 3. Seasonal mean number of aphid population densities on three wheat cultivars at Shalakan, Qalyubiya Governorate throughout two successive seasons 2011 and 2012.
HYPOPYGIA OF THE SPARETUS SPECIES GROUP OF ENTEDON DALMAN (HYMENOPTERA: EULOPHIDAE), WITH DESCRIPTIONS OF TWO NEW SPECIES

Mikdat Doğanlar*, Oğuzhan Doğanlar** and Peter S. Boyadziev***

* Mustafa Kemal University, Faculty of Agriculture, Department of Plant Protection, TR-31034, Hatay, TURKEY. E-mail: doganlar@mku.edu.tr
** Trakya University, Medical school, Department of Medical Biology, 22030, Edirne, TURKEY. E-mail: doganlaro@yahoo.com.tr
*** University of Plovdiv,"Paisii Hilendarski",24 Tsar Asen St.4000 Plovdiv, BULGARIA. E-mail: boyadz@uni-plovdiv.bg


ABSTRACT: Ten species of the sparetus species group of genus Entedon Dalman (Hymenoptera: Eulophidae) were collected in Turkey: E. bakacakicus Doğanlar, 2013, E. sparetus Walker, 1839, E. cardui Askew, 2001, E. longiventrosus Dalla Torre, 1898, E. thomsonianus Erdös, 1944, E. lixi Erdös, 1951, E. insignis Erdös, 1944, E. mecinî Askew, 1992 and two new species, E. nizipicus n. sp., E. adiyamanicus n. sp.. Hypopygia of the species, except E. bakacakicus, and morphological characters of the species were studied. Identification keys to the Turkish species of the sparetus species group of genus Entedon were provided by aid of several characters.

KEY WORDS: Hymenoptera (Eulophidae), sparetus species group of Entedon, Turkey.

In the taxonomy of Pteromalidae (Hymenoptera: Chalcidoidea) the morphology of hypopygia has been studied for separating the species of Mesopolobus Westwood, 1833 by Graham (1969), for the species of Pachyneuron Walker, 1833 and Euneura Walker, 1844 by Doğanlar (1986) and for the species of Dibrachys Förster, 1856 by Doğanlar (1987). In the taxonomy of Eulophidae (Hymenoptera: Chalcidoidea) Graham (1987, 1991) used the morphology of hypopygia in the classification of species of some genera in Tetrastichinae, Doğanlar (1991a,b) for some species of Ormyridae, and Tarla et al. (2010) for species of genus Oopristus Steffan, 1968 in Monodontomerinae (Torymidae).

Erdös (1944, 1951) erected the subgenus Megalentedon by the species of the Entedon sparetus species group. Later, Graham (1963, 1971) treated as a group of species related to E. sparetus Walker and then the group was accepted by Askew (1992) and Gumovsky (1997).

cardui Askew, 2001 from the females of E. sparetus. Gumovsky (2007) stated that the females of E. sparetus are easily confused with the females of E. cardui, which differs only by the shorter malar space (eye height 1.8–2.5 times as long as malar space in E. sparetus, but about 3.0 times in E. cardui).

In Turkey Doğanlar (1985) recorded E. insignis, E. lixi, and E. thomsonianus from the sparetus species group and some other species of Entedon from the Eastern Anatolia, and Doğanlar (2013) described a new species, E. bakacakus, from Şanlıurfa.

In this work the morphology of hypopygia of the species in the sparetus species group of Entedon was treated as diagnostic characters for the systematic of the species from Turkey, and aids some morphological characters a new identification key was created for the species of the sparetus species group of Entedon and some new synonyms were created.

**MATERIAL AND METHOD**

This study is based upon examination and identification of the specimens collected from several parts of Turkey. The examined specimens were deposited in Insect Museum of Plant Protection Department, Agriculture Faculty, Mustafa Kemal University, Antakya, Hatay, Turkey (MKUI). Specimens were collected by sweeping and putting the whole contents of the swept materials directly in 96 % ethanol. After sorting the material, individuals were mounted on cards for further morphological studies. The species were identified by following the keys of Graham (1971), Gumovsky (1997) and Gumovsky & Boyadzhiev (2003). The hypopygia were separated from metasoma by dissecting and slide mounted in Canada balsam, the other parts of the metasoma were replaced on its own card near its mesosoma. Wings and antennae of some para types were slide mounted in Canada balsam. Photographs of diagnostic characters of the genera were taken by using of Leica DM 5500 B microscope with a digital Leica DFC 295 camera attached to it.

**Terminology and abbreviations**

Morphological terminology follows Graham (1969) in hypopygia as in Fig. 1, Gibson (1997) and Gumovsky & Boyadzhiev (2003). Abbreviations used in the key and descriptions are: OOL= shorter distance between ocello-ocular line POL= distance between posterior ocelli, MDO= distance between median and lateral ocelli, OCL= shorter distance between lateral ocelli and occipital carina. The name of some parts of hypopygium given in Fig. 1.

**RESULTS AND DISCUSSION**

**Key to female of the species of the sparetus species group of Entedon by using the characters of hypopygia**

1- Hypopygium with anterior median incision almost absent, at most broadly v-shaped (Fig.2 a-c)........................................................................................................................................2

- Hypopygium with anterior median incision deep in several shapes (Fig. 2a, 3a, b)..............4

2- Antero-lateral angle circular, towards median incision slightly concaved; posterior lobe posteriorly circular, but narrowing towards median incision; median sclerotized line reached almost anterior margin of hypopygium, posterior median incision as in Fig. 2a.........................................................................................................................sparetus Walker

- Antero-lateral angle angular, towards median incision slightly convexes; median sclerotized line reached slightly above middle of hypopygium (Fig. 2b, c)......................3
3-Posterior lobe posteriorly circular, posterior median incision as in Fig. 2b....*insignis* Erdös  
-Posterior lobe narrowing towards median incision, posterior median incision as in Fig. 2c..............................................*nectini* Askew

4- Hypopygium with anterior median incision C-shaped, antero-lateral angle circular, posterior lobe gradually tapering backwards, median sclerotized line reached at most slightly above middle of hypopygium, posterior median incision as in Fig. 3a.................................................................*thomsonianus* Erdös  
-Hypopygium with anterior median incision V-shaped, or U-shaped; other characters variable...........................................5

5- Hypopygium with anterior median incision and antero-lateral angle together broadly V-shaped, antero-lateral angle narrowing apically, sides of hypopygium slightly convexes towards median incision; posterior lobe posteriorly circular, median sclerotized line reached almost anterior margin of hypopygium, posterior median incision narrow as in Fig. 3b.................................................................*adiyamanicus* n. sp.  
-Hypopygium with anterior median incision V-shaped, other characters variable.................6

6- Hypopygium with anterior median incision narrow V-shaped, antero-lateral angle angular; median sclerotized line reached about middle of hypopygium (Fig. 4a,b)............7  
-Hypopygium with anterior median incision broad V-shaped; antero-lateral angle circular; other characters variable (Fig. 4c,d).........................................................8

7- Antero-lateral angle towards median incision concaved; posterior lobe posteriorly circular, posterior median incision as in Fig. 4a)..............................................*cardui* Askew  
-Antero-lateral angle towards median incision circular; posterior lobe posteriorly narrowing towards posterior median incision; posterior median incision as in Fig. 4b..................... .............................................................................*nizipicus* n. sp.

8- Posterior lobe posteriorly almost straight, median sclerotized line reached about apical margin of hypopygium, posterior median incision as in Fig. 4c..............................................*longiventrosus* Dalla Torre  
-Posterior lobe posteriorly narrowing towards posterior median incision, median sclerotized line reached about middle of hypopygium, posterior median incision as in Fig. 4d.................................................................*fixi* Erdös

**Key to female of the species of the *sparetus* species group of genus *Entedon***

1- Apical margin of forewing without fringe.........................................................2  
- Apical margin of forewing with fringe; other characters variable.................................4

2- Head and mesosoma with unusual broad, coarse reticulations medially, meshes are about 4 times wider than meshes on side part, its diameter about 0.11 mm. side lobes finely reticulated; F1 about 2.3 times as long as broad, with 2 basiconic peg sensillae medially, additional to the apical basiconic peg sensillae (Fig. 5a-c); combined length of pedicel plus flagellum about 0.7 times breadth of head; metasoma with synterum half-length of its basal breadth, last tergum 1/3 length of its basal breadth......*bakacakicus* Doğanlar  
-Head and mesosoma with fine reticulation, its diameter at most 0.025 mm. F1 with apically placed 3 basiconic peg sensillae; combined length of pedicel plus flagellum about 0.7 times breadth of head (Fig. 6); the other characters variable.........................................................3

3- F1 about 3 times as long as broad, F2 and F3 at least slightly longer than broad; clava about twice as long as broad; (Fig. 6a-c); metasoma with synterum 2/3 length of its basal breadth, last tergite about as long as its basal breadth; Up to 6 mm.........................*thomsonianus* Erdös
F1 about 2.3 times as long as broad, F2 and F3 quadrate; clava about 2.2 times as long as broad (Fig. 6d-f); metasoma with syntergum 0.5 times as long as its basal breadth, last tergite 0.5 times as long as its basal breadth. Up to 3.4 mm. nizipicus n. sp.

4-Syntergum of metasoma nearly as long as its basal breadth, last tergite 1.4 times as long as its basal breadth; eye height about 2.5 times. F1 with two rows basiconic peg sensillae in apical half; combined length of pedicel plus flagellum about 0.78–0.8 times breadth of head. Up to 3.5 mm. longiventrosus Dalla Torre

- Metasoma with syntergum distinctly shorter than its basal breadth; last tergite at most as long as its basal breadth; the other characters variable. sparetus Walker

5- Combined length of pedicel plus flagellum at most 0.66 times breadth of head. cardui Askew

6-Eye height about 2.3–2.5 times malar space; antenna having F1 with 4 basiconic peg sensillae in apical half as in fig. 8b,c; metasoma with syntergum about 0.66 times as long as its basal breadth or slightly more; last tergite. longiventrosus Dalla Torre

- Eye height about 2.7–3.0 times malar space; antenna having F1 with 5 basiconic peg sensillae in 3 rows as in Fig. 9b; metasoma with syntergum about 0.4 times as long as its basal breadth; last tergite as long as basal breadth. Up to 3.0 mm. cardui Askew

7- Antennae with F1 having some basiconic peg sensillae medially, additional to apical ones as in fig. 10; eye height 1.8–2.5 times as long as malar space; combined length of pedicel plus flagellum about 0.72 times breadth of head; metasoma with syntergum about 0.57–0.64 times as long as its basal breadth; last tergite 0.8–0.86 times as long as basal breadth. mecini Askew

- Antennae with F1 having some basiconic peg sensillae apically. insignis Erdös

8-Antenna (Fig. 11) with F1 having one basiconic peg sensilla in 1/3 apical part, additional to the apical ones as in Fig. 11b, clava with C1 having two rows of longitudinal sensillae (Fig. 11c); combined length of pedicel plus flagellum about 0.70–0.77 times breadth of head; metasoma with syntergum about half as long as its basal breadth; last tergite about as long as its basal breadth. fii Erdös

- Antenna with F1 having mostly apically placed basiconic peg sensillae as in Fig. 11b, clava with C1 having mostly one row, of longitudinal sensillae or a few additional ones (Fig. 12c); the other characters variable. lixi Erdös

9-Antennae (Fig. 12) with F1 at least three times as long as broad, with at least 5 basiconic peg sensillae apically; eye height about 2.5 times malar space; metasoma with syntergum about 0.7 times as long as its basal breadth; last tergite as long as basal breadth. Length 2.2 mm. adiyamanicus n. sp.

Key to male of the species of the sparetus species group of Entedon

1-Antennal funicle with three segments; club with 2 segments. 2-Antennal funicle with four segments; club with 1-segmented.

2-Apical margin of forewing bare, without fringe. 3-Apical margin of forewing with a fringe.

3-Scape 3 times, pedicel 2.7–2.8 times, F1 2.8, F2 2, F3 and F4 1.3, F5 1.75 times as long as broad; longitudinal sensillae on flagellar segments at least in two rows (Fig. 14 a–c). Male genitalia as in Fig. 15b. thomsonianus Erdös
-Scape 2.75 times, pedicel twice, F1, F2 1.67, F3 1.4, F4 1.1, F5 1.5 times as long as broad; longitudinal sensillae on flagellar segments mostly in one row, sometimes with one additional sensilla (Fig. 14d-f). Male genitalia as in Fig. 15a. nizipicus n.sp.

4—Scape 3 times, pedicel 1.7, F1 2.8-3.0, F2 1.6, F3 1.3, F4 as long as broad, F5 1.33 times as long as broad; longitudinal sensillae on flagellar segments sparse as in (Fig. 16a-c).

- Scape 3.9 times, pedicel twice, F1 twice, F2 1.55, F3 1.44, F4 1.5 times, F5 twice as long as broad; longitudinal sensillae on flagellar segments dense as in (Fig. 16d-f). cardui Askew insignis Erdös

5—Head and mesosoma with unusual broad, coarse reticulations medially, meshes are about 3 times wider than meshes on side part, its diameter at least 0.11 mm. side lobes finely reticulated; F1 about 2.3 times as long as broad; flagellar segments with one row of longitudinal sensillae, except F5 with 3 rows longitudinal sensillae (Fig. 17a-c). bakacakicus Doğanlar

-Head and mesosoma with fine reticulation, its diameter at most 0.01 mm. other characters variable. bakacakicus Doğanlar

6—Scape 2.75 times as long as broad; pedicel about 1.26 as long as broad; 0.6 times as long as F1; F1 about 1.5, F2 1.25 times as long as broad, F3 quadrate, F4 1.28 times as long as broad, clava about (including spicula) 2.33 times longer than broad; flagellar segments with sparse longitudinal sensillae, mostly in one row, F1 apically broader than base, almost truncate cone-shaped (Fig. 18a-c). lixi Erdös

- Scape 3 times as long as broad; pedicel at least 1.5 times as long as broad; F1 twice or more than twice as long as broad; segments with dense longitudinal sensillae, mostly more than one row, F1 almost ellipsoidal (Fig. 19, 20).

8—Pedicel about 1.7 as long as broad; F1 about 2.44, F2 1.6, F3 1.5, F4 2.0, times as long as broad, clava about (including spicula) 3.3 times longer than broad; flagellar segments with dense longitudinal sensillae, mostly more than one row, clava with two rows longitudinal sensillae (Fig. 19a-c). sparetus Walker

- Pedicel at most 1.5 as long as broad; flagellar segments shorter than alternate species, clava at most twice longer than broad (Fig. 20).

9—Scape 5.0 times as long as broad; pedicel about 1.3 as long as broad; F1 1.4, F2 0.75, F3 and F4 0.84 times as long as broad, clava about 1.2 times longer than broad (Fig. 20a-c). longiventrosus Dalla Torre

- Scape 3.75 times as long as broad; pedicel about 1.5 as long as broad; F1 twice, F2 1.67, F3 1.1, F4 1.4, times as long as broad, clava one-segmented, about twice longer than broad (Fig. 20d-f). mecini Askew

Entedon thomsonianus Erdös
(Fig. 6a-c, 14a-c, 15b)

Entedon (Megalentedon) thomsonianus Erdös, 1944: 27.
Entedon thomsonianus Erdös; Graham, 1971: 342.

Diagnostic characters were given by Gumovsky (2007). Some additional characters as follows: Female: Hypopygium with anterior median incision C-shaped, antero-lateral angle circular, posterior lobe gradually tapering backwards, median sclerotized line reached at most slightly above middle of hypopygium, posterior median incision as in Fig. 3a. -Head and mesosoma with fine reticulation, its diameter at most 0.025 mm. flagellar segments with sparse longitudinal sensillae; F1 with apically placed 3 basiconic peg sensillae; combined length of pedicel plus flagellum about 0.7 times breadth of head (Fig. 6). F1 about 3 times as long as broad, F2 and F3 at least slightly longer than broad; clava about
twice as long as broad, (Fig. 6a-c); metasoma with syntergum 2/3 length of its basal breadth, last tergite about as long as its basal breadth; Up to 6 mm. Male: Antennal funicle with three segments; club with 2 segments; Scape 3 times, pedicel 2.7-2.8 times, F1 2.8, F2 2, F3 and F4 1.3, F5 1.75 times as long as broad; longitudinal sensillae on flagellar segments at least in two rows (Fig. 10a-c). Male genitalia as in Fig. 11b.

Distribution. Widely in Europe (Boucek & Askew, 1968; Askew et al., 2001; Gumovsky & Boyadzhiev, 2003), Ukraine, Georgia, Turkmenistan (Gumovsky, 2007).

Host. Lixus cardui Olivier (Curculionidae) (Erdös, 1944, 1951; Boucek & Askew, 1968; Gumovsky, 2007).

Material examined: Turkey: 5 ♀♀, Hatay, Belen, Kömürçukuru, 24.iv.2008, swept from pasture (M. Doğanlar); 1♀, Adiyaman, Gölbasi, Araban yol ayrimi, 02.v.2008, swept from lent field (M. Doğanlar); 2♀♂, 2♂♂, Antalya, 05.v.1988, swept from Compositae; 1♀, İzmir, Gümüldür, 21.v.1987 (H. Çam); 2♀, Sivas, Kangal, 39° 14’ 74” N 37° 10’ 45” E, 1541 m, 03.vii.2005, swept from Onopordon sp, (O. Doğanlar); 1♂, Şarkışla, Tavladeresi, 19.vi.2003, (O. Doğanlar); Erzurum, 1♀, 20.vi.1973, (M. Doğanlar); 1♀, 08.ix.1978, (M. Doğanlar); 2♀♂, 18.vi.1982 (M. Doğanlar); 2♂♂, 17.vi.1986 (M. Doğanlar) (MKUI).

Entedon nizipicus n.sp.
(Figs. 4b; 6d-f; 10d-f; 11a)

Diagnosis. Hypopygium (Fig. 4a,b) with anterior median incision almost missing, antero-lateral angle circular, towards median incision slightly concaved; posterior lobe distally circular, but narrowing towards median incision, median sclerotized line reaching almost anterior margin of hypopygium, posterior median incision as in Fig. 4b. Metasoma 1.75 times as long as head plus mesosoma, about 4 times as long as broad; penultimate tergite of metasoma as long as broad, about one fifth of length of the metasoma, last tergite 1.4 times as long as broad; antennal scape of female 5 times as long as broad; pedicel about 1.8 times as long as broad; F1 about 2.28, F2 1.7, F3 1.25 times as long as broad, clava two-segmented, about 2.3 times longer than broad, slightly 2.1 times longer than the preceding segment; eye height 2.75 times as long as malar space; breadth of mouth opening 2.06 times as long as malar space; fore wing 2.25 times as long as broad, apical margin without; hind tibia about 1.33 times as long as its tarsus, fore 1.16 and mid tibiae about 1.2 times as long as their tarsi.

Description:
Female. Body length 3.4 mm. Colour of body metallic dark blue, frons with weak greenish tint. Entire antennae dark. Legs dark, except knees, extreme distal ends of tibiae and first two tarsomere of mid and hind legs, which are pale. Dorsal pale longitudinal stripe on fore tibia discernible along entire tibia. Head in dorsal view 2.6 times as broad as long; POL: OOL: MDO: OCL= 16:7:7:2 in holotype. Occipital margin sharp. Eyes sparse setose, with short setae, eye height 3.15 times as long as malar space. Head in front view 1.36 times as broad as long. Interocular distance 2.4 times as long as eye breadth. Malar sulcus indicated by a line. Breadth of mouth opening 2.3 times as long as malar space. Clypeus reticulate, its anterior margin truncate. Antennae inserted slightly above the level of ventral eye margin. Pedicel plus flagellum 0.68 times broad of head.
Antennal scape of female 5.3 times as long as broad; pedicel about 2.4 as long as broad; 0.75 times as long as F1; F1 about 2.28, F2 1.57, F3 1.2 times as long as broad, clava two-segmented, about 2.2 times longer than broad, slightly 1.8 times longer than the preceding segment. Mesosoma 1.5 times as long as broad. Pronotal collar hardly traceable, postero-lateral corners of pronotum evenly rounded. Mesoscutum 1.43 times as broad as long, notauli traceable anteriorly as very fine sutures, posteriorly as shallow depressions; scutellum slightly longer than broad and as long as mesoscutum. Propodeal surface finely reticulate, median carina complete, lateral sulcus incomplete; parapspiracular sulcus deep, complete; supracoxal flange moderate; spiracular elevation with blunt projection below, propodeal callus with 10 long setae. Metapleuron with comparatively blunt protrusion. Hind coxa reticulate dorsally. Fore femur about 3.3 times as long as broad, fore tibia 5.7 times as long as broad, about 1.17 times as long as its femur; mid femur 3.9 times as long as broad; mid tibia 6.67 times as long as broad, spur of mid tibia as long as breadth of tibia, 0.54 as long as dorsal margin of mid basitarsus; hind femur about 3.3 times as long as broad, hind tibia about 5.6 times as long as broad, spur of hind tibia about 0.75 times as long as breadth of its tibia, and 0.75 times as long as dorsal margin of hind basitarsus. Hind tarsus 0.8 times as long as its tibia, mid tarsus 0.82 times as long as its tibia. Ratio of tibiae and tarsi of holotype are as follows: fore tibia: tarsus 60:50; fore tarsomerses: 9:13:10:12 (+ pretarsus 7); mid tibia: tarsus 80: 66; mid tarsi: 20–28 (dorsal – ventral edge of basitarsus): 14–16: 10: 10 (+ pretarsus5); hind tibia: tarsus 90: 46; hind tarsi: 20–25: 13–17: 10: 12 (+ pretarsus 8).

Fore wing 2.3 times as long as broad; costal cell bare, comparatively wide, 5.2 times as long as broad, as long as marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein slightly longer than stigmal; speculum open below; apical margin without fringe. Hind wing 2.6 times as long as broad.

Petiole reduced, strongly transverse. Metasoma almost as long as head plus mesosoma, about 1.75 times as long as broad; syntergum of metasoma 0.5 times as long as broad, about two-ninth of length of the metasoma, last tergite 0.5 times as long as broad. Hypopygium with anterior median incision narrow V-shaped, antero-lateral angle angular; median sclerotized line reached about middle of hypopygium (Fig. 4a,b), antero-lateral angle towards median incision circular; posterior lobe posteriorly narrowing towards posterior median incision; posterior median incision as in Fig. 4b.

Male. Body length 1.8 mm. Similar to female except as follows: eye height 2.33 times as long as malar space. Antennae with pedicel plus flagellum as long as breadth of head. Antennal scape 3 times as long as broad; pedicel about 1.7 as long as broad; 0.5 times as long as F1; F1 about 2.44, F2 1.6, F3 1.5, F4 2.0, times as long as broad, clava one-segmented, about (including terminal spine) 3.3 times longer than broad. Forewing twice as long as broad, with costal cell as long as marginal vein; Metasoma twice as long as breadth, slightly longer than mesosoma.

Type material. Holotype, ♂, Turkey: Şanlıurfa, From Nizip to Suruç 15 km., 04.v. 2006, swept from lent field (M. Doğanlar). Paratypes: 3♂♂, Şanlıurfa, From Nizip to Karkamış 5 km., 17.iv.2010, swept from pasture (M. Doğanlar); 1♂, Sivas, Keçili village, 18.vi. 2003, swept from pasture (O. Doğanlar). All of the types were deposited in MKUI.
Discussion: *Entedon nizipicus* n. sp. is similar to *E. thomsonianus* in having forewing margin without fringe, and F1 with apically placed 3 basiconic peg sensillae; combined length of pedicel plus flagellum about 0.7 times breadth of head (Fig. 6); but it differs from *E. thomsonianus* in having F1 about 2.3 times as long as broad, F2 and F3 at least slightly longer than broad; clava about twice as long as broad, (Fig. 6a-c); metasoma with syntergum 2/3 length of its basal breadth, last tergite about as long as its basal breadth (in *E. thomsonianus* F1 about 3 times as long as broad, F2 and F3 at least slightly longer than broad; clava about twice as long as broad, (Fig. 6a-c); metasoma with syntergum 2/3 length of its basal breadth, last tergite about as long as its basal breadth), and also similar to *E. cardui* in having hypopygium with anterior median incision narrow V-shaped, antero-lateral angle angular; median sclerotized line reached about middle of hypopygium (Fig. 4a,b), but it differs from *E. cardui* by antero-lateral angle towards median incision circular; posterior lobe posteriorly narrowing towards posterior median incision; posterior median incision as in Fig. 4b (in *E. cardui* antero-lateral angle towards median incision concaved; posterior lobe posteriorly circular, posterior median incision as in Fig. 4a); in male it is similar to *E. thomsonianus*, but it differs in having scape 2.75 times, pedicel twice, F1, F2 1.67, F3 1.4, F4 1.1, F5 1.5 times as long as broad; longitudinal sensillae on flagellar segments mostly in one row, sometimes with one additional sensilla (Fig. 10d-f).

Male genitalia as in Fig. 11a (in *E. thomsonianus* scape 3 times, pedicel 2.7-2.8 times, F1 2.8, F2 2, F3 and F4 1.3, F5 1.75 times as long as broad; longitudinal sensillae on flagellar segments at least in two rows (Fig. 10a-c). Male genitalia as in Fig. 11b).

**Entedon bakacakicus** Doğanlar

( Figs. 5a-c; 17a-c)

*Entedon bakacakicus* Doğanlar, 2013: (in press)

Diagnostic characters were given by Doğanlar (2013). some additional characters as follows: Female: Head and mesosoma with unusual broad, coarse reticulations medially, meshes are about 4 times wider than meshes on side part, its diameter about 0.11 mm. side lobes finely reticulated; F1 about 2.3 times as long as broad, with 2 basiconic peg sensillae medially, additional to the apical basiconic peg sensillae (Fig. 5a-c); combined length of pedicel plus flagellum about 0.7 times breadth of head; metasoma with syntergum half length of its basal breadth, last tergum 1/3 length of its basal breadth; Male: F1 about 2.3 times as long as broad; flagellar segments with one row of longitudinal sensillae, except F5 with 3 rows longitudinal sensillae (Fig. 13a-c).


Hosts. Unknown.

Material examined. 1 ♀, 1♂, Turkey, Şanlıurfa, Akçakale, Bakacak village (Doğanlar, 2013) (MKUI).

**Entedon sparetus** Walker

( Figs. 2a; 7a-c; 15a-c)

*Entedon sparetus* Walker, 1846: 182.
Diagnostic characters: Female: Hypopygium with anterior median incision almost absent, at most very broadly v-shaped (Fig. 2a); antero-lateral angle circular, towards median incision slightly concaved; posterior lobe posteriorly circular, but narrowing towards median incision, median sclerotized line reached almost anterior margin of hypopygium, posterior median incision as in Fig. 2a; Apical margin of forewing with fringe; Syntergum of metasoma nearly as long as its basal breadth, last tergite 1.4 times as long as its basal breadth; eye height about 2.5 times. F1 with two rows basiconic peg sensillae in apical half; Combined length of pedicel plus flagellum about 0.7-0.8 times breadth of head. Up to 3.5 mm; Antennal (Fig. 7a-c) funicle with four segments; club with 1-segmented; Male: - Scape 3 times as long as broad; pedicel at least 1.5 times as long as broad; F1 twice or more than twice as long as broad; segments with dense longitudinal sensillae, mostly more than one row, F1 almost ellipsoidal. Pedicel about 1.7 as long as broad; F1 about 2.4, F2 1.6, F3 1.5, F4 2.0, times as long as broad, clava about (including spicula) 3.3 times longer than broad; flagellar segments with dense longitudinal sensillae, mostly more than one row, clava with two rows longitudinal sensillae (Fig. 15a-c).


Material examined. Turkey: Tokat, 2♀, 6♂, 09.iv.-31.v.1989 (H. Çam); 1♀, 6.vii.1986, (M. Doğanlar); 1♀, Erzurum, Sansa deresi, 27.viii.1982, (M. Doğanlar); 1♀, Kayseri, Erciyes Mnt. 07.vii.2005 (O. Doğanlar); 1♂, Bulgaria, Stara Zagora region, Sakar Mnt. 1 km NE of Madrets village, 26.iv.2007 (A. Stajanova & P. Boyadziev) (MKUI).

**Entedon cardui Askew**
(Figs. 4a; 9a-c; 16a-c)


Diagnostic characters were given by Gumovsky (2007). Some additional characters as follows Female: Hypopygium with anterior median incision deep, narrow V-shaped, antero-lateral angle angular; median sclerotized line reached about middle of hypopygium (Fig. 4a); antero-lateral angle towards median incision concaved; posterior lobe posteriorly circular, posterior median incision as in Fig. 4a; Apical margin of forewing with fringe; Metasoma with syntergum distinctly shorter than its basal breadth; last tergite at most as long as its basal breadth; Combined length of pedicel plus flagellum at most 0.66 times breadth of head; Eye height about 2.7–3.0 times malar space; antenna having F1 with 5 basiconic peg sensillae in 3 rows as in fig. 9 b; metasoma with syntergum about 0.4 times as long as its basal breadth; last tergite as long as basal breadth. Male: Antennal funicle with three segments; club with 2 segments; Scape 3 times, pedicel 1.7, F1 2.8–3.0, F2 1.6, F3 1.3, F4, F5 1.33 times as long as broad; longitudinal sensillae on flagellar segments sparse as in (Fig. 16a-c).
Distribution. Spain (Askew et al., 2001), Bulgaria, Greece (Gumovsky & Boyadzhiev, 2003), Italy, France and Ukraine (Gumovsky, 2007).

Hosts. Unknown.

Material examined: Turkey: Kilis, 1 ♀, Oğuzeli, Keçkikuyusu, 28.iv.2012, swept from *Medicago sativa* field (M. Doğanlar); 1 ♀, Şanlıurfa, Ezgil, 26.iv.2008, swept from *Circium* sp. (M. Doğanlar); 1 ♀, Birecik, 26.iv.2008, swept from *Circium* sp. (M. Doğanlar); 1♂, Sivas, Şarkışla, 19.vi.2003, swept from pasture (O. Doğanlar).

*Entedon adiyamanicus* n. sp.

(Figs. 3b; 13a-c)

Diagnosis. Hypopygium butterfly-shaped with anterior median incision narrowly U-shaped, antero-lateral angle circular, towards median incision slightly convex; posterior lobe distally circular, median sclerotized line reaching almost anterior margin of hypopygium, posterior median incision narrow as in Fig. 3b. Metasoma 1.1 times as long as head plus mesosoma, about 1.3 times as long as broad; syntergum as long as broad, about one-tenth of length of the metasoma; antennal scape of female 6 times as long as broad; pedicel about twice as long as broad; F1 about 1.8, F2 1.4, times as long as broad, F3 quadrate, clava two-segmented, about 1.8 times as long as broad, slightly more than twice longer than F3 (Figs. 13a-c); eye height 2.7 times as long as malar space; breadth of mouth opening 2.1 times as long as malar space; fore wing 2.1 times as long as broad, apical margin with a fringe of very short setae, which half as long as width of marginal vein at its narrowest part; hind tibia about as long as its tarsus, fore and mid tibiae about 1.1 times as long as their tarsi.

Female. Body length 2.2 mm. Colour of body metallic dark blue, frons with weak bronze tint. Entire antennae dark. Legs dark, except knees, extreme distal ends of tibiae and first two tarsomeres of mid and hind legs, which are pale. Dorsal pale longitudinal stripe on fore tibia discernible along entire tibia.

Head in dorsal view 2.53 times as broad as long; POL:OOL:MDO:OCL= 25: 9: 13: 2 in holotype. Occipital margin moderately sharp. Eye with short sparse setae, eye height 2.7 times as long as malar space. Head in front view 1.2 times as broad as long. Intercocular distance 2.5 times as long as eye breadth. Malar sulcus indicated by a line. Breadth of mouth opening 2.1 times as long as malar space. Clypeus reticulate, its anterior margin truncate. Antennae inserted slightly above the level of ventral eye margin. Antennal scape of female 6 times as long as broad; pedicel about twice as long as broad; F1 about 1.8, F2 1.4, times as long as broad, F3 quadrate, clava two-segmented, with short terminal spine, about 1.8 times as long as broad, slightly more than twice longer than the preceding segment; eye height 2.7 times as long as malar space. Mesosoma 1.3 times as long as broad. Pronotal collar hardly traceable, postero-lateral corners of pronotum evenly rounded. Mesoscutum 1.75 times as broad as long, notauli traceable anteriorly as very fine sutures, posteriorly as shallow depressions; scutellum as long as broad and slightly longer than mesoscutum. Propodeal surface finely reticulate, median carina complete, lateral sulcus incomplete; supracoxal flange moderate; spiracular elevation with blunt projection below, propodeal callus with 4 long setae. Metapleuron with comparatively blunt protrusion. Hind coxa reticulate dorsally. Fore femur about 3.3 times as long as broad, fore tibia 6.3 times as long as broad, and as long as its femur; mid femur 3.6 times as long as broad; mid tibia
8.5 times as long as broad, spur of mid tibia 1.4 times as long as breadth of tibia, 1.7 as long as dorsal margin of mid basitarsus; hind femur about 3.5 times as long as broad, hind tibia about 7.7 times as long as broad, spur of hind tibia about 1.4 times as long as breadth of its tibia, 1.4 times as long as dorsal margin of hind basitarsus. Hind tarsus 0.88 times as long as its tibia, mid tarsus 0.8 times as long as its tibia. Ratio of tibiae and tarsi of holotype are as follows: fore tibia: tarsus 70: 60; fore tarsomeres: 10: 19: 10 (+ pretarsus 10); mid tibia: tarsus 53: 57; mid tarsi: 11–15 (dorsal – ventral edge of basitarsus): 11–14: 7: 8 (+ pretarsus 7); hind tibia: tarsus 54: 48; hind tarsi: 14–17: 10–12: 8: 7 (+ pretarsus 5).

Fore wing 2.1 times as long as broad; costal cell bare, comparatively wide, 5 times as long as broad, slightly longer than marginal vein; subcosta of submarginal vein with 2 dorsal setae, postmarginal vein slightly longer than stigmal; speculum open below; apical margin with very short fringe, setae of which half as long as width of marginal vein at its narrowest part. Hind wing 3.8 times as long as broad. Petiole reduced, strongly transverse. Metasoma as long as head plus mesosoma, about 1.76 times as long as broad; penultimate tergite 0.4 times as long as basal broad, about one-eighth of length of the metasoma, last tergite about as long as broad. Hypopygium butterfly-shaped with anterior median incision narrowly U-shaped, antero-lateral angle circular, towards median incision slightly convex; posterior lobe distally circular, median sclerotized line reaching almost anterior margin of hypopygium, posterior median incision narrow as in Fig. 3b.

Male: unknown.

Type material. Holotype, ♀, Turkey: Adıyaman, Side of Fırat river, near Atatürk Barage, 37° 27' 99'' N, 38° 15' 26’ E, 402 m, 24.iv.2007, swept from pasture (M. Doğanlar) (MKUI).

Host: unknown.

Discussion: Entedon adiyamanicus n. sp. is a unique species in having Hypopygium with anterior median incision and antero-lateral angle together broadly V-shaped, antero-lateral angle narrowing apically, sides of hypopygium slightly convexes towards median incision; posterior lobe posteriorly circular, median sclerotized line reached almost anterior margin of hypopygium, posterior median incision narrow as in Fig. 3b. In antennal characters E adiyamanicus is similar to E. insignis in having Antenna with F1 having mostly apically placed basiconic peg sensillae as in Fig. 12b, clava with C1 having mostly one row, of longitudinal sensillae or a few additional ones (Fig. 12c), but it differs in having antennae with F1 1.8 times as long as broad, with only two basiconic peg sensillae apically; eye height about 2.7 times malar space; metasoma with syntergum as long as its basal breadth; last tergite 0.86 times as long as basal breadth (in E. insignis Antennae (Fig. 12) with F1 at least three times as long as broad, with at least 5 basiconic peg sensillae apically; eye height about 2.5 times malar space; metasoma with syntergum about 0.7 times as long as its basal breadth; last tergite as long as basal breadth).
Entedon longiventrosus Dalla Torre  
(Figs. 4c, 8a-c; 20a-c)

Entedon longiventris Thomson, 1878: 245, fem. (nec Ratzeburg, 1848). Holotype female (entire metasoma is missing!) of Entedon longiventris Thomson (LUZM). 

Entedon longiventrosus Dalla Torre, 1898: 40 (nom. n. for longiventris Thomson nec Ratzeburg); synonymized with E. sparetus by Gumovsky & Boyadzhiev, 2003.

Diagnostic characters: Female: Hypopygium with anterior median incision broad V-shaped; antero-lateral angle circular; posterior lobe posteriorly almost straight, median sclerotized line reached about apical margin of hypopygium, posterior median incision very deep as in Fig. 4c; Apical margin of forewing with fringe; Metasoma with syntergum distinctly shorter than its basal breadth; last tergite at most as long as its basal breadth; most 0.66 times breadth of head; Eye height about 2.3-2.5 times malar space; antenna having F1 with 4 basiconic peg sensillae in apical half as in fig. 8b,c; metasoma with syntergum about 0.66 times as long as its basal breadth or slightly more; last tergite almost as long as basal breadth. Male: Pedicel at most 1.5 as long as broad; flagellar segments shorter than alternate species, clava at most twice longer than broad; Scape 5.0 times as long as broad; pedicel about 1.3 as long as broad; F1 1.4, F2 0.75, F3 and F4 0.84 times as long as broad, clava about 1.2 times longer than broad (Figs. 20a-c).

Studied material: Şanlıurfa, 1 ♀, Bozova, Kangörmez village, 04.v.2006, swept from Vicia field plus Sinapis sp.; (M. Doğanlar); 1 ♀, Akçakale, Bakacak, 26.iv.2008, swept from Circium sp. (M. Doğanlar); 1♂ , Adıyaman, Gölbashi, 19.v.2010, (M. Doğanlar); 1 ♀, Tokat, Niksar, Çamiçi, 26.vii.1993 (M. Doğanlar) (MKUI).

Entedon insignis Erdős  
(Figs. 2b, 12a-c, 16d-f).


Diagnostic characters as follows: Female: Hypopygium with anterior median incision almost absent, at most very broadly v-shaped (Fig. 2b); antero-lateral angle angular, towards median incision slightly concaved; median sclerotized line reached slightly above middle of hypopygium (Fig. 2b); posterior lobe posteriorly circular, posterior median incision as in Fig. 2b; apical margin of forewing with fringe; Combined length of pedicel plus flagellum at least 0.7 times breadth of head; Antennae with F1 at least three times as long as broad, with at least 5 basiconic peg sensillae apically, having mostly apically placed basiconic peg sensillae as in fig. 12b, clava with C1 having mostly one row of longitudinal sensillae or a few additional ones (Fig. 12c); eye height about 2.5 times malar space; metasoma with syntergum about 0.7 times as long as its basal breadth; last tergite as long as basal breadth. Male: Antennal funicle with three segments; club with 2 segments; scape 3.9 times, pedicel twice as long as broad, F1 twice, F2 1.55, F3 1.44, F4 1.5 times, F5 twice as long as broad; longitudinal sensillae on flagellar segments dense as in (Fig. 16d-f).
Studied material: 1♀, Sivas, Centrum, Keçili village, 39°30’ 49” N 36°51’ 09” E, 1388 m, swept from pasture (O. Doğanlar); 1♂, Gökçekent, Sökün village, 40°16’ 53” N 38°11’ 34” E, 910 m, swept from pasture, (O. Doğanlar); 1♀, Şanlıurfa, Bozova, Kangörmez village, 24.iv.2007, swept from Vicia sp. and Sinapis sp. plantation (M. Doğanlar); 1♀, İzmir, Urla, 11.iv.1973, (H. Çam) (MKUI).

Additional material: 2♀♀, Rodopi Mnt. V. Belastica, 300 m, 14.x.1993 (P. Boyadziev); 1♀, Rodopi Mnt. L. Mazcigonica, 24.vi.1995 (P. Boyadziev); 1♀, Plovdivska, 14.vi.1968 (A. Germanov); 1♂, Grecia Tripolis, 10.v.1987 (P. Angelov).

Entedon lixi Erdös
(Figs. 4d, 11a-c, 18a-c)


Diagnostic characters as follows: Female: Hypopygium with anterior median incision broad V-shaped; antero-lateral angle circular; other characters variable (Fig. 4d); Posterior lobe posteriorly narrowing towards posterior median incision, median sclerotized line reached about middle of hypopygium, posterior median incision as in Fig. 4d; Apical margin of forewing with fringe; Metasoma with syntergum distinctly shorter than its basal breadth; last tergite at most as long as its basal breadth; Antenna (Fig. 11) with F1 having one basiconic peg sensilla in 1/3 apical part, additional to the apical ones as in fig. 11 b, clava with C1 having two rows of longitudinal sensillae (Fig. 11c); combined length of pedicel plus flagellum about 0.70-0.77 times breadth of head; metasoma with syntergum about half as long as its basal breadth; last tergite about as long as its basal breadth. Male: Antennal funicle with four segments; club with 1-segmented (Fig. 18), scape 2.75 times as long as broad; pedicel about 1.26 as long as broad; 0.6 times as long as F1; F1 apically broader than base, almost truncate cone-shaped, about 1.5, F2 1.25 times as long as broad, F3 quadrate, F4 1.28 times as long as broad, clava about (including spicula) 2.33 times longer than broad; flagellar segments with sparse longitudinal sensillae, mostly in one row (Fig. 18a-c).

Studied materials: 1♀, Erzurum, 08.ix.1978 (H. Özbek); 1♀, 26.vi.1979 (M. Doğanlar); 1♂, Kahramanmaraş, Yukarımülk village, 02.v.2008, swept from Circium sp. (M. Doğanlar); 1♀, Şanlıurfa, Birecik, Arat mnt. Swept from lentil field (M. Doğanlar); 1♂, Bozova, Kangörmez village, swept from Vicia sp. and Sinapis sp. plantation (M. Doğanlar); 1♀, Erzincan, 09.v.1982 (M. Doğanlar) (MKUI).

Entedon mecini Askew
(Figs. 2c, 12a-c, 16d-f)


Diagnostic characters as follows: Female: Hypopygium (Fig. 2c) with anterior median incision almost absent, at most very broadly V-shaped; antero-lateral
angle angular, towards median incision slightly concaved; median sclerotized line reached slightly above middle of hypopygium; posterior lobe narrowing towards median incision, posterior median incision as in Fig. 2c. Apical margin of forewing with fringe; combined length of pedicel plus flagellum at least 0.7 times breadth of head; antennae with F1 having some basiconic peg sensillae medially, additional to apical ones as in fig. 12; eye height 1.8–2.5 times as long as malar space; combined length of pedicel plus flagellum about 0.72 times breadth of head; metasoma with syntergum about 0.57-0.64 times as long as its basal breadth; last tergite 0.8-0.86 times as long as basal breadth. Male: Antennal funicle with four segments, club with 1-segmented (Fig. 20), scape 3.75 times as long as broad; pedicel about 1.5 as long as broad; F1 twice, F2 1.67, F3 1.1, F4 1.4, times as long as broad, clava one-segmented, about twice longer than broad (Fig. 20d-f).

Studied material: Tokat, 1 ♀, 6.viii.1986 (M. Doğanlar); 1 ♀, 19.iv.1989, (H. Çam); 1 ♀, 28.v.1989 (H. Çam); 7 ♂♂, 09. iv.–11.v.1989, swept from pasture (H. Çam) (MKUI).

LITERATURE CITED


Figure 1. Hypopygium of Entedon cardui Askew.
Figure 2. Hypopygia of *Entedon sparetus* Walker, *Entedon insignis* Erdös and *Entedon mecinii* Askew.

Figure 3. Hypopygia of *Entedon thomsonianus* Erdös (a) and *E. adiyamanus* n. sp. (b).

Figure 4. Hypopygia of species of the *sparetus* species group of genus *Entedon*.
Figure 5. Female antenna of *Entedon bakacakicus* Doğanlar. Arrows state basiconic peg sensillae.

Figure 6. Female antenna of *E. thomsonianus* Erdős and *Entedon nizipicus* n. sp.

Figure 7. Female antenna of *Entedon sparetus* Walker.

Figure 8. Female antenna of *Entedon longiventrosus* Dalla Torre.
Figure 9. Female antenna of *Entedon cardui* Askew.

Figure 10. Female antenna of *Entedon mecini* Askew.

Figure 11. Female antenna of *Entedon lixi* Erdös. Arrows state basiconic peg sensilla.

Figure 12. Female antenna of *Entedon insignis* Erdös. White arrows state basiconic peg sensilla.
Figure 13. Female antenna of *Entedon adiyamanicus* n.sp. Arrows state basiconic peg sensillae.

Figure 14. Male antennae of *Entedon thomsonianus* Erdös (a-c) and *Entedon nizipicus* n.sp. (d-f).

Figure 15. Genitalia. a. *Entedon nizipicus* n. sp.; b. *Entedon thomsonianus* Erdös.
Figure 16. Male antennae of *Entedon cardui* Askew and *E. insignis* Erdős.

Figure 17. Male antenna of *Entedon bakacakicus* Doğanlar.

Figure 18. Male antenna of *Entedon lixi* Erdős.

Figure 19. Male antennae of *Entedon sparetus* Walker.
Figure 20. Male antennae of Entedon mecini Askew and *E. longiventrosus* Dalla Torre.
EMBRYONIC DEVELOPMENT IN MUGA SILKWORM, ANTHERAEA ASSAMENSIS HELFER (LEPIDOPTERA: SATURNIIDAE)

Dulal Goswami*, N. Ibotombi Singh*, Mustak Ahamed* and K. Giridhar*

* Central Muga Eri Research and Training Institute, Lahdoigarh, Jorhat-785700, Assam, INDIA. E-mail: ibotombisingh@yahoo.co.in


ABSTRACT: Chronological variations during embryonic development of normal eggs of Antheraea assamensis Helfer were recorded from 24 h to till hatching. During 10-16 h of the embryonic development, the ventral plate is formed and by 24 h trough shaped embryonic premodium floats in yolk and the protocephalon and protocorn are separated by transverse furrows. After 96 h the embryo became C-shaped. Although, mouth parts are yet not developed completely but they were at the advance stage of development. The thoracic region is clearly divisible into three thoracic segments. After 120 h, organogenesis in embryo takes place. The antennae bear segments and head region was detachable into three segments. The head capsule formation completed in after 144 h and mouth parts got matured. Three segmented antennae with antennal setae, the mandibles and labrum are well developed. After 168 h old, mandible become selerotised and pigmented at distal ends. Larval eyes appear as six brown spot on either side of head. The spiracles are clearly visible on the sides of the body. Fully developed muga silkworm larva comes out from the egg cell after 8th day of oviposition rupturing the anterior part of egg shell by the mandibles.

KEY WORDS: Antheraea, assamensis, embryonic development, different stages, organogenesis.

Muga silkworm, Antheraea assamensis Helfer is the lustrous golden yellow silk producing lepidopteran insect endemic to North-East India, which serves as an exclusive ecological niche for this species. The muga silkworm is semi-domesticated, polyphagous and multivoltine in nature having five to six generations in a year. ‘Som’, Persea bombycina Kost and ‘Soalu’, Litsaea polyantha Juss are the two primary food plants of muga silkworm.

Egg is considered as the key factor of sericulture industry. Only quality eggs can ensure a good harvest and healthy crop. The oviposition and hatching of eggs of muga silkworm are severely affected during the adverse summer months of the year i.e. July to September owing to the prevalence of high temperature coupled with very high humidity. The non-synchronized moth emergence results in wastage of valuable biological material and absence of technology for silkworm egg preservation etc. are among the main constrains of muga silk industry. Postponement of hatching sometimes becomes inevitable for solving problems associated with synchronized brushing, as per suitability of season and availability of good foliage (Pandey et al., 1992). In traditional practice, muga silkworm eggs are preserved at room condition/BOD incubator at 26 ± 2 °C for incubation just after the completion of the daily grainages in a piece meal system during all the seasons of rearing. The eggs are collected after 72 hours of laying. This practice creates problems like, synchronizing hatching with leaf sprouting, non uniform hatching due to mixing of eggs of different ages leading to unequal development of worms during rearing, timely distribution of eggs in bulk with
uniform hatching for commercial rearing, etc. which resulted in low productivity. Therefore, in commercial grainages, it becomes necessary to develop appropriate technologies of short and long term preservation of eggs in muga culture to postpone hatching for synchronizing hatching with leaf sprouting, to skip unfavourable seasons and timely supply of eggs in bulk with uniform hatching. This will protect the wastage of valuable biological material. Before proceeding to long term cold preservation of embryo, it is essential to know in details about the different embryonic developmental stages and confirm the suitable embryonic stage for preservation at low temperature. Technologies for preservation of multivoltine muga silkworm eggs have not been established thereby facing a big hurdle in the management of seed sector of the industry. The non-diapause eggs of mulberry silkworm, B. mori can be preserved at low temperature for more than 70 days without affecting the hatching (Rajanna et al., 2009). In mulberry silkworm, the longest embryonic stage i.e. stage 15 has been identified as the suitable stage of effective preservation for longer duration (Vemananda Reddy et al., 2003). In muga silkworm, the different embryonic developmental stages have not been studied. Therefore, in the present study, we present the different embryonic developmental stages of muga silkworm eggs which will help to find out the suitable stage for longer duration of preservation of eggs.

**MATERIAL AND METHOD**

Muga silkworm eggs were collected from the Muga Silkworm Breeding Section, Central Muga Eri Research and Training Institute, Central Silk Board, Jorhat, India. To isolate the different embryonic developmental stages of muga silkworm in different ages, the standard technique developed by Vemananda Reddy et al. (2003) for mulberry silkworm was followed with slight modification as the eggs of muga silkworm has thick chorionic layer covered with thick gummy substances.

The zero age eggs of muga silkworm, A. assamensis were collected and incubated at 26 ± 2 °C and relative humidity of 75-85 % for different durations from 24 h to till hatching and the stages of embryonic development at the different ages were studied at an interval of 12 h. The egg samples of different age groups were boiled in 3 – 4 % KOH solution for 2-3 minutes and then washed in 60 °C water. Care is taken so that KOH does not dissolve the embryo. The embryo was then kept in distilled water maintained at room temperature in a transparent glass petridish and kept under the dissecting stereo zoom microscope. The water was squirted by using a Pasteur pipette over the eggs to release embryos. The egg shell was removed from the micropylar end using a sharp surgery blade. With the help of a pointed needle and soft brush, the embryo was freed from the yolk material. The embryos were arranged for taking photograph of that particular age to use as reference for future. After isolation of different stages, embryos were preserved in 70 % alcohol in the small glass vial for preparation of permanent slide.

**RESULT AND DISCUSSION**

Like in most other insects, life of muga silkworm begins as an independent egg. Each egg is manufactured within the female's genital system and is eventually released from her body through an ovipositor, a component of her external genitalia (Fig. 1). The cell's cytoplasm is usually distributed in a thin band just inside the vitelline membrane and in diffuse strands that run throughout the
yolk. The egg cell's haploid nucleus lies within the yolk, usually close to one end of the egg. The egg's anterior/posterior polarity is determined by the relative positions of the nucleus and the oosome. The egg is covered by a protective "shell" called the chorion made of protein secreted before oviposition by accessory glands in the female's reproductive system. The chorion is perforated by microscopic pores called aeropyles that allow respiratory exchange of oxygen and carbon dioxide with relatively little loss of water. The micropyle, a special opening near the anterior end of the chorion, serves as a gateway for entry of sperm during fertilization.

Embryogenesis is a developmental process that usually begins once the egg has been fertilized. After two hours of oviposition, male and female pronuclei unite at a definite position near the anterior pole to form zygote (Takami, 1969). The zygote yields about 5000 daughter nuclei through 12-13 cycles of mitosis without cytokinesis. The cleavage nuclei migrate through the yolk toward the perimeter of the egg. They settle in the band of periplasm where they engineer the construction of membranes to form individual cells and a one-cell-thick layer, the blastoderm is formed. Blastoderm cells on one side of the egg begin to enlarge and multiply. This region, known as the germ band is where the embryo's body will develop. The rest of the cells in the blastoderm become part of a membrane that forms the yolk sac. Cells from the serosa grow around the germ band, enclosing the embryo in an amniotic membrane.

At the cellular blastoderm stage, when secondary membrane is formed between blastoderm cells and the yolk system, some cleavage nuclei migrating towards egg periphery are prevented from entering into the periplasm and they remain attached to the secondary yolk membrane. These become vitellophages. Cleavage nuclei remaining in yolk becomes the centers of yolk granules to supply nutrition to the developing embryo. Yolk membrane folds during late germ band stage after which the yolk system divided into masses each enclosing one or several nuclei and yolk organelles. This process is known as yolk segmentation (Miya, 1984).

The embryonic developmental stages in Bombyx mori were serially numbered from 1-30 (Takami & Kitazawa, 1960). The embryonic developmental stages in eri silkworm, Samia ricini has been studied and identified the suitable stage for cold preservation (Sarkar et al., 2012). The fertilization is considered as stage-1, Cleavage is stage -2 and Blastoderm is stage -3. The earliest embryonic stage that can be isolated and removed is from stage 4 i.e. germ band onwards.

The chronological variations during embryonic development of normal eggs were recorded from 24 h to till hatching (Fig. 2A-N). Thirteen different embryonic stages were detected and among these stages the longest stage viz. Hei - B stage was observed at 68 h to 72 h old embryo.

Stage-4: This stage is called germ band, which develops to an embryo. A group of cells attaches to the inside at a specific region of the germ band. The cytoplasm of these cells appears dense than that of germ band cells. These are primordial germ cells. The germ band is concave on the inner side and the shape is of an oval plate. In muga silkworm, it forms within 24 h of oviposition (Fig. 2A). Throughout 22-28 h, the germ band becomes slender and elongated and by 28-34 h, a long narrow depression called the primitive groove or streak or median plate is formed along the mid portion of the germ band on upper side. By 24-36 h, the development of embryo was well differentiated into head and trunk region (Fig. 2B).

Stage-5, 6 & 7: The embryo gradually contracts to the shape of Dharuma (Japanese doll). Gradually the head and tail region can be identified. After 48 h,
segmentation of the body is clearly visible. The head end is called the protocephalon and the tail end is called caudal lobe. This stage is continued from 36 h to 60 h in muga silkworm egg (Fig. 2B-2D).

Stage-15: In 68 h to 72 h of age, the embryo reaches this stage wherein the metamerism of mesoderm is completed and mesoderm is arranged segmentally (Fig. 2E). In 72 h, embryo showed three well differentiated distinct regions of the body i.e. head, thorax and abdomen. The segmentations with enough length and the amniotic fold covering the embryo were clear and serosa was completely covered with the yolk. The embryo was slender with a well-defined head and caudal region. The head has a clear cut depression in the middle. Mesoderm segments are clearly visible.

Stage-16-20: In 84-96 h, rudiments of appendages appear in thoracic region and cephalic region formed by the beginning of stomodaum.

Stage-21: The process of blastokinesis begins in 108-120 h after oviposition. Embryo starts to move around. Blastokinesis first start in the abdominal region and extend towards heads. Posterior abdominal segments are first turned vertically so that the abdominal region as a whole forms a straight line. The abdominal region then turns towards anterior side and reaches the level of prothorax. The anterior and posterior ectodermal invaginations extends to form the fore gut and hind gut respectively.

Stage-22: The head capsule formation completed in after 132 h and mouthparts got matured (Fig. 2J). Three segmented antennae with antennal setae, the mandibles and labrum are well developed. Yolk mass inside the eggs serves as a source of nutrients for the developing embryo and also help in holding the embryo on its surface as a necessary foundation.

Stage-23: After 144 h lateral walls complete and tips of labrum and labium become segmented (Fig. 2K). Thoracic legs become segmented with claws at distal end. Rudiments of the setae develop on the body surface.

Stage-24: At about 156 h, entire body of embryo is covered by strong setae and embryonic moult occurs in this stage. The caudal horns also occur in this stage.

Stage-25-29: After about 168 h, mandible become selerotised and pigmented at distal ends (Fig. 2M). Larval eyes (i.e. ocelli) appear as six brown spot on either side of head. The spiracles are clearly visible on the sides of the body. Head capsule and mouth appendages are selerotised and well pigmented. The amnion and serosa disappear by fragmentation. Embryo ingests the embryonic membranes and sensitive for adverse environmental condition. Entire body of embryo becomes sierotised.

Stage-30 (Newly born muga larvae): Fully developed muga silkworm larva comes out from the egg cell on the 8th day of oviposition rupturing the anterior part of egg shell by the mandibles and swallowing the portion of the chorion in the early morning of exposure of light (Fig. 2N). Newly born larvae are generally blackish or brownish in colour. Generally healthy larvae are blackish brown in colour with distinct yellow lines at the intersegment region. Head portion is shining black with elongated spot and larval body is yellowish with blackish tubercle.

Present finding indicates that, the embryonic development starts within a few hours of egg laying and it requires proper incubation for healthy development of embryos. Any change in temperature can hamper the development, hatching and rearing performance. Embryonic development and hatching were hampered at the stressed temperature and humidity condition because high temperature and low humidity were unfavorable condition for embryonic development (Dinesh et al., 2012). Due to global warming, this type of condition prevails during seed crop
grainages of summer seasons of A. assamensis. Higher temperature and low humidity during embryonic development leads to death of embryo during early age. Temperature stress caused poor egg laying, delay and poor hatching, depression of eggs and death of fully formed larvae inside egg. The result of the present study will help to find out the particular embryonic stage suitable for long term egg preservation which will help to skip the unfavourable season and can synchronize rearing with availability of leave.

LITERATURE CITED


Figure 1. A. Mother moth laying eggs, B. Eggs (enlarged).
Figure 2. Different developmental stages of embryos of muga silkworm (24 h to till hatching).
TAXONOMIC AID TO MAJOR CRAMBID VEGETABLE PESTS FROM NORTH INDIA (LEPIDOPTERA: CRAMBIDAE)

Rajesh Kumar*, Vishal Mittal**, Neeraj Kumar*** and V. V. Ramamurthy****

* Central Muga Eri Research and Training Institute, Central Silk Board, Ministry of textiles, Govt. of India, Lahdoigarh (Assam), INDIA.
** Central Sericultural research and training institute, Central Silk Board, Ministry of textiles, Govt. of India, Pampore (Jammu & Kashmir), INDIA.
*** Meerut College, C.C.S. University, Meerut (Uttar Pradesh), INDIA.
**** National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi, INDIA.

ABSTRACT: The six insect pest Crocidolomia binotalis Zeller, Hellula undalis (Fabricius), Leucinodes orbonalis Guenee, Maruca testulalis (Geyer), Spoladea recurvalis (Fabricius), Syllepte derogata (Fabricius) (Lepidoptera: Crambidae) reported as major pests on vegetable from North India. These pests have been reviewed taxonomically and compiled with diagnostic features. In the manuscript superfamily Pyraloidea, family Crambidae, and subfamilies Spilomelinae, Glaphyriinae, Evergestinae, characters and their major vegetable pests species treated taxonomically and illustrated with diagnostic features. Besides these, worldwide distribution, host range and North Indian distribution discussed.

KEY WORDS: Crocidolomia binotalis, Hellula undalis, Leucinodes orbonalis, Maruca testulalis, Spoladea recurvalis, Syllepte derogata.

India is the second largest producer of vegetables in the world next only to China with an estimated production of about 50 million tonnes from an area of 4.5 million hectares at an average yield of 11.3 tonnes per hectare (Sidhu, 1998). Vegetables are valuable sources of nutrients and they are also being recognised for their antioxidant properties (Salawu et al., 2006; Chipurura et al., 2010) and also recognized for the production of vegetable oils (soybean oil, sunflower oil, sesame oil, rice bran oil and olive oil), which are utilized in cooking and pharma industry (Pogori et al., 2008). Vegetables are more prone to insect pests and diseases mainly due to their tenderness and softness as compared to other crops. Perusal of literature reveals that no consolidated account is available on the Lepidopterous insects associated with vegetables in India, though the major contribution by Lefroy (1909), Fletcher (1914, 1921), Pradhan (1969), Nair (1970), Butani & Jotwani (1984), Gupta (1990), David (2001), Sharma et al. (2008), Kumar et al. (2007a,b), Kumar et al. (2008). In this paper an attempt has been made to provide the current status, illustrated diagnostic tools such as field diagnostics and taxonomically diagnostic tools with updated classification. Besides this, the superfamily, family and subfamily level characters have been reviewed and presented in illustrated from, which are helpful for taxonomists and in Insect Pest Management.

MATERIAL AND METHODS

The adults were collected in the field with aspirator, manually and aerial sweep net, and at night with the help of portable light traps of different light
sources (ultra violet, black light and mercury vapour light) (Atay, 2006; Abdullah & Shamsulaman, 2008) during year 2005 to 2008. The collected insects were killed by using tetrachloro ethane. These were stretched, pinned, labeled, identified, preserved in the wooden collection boxes and deposited in the National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi. The insect pest was identified as Crocidolomia binotalis Zeller, Hellula undalis (Fabricius), Leucinodes orbonalis Guenee, Maruca testulalis (Geyer), Spoladea recurvalis (Fabricius), Sylepte derogata (Fabricius). The collected / reference specimens preserved in the National Pusa Collection were also examined. The collected specimens were examined taxonomically and studied for diagnostic characters including genitalia. The standard technique given by Robinson (1976) and Zimmerman (1978) has been followed for wing venation and genitalia, respectively. To write the taxonomic descriptions on various morphological characters (Hampson, 1892; Kitching, 2003), wing venation (Common, 1970; Zimmerman, 1978) and external genitalia (Klots, 1970; Kitching, 2003) has been followed. For naming of various veins, Comstock-Needham system has been adopted. For external genitalia, the terminology used for various parts as suggested by Klots (1970), Robinson (1976), Winter (2000), Kitching & Cadiou (2000) and Kitching (2003) has been followed. All illustrations were made by using a drawing tube attached to a Nikon SMZ10 stereoscopic zoom microscope and finalized in plate (prepared in 300 pixels/inch) through Adobe Photoshop Element 2.0 software. In the field and laboratory observation, specimens were photographed prior to studies, using a Sony Mavica MVC FD 97, Sony DSC R1 10.3 mega pixel Cyber-shot and Canon DSC 5.0 mega pixel Powershot S50 cameras.

**Taxonomic Study**

(A). **Super family: Pyraloidea**

Pyraloidea, the third largest superfamily of the Lepidoptera following Noctuoidea and Geometroidea, are comprised two families Pyralidae and Crambidae. The group includes 16,000 species worldwide, with greatest richness in the tropics. Pyraloidea moths are ditrysian moths characterized by the following morphological features, paired tympanal chambers on second sternite, each with a tympanum and a conjunctiva and a basally scaled proboscis (Figs. 1-2).

(a). **Family: Crambidae**

The Crambidae is the larger family with just under approximately 10,000 described species worldwide. The moths of this family are small to medium size and wingspan usually 10-35 mm. The proboscis basally scaled (Plate I, Fig. B). Tympanal organs present at the base of abdomen ventrally and ‘opened’ anteriomedially. Praecinctorum is present, structure in the ears, which joins two tympanic membranes in the Crambidae, and is absent in Pyralidae (Fig. 3).

(i). **Subfamily: Spilomelinae**

This subfamily is represented by highest species among pyraloides. The moths are characterized by the absence of chaetosemata, a bilobed praecinctorium, projecting fornix tympani, pointed spinula, absence of a gnathos, and the male genitalia have no rhomboidal signum on the bursa copulatrix (Figs. 4-6).

1. **Leucinodes orbonalis Guenée** (Figs. 14-28)

**Diagnosis**

**Alar expanse:** Male/Female 22- 26 mm.
Male and Female: head and thorax variegated with black and brown. Forewing with the base fulvous, ferruginous, and black, followed by an incomplete sinuous black line; large fulvous orbicular and reniform patches with some black on their edges and almost extending to costa; a black-edged ferruginous triangular patch from lower angle of cell to inner margin with a sinuous line beyond it; a pale fulvous sinuous postmedial band not reaching costa; a sinuous black subarmpinal line obsolescent towards outer angle and with a ferruginous and fuscous band beyond it, from below costa; some black specks on margin. Hindwing opalescent, with black speck at upper angle of cell and spot at lower angle; an postmedial black line nearly straight from costa, then recurved and sinuous; some pale fulvous submarginal patches and some black specks on margin. Palpi banded with fuscous; thorax marked with ferruginous or fuscous. Forewing more or less suffused in parts with ferruginous and fuscous; male with the costal tuft ochreous and black; a double antemedial line highly dentate in and below cell; prominent dark-edged white spots at the angles of cell; a highly curved minutely dentate postmedial line, with a series of black specks on it and distinct line beyond it; an indistinct minutely waved submarginal line; cilia leaden coloured at tips; the fringe of hair below median nervure ochreous. Hindwing semihyaline ochreous white; the apical area often more or less suffused with fuscous.

Wing venation: Forewing: vein Sc straight; R₁ and R₂ free; R₃+₄ stalked; R₅, M₁ free, from below the upper angle of cell; M₂, M₃ free, from lower angle of cell; M₃ and Cu₁a close to the lower angle, nearer to M₃ than to Cu₁b. Cu₁ much before the cell angle, about thrice as far from Cu₁ the latter from M₃, and nearly in line with origin of R₁ above, 1A+2A fused; Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M₁ from a little below the angle; M₂ – M₃ stalked, from lower angle, Cu₁a and Cu₁b present and free arising from middle lower angle of discal cell.

♂ genitalia: uncus unique, long, distal end bent and more or less triangular, bearing six group of setae on dorsal surface, the ventral ending naked; gnathos conspicuous, very well developed, moderately long, curved and pointed at distal end, with six short but prominent dents on dorsal surface; tuba analis shorter than uncus; scaphium developed; subscaphium thin and well sclerotized; tegumen broad; vinculum produced anteriroy into a rounded saccus. Valva broad, almost uniformly broad symmetrically curved distally; costa with poorly defined inner lining; sacculus developed; harpe present. Transtilla with each half long; juxta narrow anteriorly and broad posteriorly, with a round shaped sclerotization at basal portion. Aedeagus moderately long, much broader in the posterior half; vesica armed with three well defined and with one cornutus.

♀ genitalia: Corpus bursae more rounded, partially sclerotized; signum absent; ductus bursae long, with posterior portion quite broadened, without any sclerotization; anterior apophyses short, each with a sharp and fine angular prominence near base based pointed; posterior apophyses longer than anterior apophyses; ovipositor lobes fringed.


**Distribution**: Throughout Southern India (Fletcher, 1914); S. Africa, throughout India, Sri Lanka, Myanmar, Java, Duke of York Island (Hampson, 1896); widely distributed not only in the Indian sub-continent but also in South Africa, Congo and Malaysia (Butani & Jotwani, 1984).

**Host Range**: Brinjal, potato and other solanaceous crops (Butani & Jotwani, 1984 and during present study).

2. *Maruca testulalis* (Geyer) (Figs. 29-43)

**Diagnosis**

**Alar Expanse**: Male/Female: 20 to 30 mm

**Male and Female**: Head, thorax, and abdomen fuscous brown; palpi white below forewing fuscous brown; the costal area tinged with fulvous; indistinct subasal and antemedial lines across the cell and white spots below the cell; a lunulate black edged white spot in end of cell; a maculae black edged semihyaline band beyond the cell from below the costa to vein Cu_{1b}, hindwing semi hyaline white; the basal costal area fuscous and a spot at upper angle of cell; two upper angle of cell; two indistinct sinuous postmedial lines; a marginal fulvous brown and fuscous band from costa to vein Sc, its inner ledge very irregular.

**Wing venation**: Forewing: vein Sc straight; R_{1} and R_{2} free; R_{3+4} stalked; R_{5}, M_{1} free, from below the upper angle of cell; M_{2}, M_{3} free, from lower angle of cell; M_{3} and Cu_{1a} close to the lower angle, nearer to M_{3} than to Cu_{1a}, Cu_{1a} much before the cell angle, about thrice as far from Cu_{1a} the latter from M_{3}, and nearly in line with origin of R_{1} above, 1A+2A fused; Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M_{1} from a little below the angle; M_{2} – M_{3} stalked, from lower angle, Cu_{1a} and Cu_{1b} present and free arising from middle lower angle of discal cell.

♂ **genitalia**: Uncus very long, narrow and strongly curved, dilated at tip, tip conspicuously fringed with flat scales dorsally and with setae ventrally, along with half ventro-distal portion setose; gnathos absent; tuba analis shorter than uncus; scaphium absent; subscaphium well developed and straplike; tegumen dome shaped, longer than broad and well sclerotized; vinculum moderately long and produced anteriorly into a blunt saccus. Valva long and almost egg shaped distally; costa broadly inflated, with sclerotized area produced into a beak-like thickening at its middle; sacculus prominent; harpe short and strongly sclerotized. Transtilla very reduced and membranous; juxta long and more or less triangular at distal end, weakly but uniformly sclerotized. Aedeagus comparatively short, with a thick sclerotized strap in one wall; vesica armed with loosely arranged denticles.

♀ **genitalia**: corpus bursae more or less dropper shaped, membranous; signum missing; ductus bursae moderately long and straight, membranous, with a sclerotized collar at ostial end; anterior apophyses long and stout, each with an angular thickening near base; posterior apophyses short and thin; ovipositor lobes densely fringed with array of long and short setae.


**Distribution**: Neotropical and Ethiopian regions, Japan, throughout the Oriental and Australian regions (Hampson, 1896); throughout Southern India (Fletcher, 1914); widespread in tropical and subtropical regions of the world (Butani & Jotwani, 1984).

**Host Range**: Indian beans, cowpea, castor, groundnut, rice, tobacco, green gram and red gram (Fletcher, 1914; Butani & Jotwani, 1984 and during present study).

### 3. Spoladea recurvalis (Fabricius) (Figs. 44-58)

**Diagnosis**

**Alar Expanse**: Male/Female: 15 to 20 mm.

**Male and Female**: Head and thorax of Adults are small sized black color ochreous suffused with rufous and abdomen is suffused with ruscos; labial palpi upcurved, three segmented, antennae thin long filiform, tibial spurs 0-2-4 (foreleg-midleg-hindleg) and foreleg with epiphysis.

**Wing venation**: Forewing: vein Sc straight; R1 and R2 free; R3+4 stalked; R5, M1 free, from below the upper angle of cell; M2, M3 free, from lower angle of cell; M3 and Cu, close to the lower angle, nearer to M3 than to Cu; Cu, much before the cell angle, about thrice as far from Cu, the latter from M3, and nearly in line with origin of R1 above, 1A+2A fused, 3A present; Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M1, from a little below the angle; M2 – M3 stalked, from lower angle, Cu, and Cu2 present and free arising from middle lower angle of discal cell.

♂ **genitalia**: Uncus extremely reduced, broad at based and rounded at distal end, apex crowned with short and thick setae; tuba nails not examined; tegumen broader than long, heavily scleroized; vinculum produced into a rounded rudimentary saccus. Valva leaf like; costa narrowly inflated, produced into a small finger like process from its middle towards inner side, with very long setae on costal margin; sacculus poorly differentiated at base only; cucullus subrounded. Transtilla inconspicuous; juxta U-shaped. Aedeagus long, moderately narrow and slender, with a sclerotized strap in one wall and the other one membranous; vesica with a long sclerotized plate, representing the cornutus.

♀ **genitalia**: Corpus bursae long, narrow and rounded anteriorly slightly broadend posteriorly, with areas of sclerotization, signum heavily scleroitized; ductus brusaev very reduced; anterior apophyses long and stout; posterior apophyses short and thin; ovipositor lobes narrow, densely setose with long setae.


**Distribution**: Throughout India.

**Host range**: Amaranthus, spinach; beet root, koorkan (Fletcher, 1914; Nair, 1970; Butani & Jotwani, 1984; Gupta, 1990; David, 2001; Capinera, 2001 and during present study)

4. *Sylepta derogata* Lefroy (Figs. 59-73)

**Diagnosis**

**Alar Expanse**: Male/Female 28 to 40 mm.

**Male and Female**: Yellowish white; the head and thorax spotted with black and brown; abdomen with segmental brown rings; a pair of black spots or dorsal band on 2nd segment and one or two black spots towards extremity. Forewing with two subbasal series of black-brown spots often developed into lines; an oblique antemedial line; an annulus in cell and smaller one below it; a large reniform discocellular mark; a postmedial sinuous line highly bent outwards between veins M2 and Cu1, and usually with a line across its sinus; the veins of outer area streaked with brown; a minutely dentate sum marginal line slightly angled on vein Cu1; a marginal line. Hindwing with discocellular annulus touching an oblique minutely dentate antemedial line; a sinuous postmedial line, highly excurred and dentate between veins M2 and Cu1, its sinus crossed by a dentate line; a minutely dentate subarginal line bent outwards to anal angle.

**Wing venation**: Forewing: vein Sc straight; R1 and R2 free; R3+4 stalked; R5, M1 free, from below the upper angle of cell; M2, M3 free, from lower angle of cell; M3 and Cu1 close to the lower angle, nearer to M3 than to Cu1a; Cu1, much before the cell angle, about thrice as far from Cu1b the latter from M3, and nearly in line with origin of R1 above, 1A+2A+3A fused; Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M1 from a little below the angle; M2 – M3 stalked, from lower angle, Cu1a and Cu1b present and free arising from middle lower angle of discal cell.

♂ **genitalia**: Uncus very long, narrow and strongly curved, dilated at tip, tip conspicuously fringed with flat scales dorsally and with setae ventrally, along with half ventro-distal portion setose; gnathos absent; tuba analis shorter than uncus; scaphium absent; subscaphium well developed and straplike; tegumen dome shaped, longer than broad and well sclerotized; vinculum moderately long and produced anteriorly into a blunt saccus. Valva long and almost egg shaped distally; costa broadly inflated, with seclerotized area produced into a beak-like thickening at its middle; sacculus prominent; harpe short and strongly sclerotized. Transtilla very reduced and membranous; juxta long and more or less triangular at distal end, weakly but uniformly sclerotized. Aedeagus comparatively short, with a thick sclerotized strap in one wall; vesica armed with loosely arranged denticles.

♀ **genitalia**: corpus bursae more or less dropper shaped, membranous; signum present; ductus bursae moderately long and straight, membranous, with a sclerotized collar at ostial end; anterior apophyses long and stout, each with an angular thickening near base; posterior apophyses short and thin; ovipositor lobes densely fringed with array of long and short setae.


**Distribution:** The tropical and warmer temperate zones (Hampson, 1896); throughout the plains of Southern India (Fletcher, 1914); India (Butani & Jotwani, 1984).

**Host Range:** Okra, cotton and other malvaceous plants (Fletcher, 1914; Butani & Jotwani, 1984).

(ii). **Subfamily: Evergestinae**  
Evergestinae is a fairly small subfamily of the lepidopteran family Crambidae, the crambid snout moths. It contains roughly 140 species on all continents and continental islands. Evergestine moths resemble Pyraustinae; however, the male genitalia have a long uncus and long, slender gnathos. The larvae feed mostly on plants of family Brassicaceae (Figs. 10-13)

5. **Crocidolomia binotalis Zeller** (Figs. 74-88)  
**Diagnosis**  
**Alar expanse:** Male/Female 24- 28 mm.  
**Male and Female:** Palpi banded with fuscous; thorax marked with ferruginous or fuscous. Forewing more or less suffused in parts with ferruginous and fuscous; male with the costal tuft ochreous and black; a double antemedial line highly dentate in and below cell; prominent dark-edged white spots at the angles of cell; a highly curved minutely dentate postmedial line, with a series of black specks on it and distinct line beyond it; an indistinct minutely waved submarginal line; cilia leaden coloured at tips; the fringe of hair below median nervure ochreous. Hindwing semihyaline ochreous white; the apical area often more or less suffused with fuscous.  
**Wing venation:** Forewing: vein R1 curved towards Sc and closely approximated to the latter but sometimes touching or shortly anastomosing with it; R2 free; R3+4 stalked; R4, M1 free, from below the upper angle of cell; M2–M3 close to each other, from lower angle of cell; Cu1a close to the lower angle, nearer to M3 than to Cu1a, three veins, i.e. M2, M3 and Cu1a equidistantly placed; Cu1a much before the cell angle, about thrice as far from Cu1a the latter from M3, and nearly in line with origin of R1 above, 1A and 2A present. Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M1 from a little below the angle; M2 – M3 stalked, from lower angle, Cu1a and Cu1b present and free arising from middle lower angle of discal cell.  
♂ **genitalia:** uncus unique, long, distal end bent and more or less triangular, bearing six group of setae on dorsal surface, the ventral ending naked; gnathos conspicuous, very well developed, moderately long, curved and pointed at distal end, with six short but prominent dents on dorsal surface; tuba analis shorter.
than uncus; scaphium not developed; subscaphium thin and well sclerotized; tegumen broad; vinculum produced anteriortly into a rounded saccus. Valva long, almost uniformly broad unsymmetrically rounded distally; costa with poorly defined inner lining; sacculus poorly demarcated; harpe absent. Transtilla with each half long and ribbon like, weakly sclerotized; juxta narrow anteriorly and broad posteriorly, with a v-shaped sclerotization at basal portion. Aedeagus moderately long, much broader in the posterior half; vesica armed with three well defined and heavily sclerotized cornuti.

♀ genitalia: Corpus bursae more or less rounded, partially sclerotized; signum absent; ductus bursae long, with posterior portion quite broadened, without any sclerotization any-where; anterior apophyses long, each with a sharp and fine angular prominence near base based pointed; posterior apophyses short and thing; ovipositor lobes fringed with different.


Distribution: South Africa, Formosa, throughout India, Ceylon, Burma, Java, Australia and Norfolk Island (Hampson, 1896); widely distributed in Indian sub-continent as also in South-east Asia, Australia and Africa (Butani & Jotwani, 1984).

Host Range: All brassica crops and specially cabbage (Butani & Jotwani, 1984 and during present study).

(iii). Subfamily: Gephyriinae
Adults are mostly small and broad-winged; labial palpus short; cheatosemata absent. In the male genitalia the uncus is usually well developed and slender, but sometimes modified or reduced; gnathos absent (Figs. 7-9).

6. Hellula undalis Fabricius (Figs. 89-103)
Diagnosis
Alar expanse: Male/ Female 18 to 22 mm.
Male and Female: Grey and brown suffused with fuscous. Forewing with pale dentate subasal line; a dark antemedial line on a pale band excurred between subcostal and median nervures; a pale-edged dark discocellar lunule; a pale postmedial line excurred from vein R₅ to Cu₃; a pale apical spot and series of pale and dark marginal specks. Hindwing pale, with slight fuscous suffusion on apical area.
Wing venation: Forewing: Sc straight and attached with discal cell, vein R₁ straight and arising from upper middle discal cell; R₂ free; R₃+4 stalked; R₅, M₁ free, from below the upper angle of cell; M₂-M₃ close to each other, from lower angle of cell; Cu₁ close to the lower angle, nearer to M₃ than to Cu₁a, three veins, i.e. M₂, M₃ and Cu₁a equidistantly placed; Cu₁a much before the cell angle, about thrice as far from Cu₁b the latter from M₃, and nearly in line with origin of R₁ above, 1A and 2A present. Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M₁, from a little below the angle; M₂–M₃ stalked from lower angle of discal cell, Cu₁a and Cu₁b present and arising from middle lower angle of discal cell.

♂ genitalia: uncus unique, long, distal end bent and more or less triangular, bearing six group of setae on dorsal surface, the ventral ending naked; gnathos conspicuous, very well developed, moderately long, curved and pointed at distal end, with six short but prominent dents on dorsal surface; tuba analis shorter than uncus; scaphium not developed; subscaphium thin and well sclerotized; tegumen broad; vinculum produced anterirolly into a rounded saccus. Valva long, almost uniformly broad symmetrically rounded distally; costa with poorly defined inner lining; sacculus poorly demarcated; harpe absent. Transtilla with each half long and ribbon like, weakly sclerotized; juxta narrow anteriorly and broad posteriorly, with a v-shaped sclerotization at basal portion. Aedeagus moderately long, much broader in the posterior half; vesica armed with sclerotized cornuti.

♀ genitalia: Corpus bursae more or less rounded, partially sclerotized; signum absent; ductus bursae long, with posterior portion quite broadened, without any sclerotization any-where; anterior apophyses long, each with a sharp and fine angular prominence near base based pointed; posterior apophyses same size as anterior apophyses; ovipositor lobes fringed.


Distribution: ASIA- Bangladesh, Brunei, Burma, Cambodia, Coco-Keeling Islands, Hong Kong, India, Indonesia, Laos, Malaysia, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam; AFRICA- Ghana, Kenya, Madagascar, Malawi, Mali, Mauritius, Mozambique, Nigeria, Rhodesia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Uganda, Upper Volta, Zaire, Zambia; AUSTRALASIA and PACIFIC ISLANDS - Australia, Caroline Islands, Cook Islands, Fiji, Mariana Islands, New Caledonia, Niue Island, Norfolk Island, Papua New Guinea, Western Samoa Solomon Islands, Tonga (CAB Map, 1979).

Host Range: Cabbage, cole crops and some root crops as well (Butani & Jotwani, 1984 and during present study).

DISCUSSION

Survey-cum-collection works on crambid lepidopterous insects associated with vegetables in North India were undertaken. On the basis of collected /
reference specimens Crambid insects associated with vegetables in India examined in the National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi, seven states/union territories of North India had been covered. In the present study integrating taxonomic aspects incorporation of the superfamily, family and subfamilies illustrated keys is the unique feature of study. The surveys led to the collection of six species on the following crops namely, brinjal, potato, Indian beans, cowpea, castor, groundnut, rice, tobacco, green gram, red gram, amaranthus, spinach, beet root, koorkan, okra, cabbage and cole crops.

The present study provided all the existing information on crambid insects associated with vegetables in North India, their host range, distribution and taxonomically identification tools, so that it will be helpful in identification. Management programs to the control of vegetable pests and for the higher productivity of vegetables.

The superfamily, family and subfamilies identification characters were reviewed earlier (Holloway et al., 1987), which was published in black and white as line diagrams. Now, all the characters of higher level taxa reviewed and illustrated in color, which will help in identification. Beside these characters, the major pests falls under these superfamilies were reviewed for the proper identification up to lower (species) level taxa. These illustrated diagnostic aid major crambid vegetable pests will help in proper identification to farmers and researchers.

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Figures 29-43. *Maruca testulalis* (Geyer) 29. adult (habitus) 30. antenna 31. head (lateral view) 32. fore leg 33. middle leg 34. hind leg 35. fore wing 36. hind wing 37, 41. male genitalia-ventral view 38, 42. aedeagus 39. male genitalia-lateral view 40, 43. female genitalia.
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A NEW SPECIES OF GENUS MACDUNNOUGHIA KOSTROWICKI (LEPIDOPTERA: NOCTUIDAE) FROM INDIA

Rajesh Kumar* and Vinay Kumar**

* Central Muga Eri Research & Training Institute, Central Silk Board, Ministry of Textiles (Govt. of India), Central Silk Board, Lahdoigarh 785700, Assam, INDIA. E-mail: rajesh.ento@gmail.com
** Department of Entomology, D.S. College, Aligarh, Uttar Pradesh, INDIA.

[Kumar, R. & Kumar, V. 2013. A new species of genus Macdunnoughia Kostrowicki (Lepidoptera: Noctuidae) from India. Munis Entomology & Zoology, 8 (2): 876-882]

ABSTRACT: Macdunnoughia kashmirensis sp. nov. from Srinagar, Jammu & Kashmir (India) is described and recognized as a member of the Macdunnoughia species group. Superficially, the species closely resembles Macdunnoughia confusa (Stephens, 1850). A discussion of the discrimination of the two species M. tetragona (Walker, 1858), M. confusa (Stephens, 1850) along with new species are presented.

KEY WORDS: Lepidoptera, Noctuidae, Macdunnoughia, new species, India.

Noctuid moths (Noctuidae) with about 25000 known species (Fibiger, 1990) represent one of the most species-rich families of Lepidoptera. The genus Macdunnoughia was erected by Kostrowicki in 1961 and belongs to the family Noctuidae and subfamily Plusiinae. Ronkey et al. (2008) published the “Taxonomic Atlas” for Plusiinae, in which genus Macdunnoughia described with five species (M. confusa, M. hybrida, M. crassisgma, M. purissima and M. tetragona). In the manuscript, three species of Macdunnoughia have been described from Srinagar, Jammu and Kashmir (India). One species is described as new and two species viz. M. confusa and M. tetragona redescribed on the basis of male genitalia. The type specimens are deposited in NPC (Insect & Mites), Division of Entomology, IARI, New Delhi (India).

MATERIAL AND METHODS

All the specimens collected from Sher-e-Kashmir University of Agricultural Sciences & Technology, Srinagar (Jammu & Kashmir) by Ultra Violet light trap and brought to National Pusa Collection (NPC), Division of Entomology, Indian Agricultural Research Institute, New Delhi (India). The collected specimens were processed for preservation in NPC after relaxing, pinning and setting. For genitalic studies, abdomens were placed in 10% aqueous KOH and heated for 20 min at 90°C using a Dry Block Heizgerät-28000, then placed for 5 min in glacial acetic acid to remove the debris. The genitalia were subsequently stored in 70% ethanol. For photographs, the genitalia were placed on a slide in glycerol and covered with a cover slip. Photographs of antennae, lateral view of the mouthparts, scales and genitalia were captured using LEICA Application Suit ver. 2.8.2 software and a LEICA DFC-290 camera attached to a LEICA MZi6A stereozoom microscope. For external genitalia, the terminology follows Klots (1970) and Winter (2000). The specimens have been deposited in the National Pusa Collection (NPC), Division of Entomology, Indian Agricultural Research Institute, New Delhi, India.
DESCRIPTION

Genus Macdunnoughia Kostrowicki, 1961
Type species: Plusia confusa Stephens, 1850

Synonym
Paraplusia Mukerji & Krishnamurthy 1955 : 295
Scleroplusia Ichinose, 1962 : 249

Key to three species of Macdunnoughia on the basis of male genitalia

1. Valvae broad, sacculus extension long .................................................................2
   - Valvae broad, sacculus extension short spine like.................. Macdunnoughia tetragona

2. Sacculus extension broad and pointed at apex; distinct projections at apex of valvae.................................................................M. confusa
   - Sacculus extension broad and blunt at apex; no distinct projections at apex of valvae.................................................................M. kashmirensis sp. nov.

1. Macdunnoughia tetragona (Walker, 1858)
   (Figs. 1, 2, 3, 10, 13, 14, 19, 20 and 21)

Plusia semivitta Moore, 1867, Proc. zool. Soc. Lond. 63, pl. 6, f. 13
Puriplusia zayuensis Chou & Lu, 1982, Insects of Xizang, 2: 98

Alar expanse: ♂ 3.0cm ± 0.05 (n=3)

Male: Vertex, frons and thorax dark grey, thorax with a very large spreading tuft. Labial palpi upturned, second segment long, third segment small, reaching up to vertex of the head. Antennae simple in filiform, ciliated, reaching about 3/4th length of forewing. Abdomen dark brown, with three large dorsal tufts on basal segments. Forewing elongated, grayish, hooked at outer angle, metallic markings being more brassy, those near outer margin less diffused, the costal portion of the subbasal line silvery, the antemedial line angled below median nervure, the two portions of the Y-mark narrow and silvery. Hindwing dark fuscous-grey in colour; legs long, beset with long hairs, deep brown in colour. Epiphysis present on prothoracic leg tibia, mesothoracic leg with a pair of tibial spur and metathoracic leg with two pairs tibial spurs.

Wing venation: Forewing with Sc arising from base of wing, ending near 3/4th of costa, R1 arising near 3/4th of discal cell, accessory cell present, R2 arising from accessory cell, R3 and R4 long stalked, R3 to costa, R4 to termen, R5 connate with R3 and R4, M1 arising near upper angle of discal cell, M1, M2 and M3 free, M2 near to M3 basally than M1, CuA1, CuA2 free, CuA1 arising from lower angle of discal cell, CuA2 arising at 2/3rd of cell, discal cell elongated, closed. Anal vein 1A long and 2A small, separate; hindwing with R, running into Sc from base of wing, joined by a bar with discal cell, Rs and M1, M2, M3 free, CuA2 arising near 2/3rd of discal cell, CuP not present, 1A+2A fused straight, 3A present, discal cell closed.


2. Macdunnoughia confusa (Stephens, 1850)
   (Figs. 4, 5, 6, 11, 15, 16, 22, 23 and 24)
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*Plusia bigutta* Staudinger, 1892, In Romanoff, Mém. Lépid. 6: 545

*Phytometra confusa* ab. *aestiva* (Krulikowski, 1908)

*Phytometra confusa* ab. *deangulata* Strand, 1917; Arch. Naturgesch. 82 A (2): 49

*Plusia gutta* ab. *grisea* Dannehl, 1933, Ent. Z. 47: 20


*Macdunnoughia monosigna* Chou & Lu, 1979, Entomotaxonomia 1: 18

**Alar expanse:** ♂ 3.2cm ± 0.1 (n=13)

**Male:** Vertex, frons and thorax dark grey, thorax with a very large spreading tuft. Labial palpi upturned, second segment long, third segment small, reaching up to vertex of the head. Antennae simple in filiform, ciliated, reaching about 3/4th length of forewing. Abdomen dark brown, with three large dorsal tufts on basal segments. Forewing elongated, grayish, hooked at outer angle, metallic markings being more brassy, those near outer margin less diffused, the costal portion of the sub basal line silvery, the antemedial line angled below median nervure, the two portions of the Y-mark narrow and silvery. Hindwing dark fuscous-grey in colour; legs long, beset with long hairs, deep brown in colour. Epiphysis present on prothoracic leg tibia, mesothoracic leg with a pair of tibial spur and metathoracic leg with two pairs tibial spurs.

**Wing venation:** Forewing with Sc arising from base of wing, ending near 3/4th of costa, R1 arising near 3/4th of discal cell, accessory cell present, R2 arising from accessory cell, R3 and R4 long stalked, R5 to costa, R4 to termen, R5 connate with R5 and R4, M1 arising near upper angle of discal cell, M1, M2 and M3 free, M2 near to M3 basally than M1, CuA1, CuA2 free, CuA1 arising from lower angle of discal cell, CuA2 arising at 2/3rd of discal cell, discal cell elongated, closed. Anal vein 1A long and 2A small, separate; hindwing with R1 running into Sc from base of wing, joined by a bar with discal cell, Rs and M1, M2, M3 free, CuA2 arising near 2/3rd of discal cell, CuP not present, 1A+2A fused straight, 3A present, discal cell closed.

**Material examined:** India: Jammu & Kashmir, Srinagar, ix.1923, 3 ♂♂, leg. Fletcher; Jammu & Kashmir, Srinagar, 03-05.ix.2007, 10 ♂♂ leg. Rajesh Kumar.

3. *Macdunnoughia kashmirensis* sp. nov. Rajesh Kumar
(Figs. 7, 8, 9, 12, 17, 18, 25, 26 and 27)

**Alar expanse:** ♂ 3.35 ± 0.07 cm (n=2)

**Male:** Vertex, frons and thorax dark grey, thorax with a very large spreading tuft. Labial palpi upturned, second segment long, third segment small, reaching up to vertex of the head. Antennae simple in filiform, ciliated, reaching about 3/4th length of forewing. Abdomen dark brown, with three large dorsal tufts on basal segments. Forewing elongated, grayish, hooked at outer angle, metallic markings being more brassy, those near outer margin less diffused, the costal portion of the sub basal line silvery, the antemedial line angled below median nervure, the two portions of the Y-mark narrow and silvery. Hindwing dark fuscous-grey in colour; legs long, beset with long hairs, deep brown in colour. Epiphysis present on prothoracic leg tibia, mesothoracic leg with a pair of tibial spur and metathoracic leg with two pairs tibial spurs.

**Wing venation:** Forewing with Sc arising from base of wing, ending near 3/4th of costa, R1 arising near 3/4th of discal cell, accessory cell present, R2 arising from accessory cell, R3 and R4 long stalked, R3 to costa, R4 to termen, R5 connate with R3 and R4, M1 arising near upper angle of discal cell, M1, M2 and M3 free, M2 near
to M₃ basally than M₁, CuA₁, CuA₂ free, CuA₁ arising from lower angle of discal cell, CuA₂ arising at 2/3rd of cell, discal cell elongated, closed. Anal vein only 1A present; hindwing with R₈ running into Sc from base of wing, joined by a bar with discal cell, Rs and M₁, M₂, M₃ free, CuA₂ arising near 2/3rd of discal cell, CuP not present, 1A+2A fused straight, 3A not present, discal cell closed.

**Diagnosis:** The *M. kashmirensis* differs externally from its close relatives, *M. confusa* by the lack of attachment with ovate silvery arm at the lower end of Y mark stigma which is always attached in the *M. confusa*. The male genitalia of *M. confusa* can be separated from *M. kashmirensis* by numerous projections present on apical portion of the valvae.

**Material examined:** **Holotype:** India: Jammu & Kashmir, Srinagar, 05.iix.2007, ♂ leg. Rajesh Kumar. **Paratype:** Jammu & Kashmir, Srinagar, 05.iix.2007, ♂ leg. Rajesh Kumar.

**Etymology:** The new species is named after the specific locality of “Kashmir” Jammu and Kashmir (India) from where two specimens were collected.

**Discussion:** This species were collected from western Himalayan region (Srinagar, Jammu & Kashmir) only. Rapid and divergent evolution of genitalia is common in several insect taxa. The characteristics of the male genitalia play the most important role in their taxonomic classification (Lafontaine, 1987; Fibiger, 1990; Fibiger, 1997). In this paper, we specifically described a new species on the basis of male genitalia. We observed the old specimens and recent collected specimens from the same location and explored the male genital structures of *M. confusa* and *M. kashmirensis*. So we found that the recently collected specimens are different in wing spotting and male genital features. On the basis of wing spotting and male genital difference, described it as new species.

The difference found morphologically in *M. confusa* (attached speck with Y-mark on forewing) and *M. kashmirensis* (separate speck with Y-mark on forewing). Another difference found in male genitalia valvae, in which the valvae of *M. confusa* have numerous distinct projections while the valvae of *M. kashmirensis* have smooth rounded and only one indistinct projection. The sacculus extension found pointed at apex in the *M. confusa* and blunt in *M. kashmirensis*. The other characters of male genitalia i.e. saccus, harpae and aedeagus were also compared, but could not find any major differences in these characters, except in valvae and sacculus extension. On the basis of these characters, we described this as new species.

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**LITERAURE CITED**


CONTRIBUTIONS OF THE LONGHORNED BEETLES KNOWLEDGE OF TURKEY BY THE SUBFAMILIES PRIONINAE, LEPTURINAE AND LAMIINAE (COLEOPTERA: CERAMBYCIDAE)

Naciye Cihan*, Hüseyin Özdikmen* and Fatih Aytar**

* Gazi Universitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü, 06500 Ankara, TÜRKİYE. Emails: naciyecihan@windowslive.com; ozdikmen@gazi.edu.tr
** Eastern Mediterranean Forestry Research Institute, Dept. of Entomology, Tarsus-Mersin, TURKEY. E-mail: f_aytar@hotmail.com


ABSTRACT: The present work presents new contributions to the knowledge of the subfamilies Prioninae, Lepturinae, Dorcadioninae and Lamiinae that are 4 of 5 richest subfamilies in terms of diversity among cerambycids, of Turkey. The specimens for this study were collected over various years (2001-2012) from different localities in Adana, Balıkesir, Bolu, Düzce, İçel, Kahramanmaraş, Karaman, Muğla, Niğde and Osmaniye provinces in Turkey. As a result of the work, a total of 58 species (25 of them into subspecies level) belonging to 37 genera of 20 tribes of 4 subfamilies were determined from Turkey. One species of them is recorded from Turkey for the second time. Two species of them are the first record for Southern Turkey. Also, four species for Central Anatolian Region, six species for Mediterranean Region and three species for Eastern Mediterranean Region are recorded for the first time. Moreover, a total of forty-five species are the first record for various provinces (8 for Adana, 4 for Balıkesir, 14 for İçel, 3 for Kahramanmaraş, 10 for Niğde, 6 for Osmaniye) in Turkey. Furthermore, about 15% of the examined taxa in the present work comprise of endemic taxa for Turkey.

KEY WORDS: Coleoptera, Cerambycidae, new data, new records, Turkey.

According to Özdikmen (2012), Cerambycidae is divided into several subfamilies as Parandrinae, Prioninae, Lepturinae, Necydalinae, Aseminae, Saphaninae, Spondylidinae, Apatophyseinae, Cerambycinae, Stenopterinae, Dorcadioninae and Lamiinae.

Parandrinae are not represented in Turkey. Also, a total of 6 subfamilies as Necydalinae, Aseminae, Saphaninae, Spondylidinae, Apatophyseinae and Stenopterinae are represented with only some taxa in Turkey. So, only 5 subfamilies as Prioninae, Lepturinae, Cerambycinae, Dorcadioninae and Lamiinae have the richest diversity for Turkey.

In accordance with the status, the aim of present work is contributed to the knowledge of the subfamilies Prioninae, Lepturinae, Dorcadioninae and Lamiinae of Turkey on the base of Özdikmen (2007, 2008a,b, 2010, 2011, 2013).

MATERIAL AND METHOD

The specimens for this study were collected by the third author over various years (2001-2012) from different localities in Eastern Mediterranean Region (Adana, İçel, Kahramanmaraş and Osmaniye provinces), Central Anatolian Region (Niğde and Karaman provinces), Western Black Sea Region (Bolu and Düzce provinces), Marmara Region (Balıkesir province), Aegean Region (Muğla province) in Turkey and deposited in Entomology Department of Eastern Mediterranean Forestry Research Institute (İçel province, Turkey). All of the
specimens were determined by the authors. In this paper classification and nomenclature of the longhorn beetles suggested by Özdikmen (2012) are followed. Within the subfamilies all genera are listed in the same order as in Özdikmen (2012). Within the genera the species are listed alphabetically. Each name of a species or subspecies is accompanied by the author's name and description date.

RESULTS AND DISCUSSION

SUPERFAMILY CERAMBYCOIDEA Latreille, 1802

FAMILY CERAMBYCIDAE Latreille, 1802: 211

SUBFAMILY PRIONINAE Latreille, 1802: 212

TRIBE ERGATINI Fairmaire, 1864: 117

GENUS CALLERGATES Lameere, 1904: 47

SPECIES C. gaillardoti (Chevrolat, 1854: 481)


TRIBE MACROTOMINI Thomson, 1861: 312

GENUS PRINOBIUS Mulsant, 1842: 207

SPECIES P. myardi Mulsant, 1842: 207

SUBSPECIES P. m. atropos Chevrolat, 1854: 482

Material examined: İçel: Mut, 24.IV.2006, from wood of *Prunus armeniaca*, 2 specimens; Sadiye, 28.VII.2008, 1 specimen; Central, Toroslar, Aslanköy, 10.VI.2010, in the garden, 1 specimen.

TRIBE REMPHANINI Lacordaire, 1868: 103

GENUS RHAESUS Motschulsky, 1875: 153 [RN]

SPECIES R. serricollis (Motschulsky, 1838: 187)


TRIBE AEGOSOMATINI Thomson, 1861: 308

GENUS AEGOSOMA Audinet-Serville, 1832: 162

SPECIES A. scabricorne (Scopoli, 1763: 54)

Material examined: İçel: Central, Toroslar, Aslanköy, 26.VIII.2005, in the garden, 1 specimen; Niğde: Alıhoça, 07.VIII.2011, with net, 1 specimen.

Remarks: The species is the first record for İçel and Niğde provinces.

TRIBE PRIONINIA Latreille, 1802: 212

GENUS MESOPRIONUS Jakovlev, 1887: 323

SPECIES M. besikanus (Fairmaire, 1855: 318)


Remarks: The species is the first record for Niğde province.
SPECIES *M. lefebvrei* (Marseul, 1856: 47)
Material examined: Adana: Feke, 29.VII.2010, with net, 1 specimen; İçel: Tarsus, Karabucak, 17.IV.2003, light trap, 1 specimen; Gülmar, Büyükçekeli, 28.VI.2003, with net, 1 specimen; Tarsus, Ayvalı, 22.VI.2009, 2 specimens.
Remarks: The species is the first record for Adana and İçel provinces.

GENUS *PRIONUS* Geoffroy, 1762: 198
SPECIES *P. coriarius* (Linnaeus, 1758: 389)
Remarks: The species is the first record for Adana, İçel and Niğde provinces.

SUBFAMILY LEPTURINAE Latreille, 1802: 218
TRIBE RHAMNUSIINI Sama [in Sama and Sudre], 2009: 383
GENUS *RHAMNUSIUM* Latreille, 1829: 130
SPECIES *R. bicolor* (Schrank, 1781: 132)
SUBSPECIES *R. b. bicolor* (Schrank, 1781: 132)
Material examined: İçel: Erdemli, Güzeloluk, 28.VII.2011, on *Quercus infectoria*, 1 specimen.
Remarks: The species is the first record for İçel province and Mediterranean Region of Turkey and thereby the second record for Turkey.

SPECIES *R. testaceipenne* Pic, 1897: 299
Material examined: İçel: Anamur, Abanoz road, 23.VI.2005, on *Quercus cerris*, 1 specimen.
Remarks: The species is the first record for İçel province and Mediterranean Region of Turkey.

TRIBE RHAGIINI Kirby, 1837: 178
GENUS *RHAGIUM* Fabricius, 1775: 182
SUBGENUS *MEGARHAGIUM* Reitter, 1913: 6
SPECIES *R. syriacum* Pic, 1892: cxi
Remarks: The species is the first record for İçel and Niğde provinces and thereby Central Anatolian Region of Turkey.

SUBGENUS *RHAGIUM* Fabricius, 1775: 182
SPECIES *R. inquisitor* (Linnaeus, 1758: 393)
SUBSPECIES *R. i. fortipes* Reitter, 1898: 357
25.IV.2001, on Abies cilicica, 1 specimen; Alihoca, V-VII.2007, pheromone traps, 39 specimens; Osmaniye: Karatepe, 10.X.2005, from pupa, on Abies cilicica, 1 specimen; Karatepe, 20.VI.2006, on Abies cilicica, 1 specimen.
Remarks: The species is the first record for Adana, Kahramanmaraş, Niğde and Osmaniye provinces and Eastern Mediterranean Region of Turkey.

GENUS DINOPTERA Mulsant, 1863: 494
SUBGENUS DINOPTERA Mulsant, 1863: 494
SPECIES D. collaris (Linnaeus, 1758: 398)

GENUS CORTODERA Mulsant, 1863: 572
SPECIES C. omophloides Holzschuh, 1975: 77
Material examined: İçel: Gülnar, Kayrak, 18.V.2006, with net, 1 specimen; Erdemli, Sorgun road, 14.VI.2006, with net, 1 specimen; Osmaniye: Karatepe, Taurus, 14.VI.2006, on flower, 1 specimen.
Remarks: The species is the first record for Osmaniye province.

TRIBE LEPTURINI Latreille, 1802: 218
GENUS VADONIA Mulsant, 1863: 559
SUBSPECIES V. s. tauricola Holzschuh, 1993: 14
Material examined: İçel: Erdemli, Karahıdırlı, 16.VI.2008, on flower, 1 male specimen.

GENUS PSEUDOVDONIA Lobanov, Danilevsky & Murzin, 1981: 787
SPECIES P. livida (Fabricius, 1777: 233)
SUBSPECIES P. l. livida (Fabricius, 1777: 233)
Material examined: Adana: Pozantı, 09.VI.2008, on flower, 2 specimens; Feke, Süphandere, 14.VII.2009, 1 specimen; Karaisalı, 10.VIII.2010, on flower, 1 specimen; Karaisali-Yedigözelegen, 10.VIII.2010, on flower, 1 specimen; İçel: Anamur, Abanoz road, 23.VI.2005, 2 specimens; Çamlıyayla, Cehennemdere, 28.V.2006, 1 specimen; Çamlıyayla, Pamukkuk, 11.VI.2006, on flower, 2 specimens; Central, Toroslar, Ayvagediği,14-16.VI.2006, on flower, 3 specimens; Central, Toroslar, Aslanköy, 16.VI.2006, on flower, 1 specimen; Tarsus-Yalamık, 09.VII.2007, on flower, 1 specimen; Erdemli, Hacalaman, 30.VI.2009, on flower, 1 specimen; Silifke, Değirmendere, 29.IV.2009, with net, 1 specimen; Erdemli, Hacalaman, 27.V.2011, on flower, 1 specimen; Kahramanmaras: Göksun-Çardak, 29.VI.2009, on Sambucus sp., 1 specimen; Niğde: Alihoca, 15.V.2010, with net, 1 specimen; Alihoca, 06.VI.2010, with net, 1 specimen; Osmaniye: Karatepe- Taurus, 15.VI.2006, on Sambucus sp., 1 specimen; Karatepe- Taurus, 16.VI.2006, on Sambucus sp., 1 specimen.
Remarks: The species is the first record for Adana and Kahramanmaraş provinces.

GENUS ANOPLODERA Mulsant, 1839: 285
SUBGENUS ANOPLODERA Mulsant, 1839: 285
SPECIES A. rufipes (Schaller, 1783: 296)
SUBSPECIES A. r. rufipes (Schaller, 1783: 296)
Material examined: Balıkesir: Kazdağı, 08.VI.2011, on Cistus creticus, 1 specimen.
Remarks: The species is the first record for Balıkesir province.

GENUS STICTOLEPTURA Casey, 1924: 280
SUBGENUS STICTOLEPTURA Casey, 1924: 280
SPECIES S. cordigera (Fuessly, 1775: 14)
SUBSPECIES S. c. cordigera (Fuessly, 1775: 14)
Material examined: Adana: Karaisali, 10.VIII.2011, from wood of Quercus infectoria, 1 specimen; Balıkesir: Kazdağı, 11 and 15.VI.2011, on Cistus creticus, 2 specimens; İçel: Anamur, Kızılcakaya, 02.VI.2004, with net, 1 specimen; Anamur, Sarıyayla, 26.VI.2005, with net, 1 specimen; Gülbar, Aydincik road, 14.VII.2010, from wood of Quercus cerris, 1 specimen.
**SPECIES S. excisipes** (Daniel & Daniel, 1891: 6)

Remarks: The species is the first record for Adana province.

**SPECIES S. sambucicola** (Holzschuh, 1982: 65)
Material examined: İçel: Anamur, Aboz road, 23.VI.2005, on Sambucus sp., 1 specimen; Erdemli, Sorgun road, 14.VI.2006, on Sambucus sp., 1 specimen; Central, Ayvagediği, Taurus, 15.VI.2006, on Sambucus sp., 1 specimen; Central, Ayvagediği, Taurus, 14.VI.2006, on Sambucus sp., 1 specimen; Toroslar, Aslanköy, 10.VI.2010, on Sambucus sp., 1 specimen; Kahramanmaraş: Göksun, Çardak, 29.VI.2009, on Sambucus sp., 1 specimen; Karatepe, Taurus, 14.VI.2006, on Sambucus sp., 1 specimen; Karatepe, Taurus, 15.VI.2006, on Sambucus sp., 1 specimen.

Remarks: The species is the first record for Osmaniye province.

**GENUS ANASTRANGALIA** Casey, 1924: 280

**SPECIES A. dubia** (Scopoli, 1763: 47)
**SUBSPECIES A. d. dubia** (Scopoli, 1763: 47)
Material examined: Karaisalı, 10.VIII.2010, with net, 1 specimen; İçel: Hacialamı, 27.V.2011, pheromone trap, 1 specimen; Osmaniye: Karatepe, Taurus, 10.VI.2010, Carduus sp., 1 specimen.

Remarks: The species is the first record for Adana, Balıkesir and İçel provinces.

**SPECIES A. montana** (Mulsant & Rey, 1863: 179)
**SUBSPECIES A. m. montana** (Mulsant & Rey, 1863: 179)
Material examined: Adana: Feke, Buğlayan, 25.VI.2009, on flower, 2 specimens; Feke, Süphandere, 14.VII.2009, on flower, 1 specimen; İçel: Çamlıyayla, Cehennem dere, 28.V.2006, 1 specimen; Central, Toroslar, Kızılkaça village (Çamlıyayla part), 16.VI.2009, pheromone trap, 1 specimen; Erdemli, Hacialamı, 30.VI.2011, on plant, 4 specimens.

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

Remarks: The species is the first record for Adana province and Mediterranean Region and thereby also the first record for south half of Turkey.

**GENUS PEDOSTRANGALIA** Sokolov, 1897: 461
**SUGENUS NEOSPHENALIA** Löbl, 2010: 110

**SPECIES P. adaliae** Reitter, 1885: 390
Material examined: İçel: Gözne, Taurus, 30.IV.2004, with net, 1 specimen.

Remarks: The species is the first record for İçel province and Eastern Mediterranean Region of Turkey.

**SPECIES P. emmipoda** (Mulsant, 1863: 531)
Material examined: Adana: Pozanti, 09.VI.2008, 1 specimen; Karaisalı, 10.VIII.2010, on flower, 1 specimen; İçel: Mut, Dandi, 07.VI.2003, with net, 1 specimen; Anamur, Aboz road, 23.VI.2005, on Sambucus sp., 1 specimen; Erdemli, Sorgun road, 14.VI.2006, with net, 2 specimens; Central, Toroslar, Ayvagediği, 14.VI.2006, 1 specimen; Silifke, Değirmendere, 29.VI.2009, with net, 2 specimens; Niğde: Ali hoca, 15.IV.2006, with net, 1 specimen; Alihoca, 06.VI.2010, with net, 1 specimen.
GENUS CARLANDREA Sama & Rapuzzi, 1999: 467
SPECIES C. syriaca (Pic, 1891: 1)
Material examined: Niğde: Alihoca, 07.VIII.2011, with net, 1 specimen.
Remarks: The species is the first record for Niğde province and Central Anatolian Region.

GENUS JUDOLIA Mulsant, 1863: 496
SPECIES J. erratica (Dalman, 1817: 490)
SUBSPECIES J. e. erratica (Dalman, 1817: 490)
Material examined: Bolu: Şerifyük forest, 22.VI.2011, on flower, 1 specimen; Düzce: Şelale, 21.VI.2011, on flower, 1 specimen.

GENUS LEPTURA Linnaeus, 1758: 397
SUBGENUS LEPTURA Linnaeus, 1758: 397
SPECIES L. quadrifasciata Linnaeus, 1758: 398
SUBSPECIES L. q. quadrifasciata Linnaeus, 1758: 398
Material examined: İçel: Erdemli, Sorgun road, 28.VII.2011, with net, 1 specimen.
Remarks: The species is the first record for İçel province and Mediterranean Region of Turkey and thereby also for south Turkey.

GENUS RUTPELA Nakani & Ohbayashi, 1957: 242
SPECIES R. maculata (Poda, 1761: 37)
SUBSPECIES R. m. maculata (Poda, 1761: 37)
Material examined: Adana: Pozantı, 09.VI.2008, with net, 1 specimens; Karaisalı, 10.VIII.2010, on Rubus sp., 2 specimens; Balıkesir: Kazdağ, 13.VI.2011, on Cistus creticus, 1 specimen; İçel: Çamlıyayla, 27.V.2006, with net, 1 specimen; Çamlıyayla, Pamuklu, 11.VI.2006, on Rubus sp., 2 specimens; Erdemli, Karahıdırlı, 27.V.2011, on Rubus sp., 2 specimens; Osmaniye: Karatepe, Taurus, 14.VI.2006, on Rubus sp., 4 specimens.

GENUS STENURELLA Villiers, 1974: 217
SUBGENUS PRISCOSTENURELLA Öz dikmen, 2013: 516
SUBSPECIES S. bifasciata (Müller, 1776: 93)
SUBSPECIES S. b. nigrosuturalis (Reitter, 1895: 88)
Material examined: Adana: Pozantı, 09.VI.2008, on flower, 1 specimen; Feke, Buğlayan, 25.VI.2009, 1 specimen; Feke, Sıphandere, 14.VI.2009, on flower, 1 specimen; Karaisalı, Yedigözlüyên, 10.VIII.2010, on flower, 1 specimen; İçel: Erdemli, Sorgun road, 30.IV.2003, with net, 1 specimen; Mut, Dandi, 07.VI.2003 with net, 1 specimen; Gözne, 14.VI.2005, 1 specimen; Anamur, Abanoz road, 23.VI.2005, on flower, 1 specimen; Anamur, Sarıyayla, 26.VI.2005, on Cistus creticus, 2 specimens; Erdemli, Sorgun road, 14.VI.2006, on flower, 1 specimen; Central, Toroslar, Kızılkaya village, 16.VI.2009, on Cistus creticus, 1 specimen; Erdemli, Hacalani, pheromone traps, 14.VII.2011, 1 specimen, 28.VII.2011, 7 specimens, 11.VIII.2011, 4 specimens; Erdemli, Gülzeloluk, 28.VII.2011, on Cistus creticus, 1 specimen; Kahramanmaraş: Gökşun, Çardak, 29.VI.2009, on Sambucus sp., 2 specimens; Andırin, Akifiye, 27.VII.2010, with net, 1 specimen; Niğde: Alihoca, 15.V.2004, with net, 1 specimen; Alihoca, 06.VI.2010, on flower, 1 specimen; Osmaniye: Karatepe, Taurus, 15.VI.2006, on Sambucus sp., 1 specimen.
Remarks: The species is the first record for Niğde province.

SPECIES S. septempunctata (Fabricius, 1792: 346)
SUBSPECIES S. s. lateneigra (Pic, 1915: 5)
Material examined: Balıkesir: Kazdağ, 09-16.VI.2011, on Cistus creticus, 6 specimens; Bolu: Şerifyük forest, 23.VI.2011, on flower, 1 specimen; Düzce: Şelale, 21.VI.2011 on flower, 5 specimens.
Remarks: The species is the first record for Balıkesir province.
SUBFAMILY DORCADIONINAE Swainson, 1840: 290

TRIBE DORCADIONINI Swainson, 1840: 290

GENUS DORCADION Dalman, 1817: 397

SUBGENUS CIBRIDORCADION Pic, 1901: 12

SPECIES D. sauleyi Thomson, 1865: 549

SUBSPECIES D. s. sauleyi Thomson, 1865: 549

Material examined: İçel: Erdemli, Sorgun road, 30.IV.2003, with net, 1 specimen; Erdemli, Sorgun road, V.2003, with net, 1 specimen.

SPECIES D. seabricolle (Dalman, 1817: 174)

SUBSPECIES D. s. caramanicum K. Daniel & J. Daniel, 1903: 332

Material examined: İçel: Tarsus, Melemez, 28.III.2006, on herbaceous plant, 1 specimen.

SUBFAMILY LAMIINAE Latreille, 1825: 401

TRIBE BATOCERINI Thomson, 1864: 71

GENUS BATOCERA Dejean, 1835: 341

SPECIES B. rufomaculata (DeGeer, 1775: 107)

Material examined: Osmaniye: Karatepe, 27.VII.2011, from wood of Ficus carica, 1 specimen.

TRIBE MONOCHAMINI Gistel, 1848: [9]

GENUS MONOCHAMUS Dejean, 1821: 106

SUBGENUS MONOCHAMUS Dejean, 1821: 106

SPECIES M. galloprovincialis (Olivier, 1795: No. 67: 125)

SUBSPECIES M. g. tauricola Pic, 1912: 18


Remarks: The species is the first record for Balıkesir, Kahramanmaraş, Niğde and Osmaniye provinces.

TRIBE LAMIINI Latreille, 1825: 401

GENUS MORIMUS Brullé, 1832: 258

SPECIES M. orientalis Reitter, 1894: 43

Material examined: İçel: Central, 2002, 1 specimen.

Remarks: The species is the first record for İçel province and Eastern Mediterranean Region of Turkey. Probably the old records of M. funereus should be belonging to this species. Since, according to Sama & Löbl in Löbl & Smetana (2010), M. funereus does not occur in Turkey.
TRIBE PTEROPLIINI Thomson, 1860: 73
GENUS NIPHONA Mulsant, 1839: 169
SUBGENUS NIPHONA Mulsant, 1839: 169
SPECIES N. picticornis Mulsant, 1839: 169
Material examined: Adana: Karaiseda, 10.VIII.2010, from wood of Spartium junceum, 1 specimen; Iğd: Erdemli, beach, 01.VII.2006, from wood of Pistacia lentiscus, 1 specimen; Tarsus, Melemez, 22.III.2007, Rosmarinus officinalis, 1 specimen; Tarsus, Melemez, 25.VI.2007, on wood of Rosmarinus officinalis, 1 specimen; Silifke, Forest store, 19.VI.2008, from wood of Ficus carica, 1 specimen; Tarsus, Dörtler, 26.V.2009, from wood of Spartium junceum, 1 specimen; Musali, 10.IV.2010, from wood of Pistacia terebinthus, 1 specimen.
Remarks: The species is the first record for Adana province.

TRIBE POGONOCHERINI Mulsant, 1839: 151
GENUS POGONOCHERUS Dejean, 1821: 107
SUBGENUS POGONOCHERUS Dejean, 1821: 107
SPECIES P. perroudi Mulsant, 1839: 158
SUBSPECIES P. p. perroudi Mulsant, 1839: 158
Remarks: The species is the first record for Osmaniye province.

TRIBE ACANTHOCININI Blanchard, 1845: 154
GENUS ACANTHOCINUS Dejean, 1821: 106
SPECIES A. aedilis (Linnaeus, 1758: 392)
Remarks: The species is the first record for Iğd province and Eastern Mediterranean Region of Turkey.

SPECIES A. griseus (Fabricius, 1792: 261)
Remarks: The species is the first record for Osmaniye province.

**GENUS LEIOPUS** Audinet-Serville, 1835: 86
**SPECIES L. nebulosus** (Linnaeus, 1758: 391)
**SUBSPECIES L. n. nebulosus** (Linnaeus, 1758: 391)
Remarks: The species is the first record for İçel and Niğde provinces and thereby Eastern Mediterranean Region and Central Anatolian Region of Turkey.

**TRIBE TETROPINI** Portevin, 1927: 39
**GENUS TETROPS** Stephens, 1829: 16
**SPECIES T. praeustus** (Linnaeus, 1758: 399)
**SUBSPECIES T. p. anatolicus** Özdikmen & Turgut, 2008: 267

**TRIBE SAPERDINI** Mulsant, 1839: 181
**GENUS SAPERDA** Fabricius, 1775: 184
**SUBGENUS COMPSIDIA** Mulsant, 1839: 182
**SPECIES S. quercus** Charpentier, 1825: 224
**SUBSPECIES S. q. ocellata** Abeille de Perrin, 1895: CCXXIX

**TRIBE PHYTOECINI** Mulsant, 1839: 191
**GENUS OXYLIA** Mulsant, 1862: 398
**SPECIES O. argentata** (Ménétriés, 1832: 227)
**SUBSPECIES O. a. languida** (Ménétriés, 1839: 42)
Material examined: İçel: Erdemli, Güney village, 15.IV.2008, from root of *Carduus* sp., 1 specimen.

**GENUS MALLOSIA** Mulsant, 1862: 399
**SUBGENUS ANATOLOMALLOSIA** Özdikmen & Aytar, 2012: 656
**SPECIES M. nonnigra** Özdikmen & Aytar, 2012: 656
Material examined: İçel: Erdemli, Sorgun road, 30.IV.2003, with net, 1 specimen.
Remarks: The species was described by Özdikmen & Aytar (2012) on the base of the specimen.

**GENUS COPTOSIA** Fairmaire, 1864: 177
**SUBGENUS COPTOSIA** Fairmaire, 1864: 177
**SPECIES C. bithynensis** (Ganglbauer, 1884: 573)
Material examined: Niğde: Ali hoca, 06.VI.2008, with net, 1 specimen.
Remarks: The species is the first record for Niğde province and Central Anatolian Region of Turkey.

**GENUS PHYTOECIA** Dejean, 1835: 351
**SUBGENUS PILEMIA** Fairmaire, 1864: 175
**SPECIES P. hirsutula** (Frölich, 1793: 141)
**SUBSPECIES P. h. hirsutula** (Frölich, 1793: 141)
Material examined: İçel: Tarsus- Karabucak, 17.IV.2008, light trap, 1 specimen; Gülner, Gezende, 13.VII.2011, 1 specimen.

**SUBGENUS HELLADIA** Fairmaire, 1864: 176
**SPECIES P. humeralis** (Waltl, 1838: 471)
**SUBSPECIES P. h. caneri** Özdikmen & Turgut, 2010: 331
Material examined: İçel: Tarsus, Karabucak, 06.IV.2011, on *Carduus* sp., 3 specimens.
Remarks: The species is the first record for İçel province.
SUBGENUS **MUSARIA** Thomson, 1864: 121  
**SPECIES** *P. puncticollis* Faldermann, 1837: 291  
**SUBSPECIES** *P. p. puncticollis* Faldermann, 1837: 291  
Material examined: İçel: Değirmençay, 04.IV.2008, with net, 1 specimen.  
Remarks: The species is the first record for İçel province and Mediterranean Region of Turkey.

SUBGENUS **NEOMUSARIA** Plavilstshikov, 1928: 123  
**SPECIES** *P. merkli* Ganglbauer, 1884: 560  

SUBGENUS **PHYTOECIA** Dejean, 1835: 351  
**SPECIES** *P. croceipes* Reiche & Saulcy, 1858: 17 [RN]  
Material examined: İçel: Central, Toroslar, Yeniköy, 21.V.2009, with net, 3 specimens.

**SPECIES** *P. geniculata* Mulsant, 1862: 420  
Material examined: İçel: Tarsus, Karabucak, 16.IV.2009, on *Carduus* sp., 2 specimens; Tarsus, Hal, 22.IV.2009, 1 specimen; Celebili, 21.V.2009, with net, 1 specimen; Yenişehir, 25.III.2010, on *Carduus* sp., 3 specimens; Tarsus, Karabucak, 06.IV.2011, on *Carduus* sp., 11 specimens; Erdemli, Sorgun road, 28.VII.2011, with net, 1 specimen.

SUBGENUS **OPSILIA** Mulsant, 1862: 387  
**SPECIES** *P. coerulescens* (Scopoli, 1763: 49)  

TRIBE **AGAPANTHIINI** Mulsant, 1839: 172  
**GENUS** **CALAMOBIUS** Guérin-Méneville, 1847: XVIII  
**SPECIES** *C. filum* (Rossi, 1790: 152)  
Material examined: Adana: Pozanti, 09.VI.2008, on *Poaceae* with net, 1 specimen; İçel: Silifke, Değirmendere, 25 and 29.IV.2009, from root of *Sorghum halepense*, 3 specimens; Erdemli, Karahıdır, 27.V.2011, on *Poaceae* with net, 1 specimen; Central, Toroslar, Kızılcaha, 16.VI.2009, on *Poaceae*, 1 specimen; Central, Toroslar, Kızılcaha, 16-17.VI.2009, from root of *Avena sterilis*, 1 specimen; Gülmar, 12 and 13.VII.2011, 9 specimens; Muğla: Fethiye, 25.V.2010, on *Poaceae*, 1 specimen; Osmaniye: Nurdağı, 16.IX.2011, 1 specimen.

**GENUS** **AGAPANTHIA** Audinet-Serville, 1835: 35  
**SUBGENUS** **SYNTHAPSIA** Pesarini & Sabbadini, 2004: 121  
**SPECIES** *A. kirbyi* (Gyllenhal, 1817: 186)  
Material examined: İçel: Gülmar, Köseçobanlı, 07.V.2012, *Carduus* sp., 1 specimen.

**SPECIES** *A. kindermanni* Pic, 1905: 13  

**SPECIES** *A. lateralis* Ganglbauer, 1884: 541  
Material examined: İçel: Çamlıyayla, Dikenlioluk, 27.VI.2006, root of *Carduus* sp., 1 specimen.
SUBGENUS AGAPANTHIA Audinet-Serville, 1835: 35
SPECIES A. suturalis (Fabricius, 1787: 149)

SUBGENUS SMARAGDULA Pesarini & Sabbadini, 2004: 128
SPECIES A. pesarinii Sama & Rapuzzi, 2010: 177
Material examined: Adana: Karaisalı, 10.VIII. 2010, with net, 1 specimen; İçel: Erdemli, Sorgun road, 10.VI.2006, with net, 1 specimen.

Consequently, a total of 8 species among the examined 58 species are endemic to Turkey as Cortodera omophloides, Vadonia soror, Carlandrea syriaca, Dorcadion sauleyi, Mallosia nonnigra, Coptosia bithynensis, Agapanthia kindermanni and Agapanthia lateralis. Namely, about 15% of the examined taxa in the present work comprise of endemic taxa.

A total of 45 species are the first records for different provinces as follows:
A total of 8 species are the first records for Adana province [two species of the subfamily Prioninae as Mesoprionus lefebvrei and Prionus coriarius, five species of the subfamily Lepturinae as Rhagium inquisitor, Pseudovadonia livida, Stictoleptura cordigera, Anastrangalia dubia and A. sanguinolenta, one species of the subfamily Lamiinae as Niphona picticornis].
A total of 4 species are the first records for Balıkesir province [three species of the subfamily Lepturinae as Anoplodera rufipes, Anastrangalia dubia and Stenurella septempunctata, one species of the subfamily Lamiinae as Monochamus galloprovincialis].
A total of 14 species are the first records for İçel province [three species of the subfamily Prioninae as Aegosoma scabricorne, Mesoprionus lefebvrei and Prionus coriarius, six species of the subfamily Lepturinae as Rhamnusium bicolor, R. testaceipenne, Rhagium syriacum, Anastrangalia dubia, Pedostrangalia adaliae and Leptura quadrifasciata, five species of the subfamily Lamiinae as Morimus orientalis, Acanthocinus aedilis, Leiopus nebulosus, Phytoecia humeralis and P. puncticolis].
A total of 3 species are the first records for Kahramanmaraş province [two species of the subfamily Lepturinae as Rhagium inquisitor and Pseudovadonia livida, one species of the subfamily Lamiinae as Monochamus galloprovincialis].
A total of 10 species are the first records for Niğde province [three species of the subfamily Prioninae as Aegosoma scabricorne, Mesoprionus besikanus and Prionus coriarius, four species of the subfamily Lepturinae as Rhagium syriacum, R. inquisitor, Cortodera syriaca and Stenurella bifasciata, three species of the subfamily Lamiinae as Monochamus galloprovincialis, Leiopus nebulosus and Coptosia bithynensis].
A total of 6 species are the first records for Osmaniye province [three species of the subfamily Lepturinae as Rhagium inquisitor, Cortodera omophloides and Stictoleptura sambucicola, three species of the subfamily Lamiinae as Monochamus galloprovincialis, Pogonocherus perroudi and Acanthocinus griseus].
A total of 6 species are the first records for Eastern Mediterranean Region [one species of the subfamily Lepturinae as Pedostrangalia adaliae, two species of the subfamily Lamiinae as Acanthocinus aedilis and Leiopus nebulosus].
A total of 6 species are the first records for Mediterranean Region [four species of the subfamily Lepturinae as Rhamnusium bicolor, R.
testaceipenne, Anastrangalia sanguinolenta and Leptura quadrifasciata, two species of the subfamily Lamiinae as Morimus orientalis and Phytoecia puncticollis].

A total of 4 species are the first records for Central Anatolian Region [two species of the subfamily Lepturinae as Rhagium syriacum and Cortodera syriaca, two species of the subfamily Lamiinae as Leiopus nebulosus and Coptosia bithynensis].

A total of 2 species are the first records for South Turkey [two species of the subfamily Lepturinae as Anastrangalia sanguinolenta and Leptura quadrifasciata].

Finally, 1 species is the second record for Turkey [subfamily Lepturinae as Rhamnusium bicolor].

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

LITERATURE CITED


**FIELD EFFICACY OF BIOPESTICIDES AND PESTICIDE COMBINATIONS AGAINST WHITEFLY INFESTING GERBERA**

Shivani Jaggi Guleria*

* Department of Chemistry, Maya Institute of Technology & Management, Selaqui, Dehradun, Uttarakhand, INDIA. E-mail: shivani_jaggi@yahoo.com


**ABSTRACT:** Whiteflies (Trialeurodes vaporariorum) are one of the most intricate pests to control in gerbera grown under polyhouse conditions. Whiteflies have shown an ability to develop resistance to many pesticides so an attempt was made to test various pesticide biopesticides combinations. To test the efficacy of some pesticide, biopesticides, their combinations and cow urine extract against whitefly in gerbera an experiment was designed at Badamawala polyhouse, Vikasnagar Dehradun during 2011. An experiment was conducted in polyhouse conditions to evaluate and compare the effectiveness of synthetic pesticides (Imidacloprid-T1 and T2, Acetamiprid-T3 and T4), biopesticides (NeemAzal-T5), their combinations (T6-T1+T5, T7-T3+T5) and extract containing cow urine and garlic paste (T8). Whitefly population was assessed by randomly selecting 5 flowers along with stem and leaves for each replicate just before the spray (pre count) and 1st, 5th, 7th and 10th day after spray (post count). Monitoring the population during the test period revealed that all the treatments were found superior over the control as per mean whitefly population count. In addition the spray of cow urine extract also showed results parallel with the treatment T5. Besides the extract of cow urine fermented with garlic extract showed good efficacy against white fly suggesting a prospect for organic production of gerberas in India.

**KEY WORDS:** Gerbera, white fly, efficacy, biopesticides.

Polyhouse cultivation of flowers in India is of latest origin and is being gradually practiced for production of quality produce for export. Gerbera L. is a genus of ornamental plants from the sunflower family. In polyhouses gerbera is highly susceptible to various pests and diseases. Among them whiteflies, spider mites, cut worm and leaf miners takes the major share in reducing the flower yield. White flies are the major pests of greenhouse crops. They attack more than 500 species of food, fiber and ornamental plants such as gerbera and cause crop losses which amounts to hundreds of millions of dollars as informed by (Gerling & Mayer, 1996). When there infestation becomes excessive, the most noticeable symptom is a yellow tinge on the daisy’s leaves. They attack themselves as pupa to the underside of a gerbera daisies leaves. When they mature, they inhibit the daisy’s bloom growth by draining it of its sap and other vital nutrients. They reproduce quickly, like to hide on parts of the plant which makes it hard to reach when spraying and have certain stages which are not susceptible to chemicals.

A wide range of pesticides are used in the cultivation of gerbera (Cresswell et al., 1994; George et al., 1994). But pesticides cause toxicity to humans and warm-blooded animals and may also kill the beneficial insects. Therefore, there is a need to use biopesticides and various pesticide biopesticides combinations which are effective, biodegradable and do not leave any harmful effect on the environment. Few studies have been cited in the literature where biopesticides were used for the control of white flies. The effective use of biopesticide for the control of white flies was shown by a group of researchers. (George et al., 2007; Menke & Gerhard, 2010).

Imidacloprid and Acetamiprid are the commonly used pesticides in the control of whitefly in gerbera but they have shown reduced flower production and
residual problems when used at recommended and double the recommended dose. Currently most of the works about pesticides in gerbera is focused on the study of fate of these pesticides in gerbera. The studies related to the pesticide fate were shown by various groups of researchers. (Oliver & Meyhofer, 2008; Hatzilazarou et al., 2004; Romero et al., 2011; Benson & Parker, 2011). But the information regarding bioefficacy of various pesticides and biopesticides combinations are limited. Various pesticide and biopesticide combinations for the control of pests were tried by different research groups (Khanapara & Kapadia, 2011; Meena & Khan, 2006, Olaitan & Abiodun, 2011). Due to incomplete literature found on the study of pesticides biopesticides combination in gerbera plantation a study was initiated to study the field efficacy of various pesticide and biopesticides combinations against whitefly in gerbera grown in poly house conditions.

MATERIALS AND METHODS

Working solutions
For the field studies, Acetamiprid (Prime 20 SP) and Imidacloprid (Confidor 200 SC) and the biopesticide Neem Azal (T/S 1%) were procured from the local market.

Cow urine garlic extracts preparation
25 g of garlic paste is added to 5 litres of cow urine and 5 litres of water. The mixture is mixed well and kept for fermentation for 5 days. The mixture is filtered and mixed with 10 litres of water containing 2 tablespoons of liquid detergent.

Trials
A field trial was conducted to study the bioefficacy of the biopesticides alone and in combination with pesticides in polyhouse conditions at Paachamiwala farm, Vikasnagar, Dehradun, Uttarakhand, India during 2011 with eight different treatments replicated thrice. The treatments were laid in complete randomized block design with three replicates. For these experiments flower beds of yellow flowers were selected. The spacing between the rows should be 30-40 cm and 25-30 cm within the row accommodating 8-10 plants/m². The experiment was carried out with 8 different treatments (T₁-Imidacloprid, recommended dose T₂-double the recommended dose, T₃-Acetamiprid, recommended dose T₄-double the recommended dose, T₅=NeemAzal, T₆=T₁+T₅ and T₇=T₃+T₅) and T₈=Cow urine and garlic paste. The treatments were imposed using Knapsack sprayer. The selected plants were heavily infested with whiteflies. Spray was done during day time with temperature averaging 30-35°C. Whitefly population was assessed by randomly selecting 5 flowers along with stem and leaves for each replicate. Unsprayed plots were included as control.

The white fly on the leaf were recorded with the help of 10 X hand lens. The growth parameters like total number of good flowers, diameter of opened flower and quality of flowers like unopened, discolored and malformed flowers were observed. The mean populations of whitefly were worked out and the data were arc sine transformed and tabulated to deduce the results.

RESULTS

The efficacy ratings presented here are based on the results of field studies. The bioefficacy of biopesticides alone and in combination with insecticides against whitefly was tested under polyhouse conditions. The experimental data tabulated in Table 1 showed significant reduction in whitefly population in all the
treatments over the control. All the treatments were found significantly superior showing high mortality of whitefly with respect to the control. Among the treatments T7 and T6 showed superior efficacy on bringing down whitefly population followed by treatment T2, T1, T4, T3, T5 and T6. A single spray with treatment T6 killed all the nymphs in 10 days without apparent damage to the plants. The results revealed that there was a significant difference in percentage reduction at each observation days. After 1st day, the treatment T4 showed highest percentage reduction (81.34% reduction) followed by T2, T6 and T7. Data recorded after 5 days have shown T6 (84.34% reduction) to be superior followed by T2 and T4. After 7th and 10th day treatments T7 and T6 produced better results (90.86 and 88.71% reduction respectively). The compiled results thus show that the biopesticide and pesticide combinations have shown better results in percentage reduction of whitefly as compared to the pesticide taken alone. The efficacy study with treatment T8 is at par with the treatment T5 which suggest that treatment T8 can be developed as an effective biopesticide after selecting a suitable ratio and preparing an emulsified solution.

Growth parameters were also recorded to see the overall effects of the combination products of pesticides and biopesticides. Results of various growth parameters like flower yield, diameter, stalk length and vase life are tabulated in Table 2. The data presented in Table 2 revealed that Treatment T7 and T6 showed comparative better results as far as flower yield, diameter, stalk length and vase life is concerned. The results tabulated in table 2 have shown that there were 245 flowers/sq mt in case of treatment T6 and 244 flowers/sq mt for treatment T7 as compared to 95 flowers/sq mt in case of control. When the diameters and stalk length of the flowers were compared the pesticide biopesticide combinations have shown a healthy flower (diameter 11 cm both for treatment T6 and T7 and stalk length 46 and 48 cm for T6 and T7) respectively as compared to the control which was infested with whitefly. Even the vase life of the flower in plot treated with T6 and T7 was 9.5 and 10.5 days respectively.

**DISCUSSION**

The promising effect of pesticide biopesticide combinations against whitefly which have increased the yield in the present investigation agreed with the finding of one of the research group (Khanapara & Kapadia, 2011). According to their findings the combinations of pesticide biopesticide were effective against Helicoverpa armigera on pigeonpea. Meena & Khan (2006) has also shown positive results when pesticide biopesticide combinations were taken against Spilaretia oblique on Soyabean.

Similar study using pesticide biopesticide combinations were done by Boricha et al. (2010) where various combinations were effectively used against whitefly infesting cotton. Results shown by treatment T8 were also at par with treatment T5 which indicates that mixture of cow urine and garlic paste at various ratios can prove to be an effective biopesticide. Whitefly population can be controlled and managed effectively and economically by applying well emulsified solution of cow urine and garlic paste. The quantitative data indicates that the biopesticides if used in combinations with synthetic pesticide showed best result in controlling the whitefly population without apparent damage to plants. These treatments also maximized the marketable flower yield.
CONCLUSION

On the basis of results obtained from field trials among the pesticide/biopesticides applied, Treatment T6 and T7 significantly reduced the whitefly population. Treatments T8 were also found to be effective compared to untreated control. Half dose of chemicals along with half dose of botanicals reduces the pesticide load on the crop and also cost of the treatment which in turn safeguards the natural enemies. The combinations if used will lower the cost of production incurred by farmers, allow increase of whitefly natural enemy and reduce resistance developed by pest to the synthetic pesticides. Hence, the mixture of the new molecules with botanicals and mycopathogens can be included in the IPM strategy in gerbera cultivation.

ACKNOWLEDGEMENT

Author is greatful to Mr. Saurabh Guleria for providing the necessary facilities for carrying out the trials in polyhouse conditions.

LITERATURE CITED


Table 1. Effect of pesticides and biopesticides and their combinations on the population of white flies in Gerbera at Paachamiwala farm Vikasnagar, Dehradun Uttarakhand.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Dosage</th>
<th>1st DAS</th>
<th>5th DAS</th>
<th>7th DAS</th>
<th>10th DAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>0.5 ml/l</td>
<td>70.52(57.11)</td>
<td>75.54(60.35)</td>
<td>82.06(64.94)</td>
<td>84.7(66.97)</td>
</tr>
<tr>
<td>T₂</td>
<td>1 ml/l</td>
<td>76.54(61.029)</td>
<td>82.06(64.94)</td>
<td>84.32(66.67)</td>
<td>85.97(68.97)</td>
</tr>
<tr>
<td>T₃</td>
<td>0.4 g/l</td>
<td>74.16(59.44)</td>
<td>79.71(63.22)</td>
<td>79.32(62.95)</td>
<td>80.63(63.47)</td>
</tr>
<tr>
<td>T₄</td>
<td>0.8 g/l</td>
<td>81.34(64.40)</td>
<td>81.56(64.56)</td>
<td>84.08(66.48)</td>
<td>84.86(67.10)</td>
</tr>
<tr>
<td>T₅</td>
<td>3 ml/l</td>
<td>68.37(55.57)</td>
<td>71.23(57.56)</td>
<td>74.84(59.59)</td>
<td>76.81(61.21)</td>
</tr>
<tr>
<td>T₆</td>
<td>1:3 v/v</td>
<td>75.65(60.4)</td>
<td>84.34(66.68)</td>
<td>85.16(67.34)</td>
<td>88.71(70.36)</td>
</tr>
<tr>
<td>T₇</td>
<td>1:3 v/v</td>
<td>74.26(59.51)</td>
<td>75.18(60.11)</td>
<td>85.56(67.66)</td>
<td>90.86(72.40)</td>
</tr>
<tr>
<td>T₈</td>
<td>64.32(53.32)</td>
<td>73.32(58.90)</td>
<td>74.36(59.57)</td>
<td>75.96(60.63)</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>8.32(16.76)</td>
<td>8.36(16.80)</td>
<td>8.4(16.84)</td>
<td>8.42(16.86)</td>
</tr>
</tbody>
</table>

DAS-Days after spray
Figure in parenthesis are arc sin√p values

Table 2. Growth Parameters of flowers with different treatments.

<table>
<thead>
<tr>
<th>Growth parameters of Flowers</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
<th>T₅</th>
<th>T₆</th>
<th>T₇</th>
<th>T₈</th>
<th>Untreated Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowers/sq.mt</td>
<td>240</td>
<td>242</td>
<td>232</td>
<td>236</td>
<td>156</td>
<td>245</td>
<td>244</td>
<td>152</td>
<td>95</td>
</tr>
<tr>
<td>Diameter cm</td>
<td>8.5</td>
<td>8.0</td>
<td>9</td>
<td>7.5</td>
<td>9</td>
<td>11</td>
<td>11.6</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Stalk length cm</td>
<td>32</td>
<td>36</td>
<td>40</td>
<td>38</td>
<td>36</td>
<td>46</td>
<td>44</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>Vase life days</td>
<td>8.5</td>
<td>9.0</td>
<td>8.0</td>
<td>8.2</td>
<td>8.0</td>
<td>9.5</td>
<td>10.5</td>
<td>7.5</td>
<td>6.5</td>
</tr>
</tbody>
</table>
SCIENTIFIC NOTES

NEW PESTS OF KESSERU, HETEROPANAX FRAGRANS (ROXB.) SEEM A PERENNIAL HOST PLANT OF ERI SILKWORM, SAMIA RICINI (DONOVAN)

M. C. Sarmah*, S. A. Ahmed* and B. N. Sarkar*

* Central Muga Eri Research & Training Institute, Central Silk Board, Ministry of Textiles, Govt. of India, Lahdoigarh, Jorhat 785700, Assam, INDIA. E-mail: mridulcsbsarmah@yahoo.co.in


The eri silkworm, Samia ricini (Donovan) is multivoltine and polyphagous in nature feeding on a number of host plants namely Castor, Ricinus communis, Kesseru, Heteropanax fragrans, Tapioca, Manihot utilissima, Payam, Evodia flaxinifolia, Barpat, Ailanthus grandis, Borkesseu, Ailanthus excels and several others. Kesseru (Heteropanax fragrans, Seem) belongs to Ginseng family Araliaceae. It ranks second among all the food plant of eri silkworm Samia ricini (Donovan) next to castor. It is perennial in nature and is widely distributed in the North Eastern States of India, both in wild and cultivated condition. Kesseru plants grow up to 1000 m MSL. Kesseru leaves are coarse and fibrous. The Kesseru fed eri cocoons are compact and take more time for degumming during spinning. Actually, Kesseru is used as an alternative food plant of eri silkworm during shortage of castor leaves. Kesseru is used as the best alternative food plant for eri silkworm rearing (Phukan, 2006). It is widely distributed in the North Eastern States of India, both in wild and cultivated condition. Kesseru is extensively utilized under developmental scheme of Govt. of India, like augmentation of eri food plant programme at farmers level in the North Eastern region of India.

Kesseru is less susceptible to disease and pest. Occasionally, pest like termite and a nocturnal beetle caused damage to kesseru (Sarmah, 2004). There are different genotype of Kesseru exist in nature. So far, 10 accessions of kesseru viz., HF 001, HF 002, HF 001, HF 003, HF 004, HF 005, HF 006, HF 007, HF 008, HF 009 and HF 010 has been identified and maintained in the Germplasm Bank of Central Muga Eri Research & Training Institute at Chenijan, Assam (Fig. 1).

During regular monitoring of diseases and pests of Kesseru in different seasons a new Pyralid Lepidopteran pest leafroller (Fig. 3) has been identified infesting kesseru foliage causing 100% defoliation (Fig. 2) out of 2% plantation of HF002 accession. Another, new pest of Brown Bug, Agonoscellis nubile Fab. (Hemiptera: Pentatomidae) infesting on Kesseru, Heteropanax fragrans (Roxb.) Seem recorded during summer season (Fig. 4).

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Figures 1-2. 1) Kesseru plantation, 2) A defoliated kesseru infested by Leafroller.

Figures 3-4. 3) Pest on the leaves, 4) Brown Bug, *Agonoscellis nubile* Fab.
SCIENTIFIC NOTES

NEW RECORD OF A NATURAL ENEMY ON MULBERRY
WHITE FLY, DIALEUROPORA DECEMPUNCTA
(QUAINTANCE & BAKER) IN ASSAM

Yumnam Debaraj*, S. N. Gogoi*,
T. K. Biswas* and B. B. Bindroo**

* Regional Sericultural Research Station, Jorhat-785005, INDIA. E-mail: yumnamdebaraj@yahoo.com
** Central Sericultural Research and Training Institute, Berhampore-742101, INDIA.

In Eastern and North Eastern regions of India, the banded winged whitefly, Dialeuropora decempuncta (Quaintance & Baker) (Homoptera: Aleyrodidae) is a serious pest of mulberry and responsible for loss of about 24% mulberry leaf yield production during post-monsoon season (Bandyopadhyay et al., 2000, 2001; Rajkhowa & Chakravorty, 2004). The Economic Threshold Level of whitefly is found to be 20 nos./plant. Due to heavy infestation leaf quality deteriorates resulting chlorosis, leaf curl, depletion of leaf moisture, dryness of leaves in the initial stages and causing sooty mould on the later stages of the infestation (by nymphal stages). These entire symptoms make the leaves unfit for silkworm rearing. Eggs are deposited on the lower surface of leaves. Nymphs suck the juice and secrete honeydew which acts as a medium for the growth of sooty mould fungus, ultimately forms a black coating on the upper surface of mulberry leaves. This affects the photosynthesis of mulberry leaves and results in low nutritive value, renders them unfit for silkworm rearing. From the previous studies, it is established that due to whitefly infestation, crop loss in mulberry silkworm rearing was upto 5 kg cocoons/ 100 dfl (disease free layings).

For the management of this pest, different chemical insecticides (0.1% dimethoate/ 0.1% dichlorvos/ 0.02% monocrotophos) are recommended. However, due to indiscriminate use of the chemical insecticides the pests develop resistance and pose serious threat to the environment and mulberry ecosystem particularly the natural enemies of the whitefly (Bandyopadhyay et al., 2005).

Maximum incidence of the pest was found during autumn season, during which the most favourable silkworm crop is being conducted due to congenial climatic conditions in this region. Farmers used to rear high yielding silkworm races / breeds during this crop. Unless these breeds are supplied with good quality mulberry leaves, the silkworm crop may not be succeeded.

A total of 10 native predators and two Hymenopteran parasitoids were recorded on whitefly as natural enemies. The incidence of whitefly and its natural enemies was studied in West Bengal (Bandyopadhyay & Santhakumar, 2001-02). The biology and feeding efficacy of two native predators of whitefly viz, Micraspis discolor and Brumoides suturalis (Coleoptera: Coccinellidae) have been worked out (Santhakumar & Bandyopadhyay, 2001-02). However, no studies have been conducted about the coccinellid predators as bio-control agent against whitefly in Assam and North East India. Hence, an attempt was made in the present study to
survey and identify the efficient predators for the management of whitefly on mulberry.

In view of the serious threat posed by the pest in mulberry ecosystem, a regular survey was conducted in Jorhat district of Assam, India in 2009-2011 in the mulberry fields for collection of natural enemies of whitefly. The grubs and adult predators were collected from the mealy bug and whitefly colonies infesting mulberry along with the infested shoots. These grubs and adults were reared in the laboratory providing sufficient food for adult emergence and further observation. The newly emerged adult was identified as Scymnus posticalis Sicard (Coleoptera : Coccinellidae). This is the first report of the predator as new record feeding on mulberry whitefly, Dialeuropora decempuncta in Assam (Fig. 1-4).

The adult predator beetles are small and dark brown in colour. Males are 1.88 × 1.16 mm and females are 2.56 × 1.24 mm in sizes. Eggs are light yellow in colour. There are four instars in the grub stages with thick white waxy covering. The size of a matured grub was 3.49 × 1.60 mm. The grub stage was followed by prepupal and pupal stages. The larval period was completed in 13.71 days. The life cycle from egg to adult was completed in 28.0 days. The biological studies of the predator can be taken up in the laboratory for management of whitefly in mulberry.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. J. Poorani, Principal Scientist, National Bureau of Agriculturally Important Insects, ICAR, Bangalore, India for identification of the predator.

LITERATURE CITED


Figures 5-6. 5) Mulberry leaf infested by whitefly nymphs, 6) Heavily infested tender leaves by adult whitefly.